Contents

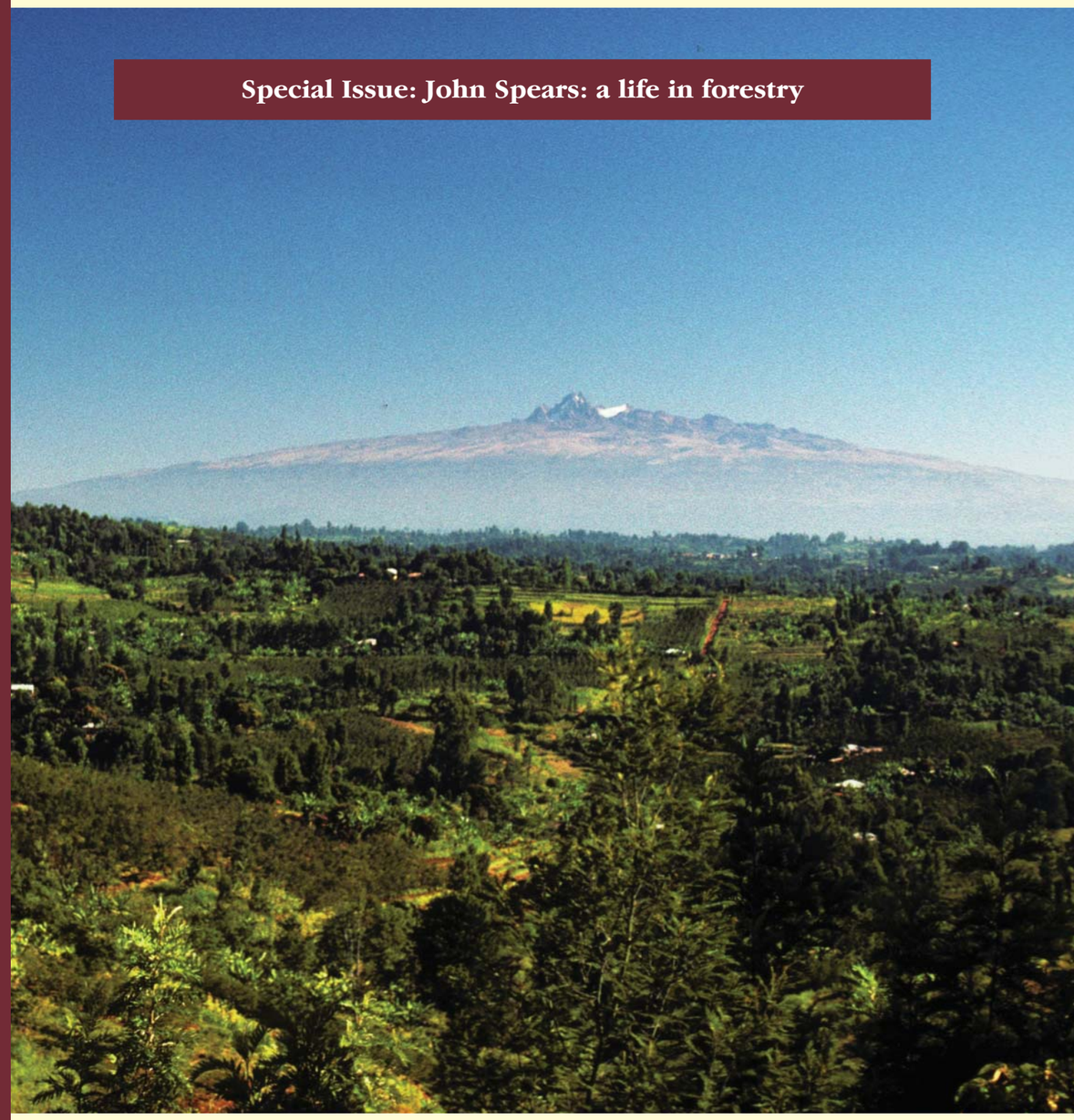
PROFOR
INNOVATION AND ACTION FOR FORESTS

THE INTERNATIONAL FORESTRY REVIEW Vol. 22 (S1), 2020

The International Forestry Review

COMMONWEALTH FORESTRY ASSOCIATION 1921

Special Issue: John Spears: a life in forestry



EDITORS: P.A. DEWEES, N. KISHOR AND A.J. POTTINGER

International Forestry Review (print) ISSN 1465-5489
International Forestry Review (online) ISSN 2053-7778

PROFOR INNOVATION AND ACTION FOR FORESTS

Vol.**22**(S1), 2020

PUBLISHED BY THE COMMONWEALTH FORESTRY ASSOCIATION www.cfa-international.org

The International Forestry Review

Contact

The Editor, International Forestry Review,
The Crib, Dinchope, Shropshire SY7 9JJ, UK
Telephone: +44 (0)1588 672868
Email: cfa@cfa-international.org,
Web: www.cfa-international.org

Cover photo: Mt. Kenya from Muranga District. (*Credit: Peter Dewees*)

GUIDELINES FOR AUTHORS

Please send the Summary of the paper to the Editor at cfa@cfa-international.org. If it is considered suitable for consideration you will be asked to send the complete manuscript.
Manuscripts submitted for consideration must conform to the following points. Any deviation will result in the manuscript being returned to the author.

COMPOSITION
- Contributions must be original* and not have been submitted for publication elsewhere.
  (Note: Plagiarism is evaluated by use of electronic software. For more information on what constitutes plagiarism, and why it is important please click here).
- The text, excluding tables, references and appendices, should not exceed 7000 words, although exceptions may be permitted in special cases.
- A SUMMARY of not more than 150 words must be supplied, together with 5 keywords.
- All spelling must conform to UK/international English.
- The layout of the text and style of table and figure legends and references must conform to that of the International Forestry Review. This means:
  - Main title in Arial, Text in Times New Roman
  - The hierarchy of headings is: CAPITALS, **bold lower case**, *italics lower case.*

TEXT
- Manuscripts should be produced in Microsoft Word, written in Times New Roman typeface (size 12 pt), with single row spacing, left justification and without hyphenation.
- The manuscript should be written in the passive voice, e.g. 'The experiment was carried out' *is correct*; 'We carried out the experiment' *is incorrect.*
- Manuscripts should be submitted with UK English spellings. Make sure that a spell check with UK English spellings is used prior to submission.
- Paragraphs should not be separated by any additional line spacing. The first paragraph in a section should not be indented. The first line of each subsequent paragraph should be indented to 1.27cm.
- Use quotation marks (" ") only around quotations or titles. Do not use them to highlight or emphasise text.
- *et al.* is correct, et al is incorrect.
- The document should be saved as a Microsoft Word file with *.doc file extension.

TITLE
- The title and author's details should be in the following format

Mutually beneficial company-community partnership in ensuring its long-term viability: emerging lessons from Indonesia

A.A. NAWIR and L. SANTOSO

Center for International Forestry Research, Jl. CIFOR, Situ Gede, Sindang Barang, Bogor 16680, Indonesia

Email: a.nawir@cgiar.org and l.santoso@cgiar.org

TABLES
- Tables should clear and simple, with a maximum of 8 columns. (Note that tables have limited space in the final layout and therefore the reduction of font size to a minimum of 8 pt during typesetting should be taken into account when preparing tables).
- Headings and other texts in table cells should to be concise. Tables including captions, legends and footnotes should be written in Microsoft Word (in exceptional cases Microsoft Excel can be used following agreement of the Editor).
- Tables should be saved in a separate file (not as an integral part of manuscript) and the manuscript text should contain the reference to the position of the table (or figure) in brackets.

NUMBERS
- Numbers greater than 999 should be written with appropriate spaces and without commas, e.g 10 000 is correct, 10,000 and 10000 are incorrect

FOOTNOTES
- References to footnotes in the main text should be marked with arabic numerals in superscript form.

GRAPHS AND FIGURES
- Graphs, diagrams and other figures should be prepared in Microsoft Excel or in Microsoft PowerPoint and saved in separate files. Graphs and diagrams should be drawn in 2-D form (not in 3-D spatial form) and single columns or circle sectors (in case of pie diagrams) should be filled with graycscale colours (not with colour filling or by using of automatic hatching). The line weight of axes and other lines and also the size of used letters or numerals should be appropriate to the final size reduction of diagrams during layout of final magazine page (maximum width of finally reduced diagram is either 8 or 18 cm depending on whether it fits one or two columns).
- Complex images such as maps (drawn in line draw or grayscale format) should be prepared in one of the following: CorelDraw, Adobe Illustrator, Adobe Photoshop, Macromedia Freehand or similar in which he finished images can be saved as *.eps (Encapsulated PostScript) file format. B&W photographs should be submitted as *.tif image file format with a resolution of at least 300 dpi. Colour photographs may be submitted only after agreement with the Editor. Colour images should be saved in CMYK colour format, as *tif file format and with a resolution of at least 300 dpi.
- Titles should be in the format: TABLE X *Title of table*

SCIENTIFIC NAMES
- The complete scientific name (genus, species, authority and, where appropriate, cultivar) should be cited at the first occasion of its mention and written in italics (authority in normal type). If vernacular names are used, they must be accompanied by the correct scientific name at first use.

CITATIONS
- For text citations, papers should be referred to as (Smith 1998) and papers by the same author in the same year should be distinguished by lettering in sequence (1998a, 1998b, etc.). Where papers are written by a single author or two authors their names should be cited. If three or more authors are involved the first name should be listed followed by '*et al.*', e.g. (Smith *et al.* 2002).
- Citations should be separated by a comma, not a semi-colon, i.e. (Johnstone 2003, Smith 2002, Smith *et al.* 2002).
- Multiple citations by different authors should be listed alphabetically, e.g. (Brown 2001, Jones 2003 and Smith 2002).
- Multiple citations by the same author should conform to the following format (Brown 2001, 2005, 2009).

QUOTATIONS
- Direct quotations from papers or books should be referenced in the format (Smith 1998: 23-24).

REFERENCES
- At the end of the paper, the list of references must be arranged in alphabetical ordering without serial numbering.
- References should be formatted with a ‚hanging' indent.
- There should be no additional line spacing between individual references.
- The following standard forms of citation must be used:
  Author's name, all authors' initials to follow surname, journal and book titles in italics. Volume number in bold. Second and subsequent lines should not be indented. For example:

  Journal paper
  LÄHDE, E., LAIHO, O., NOROKORPI, Y. and SAKSA, T. 1999. Stand structure as the basis of diversity index. *Forest Ecology and Management* **115** (2/3): 213-220.

  Paper or chapter in proceedings
  SMITH, W.J. 2001. Selection of tree species for arid environments. In: BLACKBURN, J.W. (ed.) *Multipurpose trees and shrubs for fuelwood and agroforestry*. CNRD Monograph No4. 366 pp.

  Book
  PHILIP, M.S. 1994. *Measuring trees and forests.* 2nd edition, CAB International, Wallingford, England. 310 pp.

- Unnecessary use of capitals should be avoided. For example
  HOLMGREN, J., JOYCE, S., NILSSON, M. and OLSSON. H. 2000. Estimating Stem Volume and Basal Area in Forest Compartments by Combining Satellite Image Data with Field Data. *Scandinavian Journal of Forest Research* 15: 103–111. Is incorrect.
  HOLMGREN, J., JOYCE, S., NILSSON, M. and OLSSON. H. 2000. Estimating stem volume and basal area in forest compartments by combining satellite image data with field data. *Scandinavian Journal of Forest Research* 15: 103–111. Is correct.
- Websites should only be quoted in isolation where hard copies are not available.

ACKNOWELDGEMENT
- It is necessary for authors to acknowledge suggestions made by referees with a simple statement such as 'The valuable suggestions made by anonymous referees is gratefully acknowledged'.

SUBMISSION
- Manuscripts offered for publication should be submitted by email to cfa@cfa-international.org

REFEREEING
- Contributions will be referred to at least two expert referees. Authors will be consulted if the paper is considered suitable but alterations are thought desirable. After alterations have been agreed and incorporated, the paper will be considered final.

ASSISTANCE WITH PUBLICATION
- For assistance with preparing manuscripts visit our **Online guide to scientific writing** at http://www.cfa-international.org/ONGSWintro.html

* Original means that the paper, or any close derivative of it, has not been published previously in any form, including on the internet.

Contents

PAPERS

John Spears, a life in forestry: an introduction to the Special Issue

P. DEWEES[a], N. KISHOR[b] and L. IVERS[b]

[a]*Independent researcher, Juntulantie 80, Taipalsaari 54920, Finland*
[b]*World Bank, 1818 H St., N.W. Washington, DC. 20433, United States*

Email: pdewees@gmail.com; nkishor@worldbank.org; laivers@worldbankgroup.org

SUMMARY

This article introduces the Special Issue of the International Forestry Review published to honour the legacy, impact and career of the late John Spears, who was for many years the Senior Forestry Adviser at the World Bank. It outlines the long arc of his career and draws on some of the key themes which motivated John, and to which he returned throughout his life. In particular, it focuses on why he came to advocate for social and community forestry, the involvement of the private sector in forest plantation development, forestry research, education and training, the role of forests in reducing poverty, the challenges of conserving and managing tropical forests, and the potential of small and medium forest-based enterprises to contribute to job creation and economic growth. It closes with a reflection on some of the processes which were launched in parallel with his career and to which he contributed.

Keywords: forests, policy, development, climate change, poverty

John Spears, une vie dans la foresterie: une introduction à l'édition spéciale

P. DEWEES, N. KISHOR et L. IVERS

Cet article est une introduction à l'édition spéciale de la Revue Forestière Internationale publiée en l'honneur de l'héritage, de l'impact et de la carrière de feu John Spears, qui fut durant de longues années le conseiller forestier principal à la Banque Mondiale. Il dessine le long arc de sa carrière et met en exergue plusieurs des thèmes-clé qui motivèrent John, et vers lesquels il se réorienta tout au long de sa vie. Il se concentre en particulier sur les raisons pour lesquelles il devint un défenseur de la foresterie collective et sociale, de la participation du secteur privé dans le développement des plantations forestières, dans la recherche forestière, l'éducation et la formation. Il défendit également le rôle des forêts dans la réduction de la pauvreté, les défis de la conservation et de la gestion des forêts tropicales, et le potentiel des petites et moyennes entreprises basées sur la forêt à contribuer à la création d'emplois et à la croissance économique. Il se conclut par une réflexion sur certains des processus ayant été lancés en parallèle avec la carrière de John et auxquels il contribua.

John Spears, toda una vida de silvicultura: introducción a este número especial

P. DEWEES, N. KISHOR y L. IVERS

Este artículo presenta este Número Especial de la Revista Forestal Internacional publicado para honrar el legado, el impacto y la carrera del difunto John Spears, quien fue durante muchos años el Asesor Forestal Principal del Banco Mundial. El artículo esboza la larga trayectoria de su carrera y se basa en algunos de los temas clave que motivaron a John, y que él estudió a lo largo de su vida. En particular, se centra en las razones por las que llegó a abogar por la silvicultura social y comunitaria, la participación del sector privado en el desarrollo de plantaciones forestales, la investigación, la educación y la capacitación forestales, la función de los bosques en la reducción de la pobreza, los desafíos de la conservación y la gestión de los bosques tropicales, y el potencial de las pequeñas y medianas empresas forestales para contribuir a la creación de empleo y al crecimiento económico. El artículo concluye con una reflexión sobre algunos de los procesos que se iniciaron en paralelo con su carrera y a los que él contribuyó.

INTRODUCTION

John Spears, known to many readers of this journal, passed away in September 2018. John's long career and his influence on much of the international discourse in many areas of forest policy are well known and widely appreciated. The International Forestry Review acknowledged this by publishing a remembrance of Spears and his life's work in the March 2019 issue (Lele *et al*. 2019).

As that article noted, Spears' contributions to thinking about forests, trees and sustainable development were extensive and influential. They resulted in significant actions taken both by the institution with which he is most strongly associated – the World Bank – as well as by other development agencies, governments, the private sector, and research and academic institutions.

The objective of this Special Issue of the International Forestry Review is to honour Johns' legacy, impact and his career. We wanted to do this by inviting well known scholars of forest policy and practice to reflect on some of the significant advances which have improved our understanding of the dynamics that have shaped actions in a wide range of areas of relevance to forests, trees, and sustainable development – in ways John first began thinking about over 65 years ago as a young forester in the Colonial Forest Service. In addition, we challenged the writers to articulate how the future might look, especially how continuing challenges to forest and landscape management might be met. In doing so, we were hoping to capture some of John's practical and deeply felt optimism. He saw it as very counterproductive and off-putting to present policymakers with fatalistic studies reporting actions needed in battles which were already mostly lost. It served no purpose, and he tended to look far beyond narrow and gloomy predictions to chart a course ahead.[1]

The long arc of John's career paralleled growing global interest and concern about the role of forests and trees in developing economies. It would be difficult to discuss John's impact and legacy without reflecting on his career, and how his thinking and his approach was very much a response, practically rooted, to what he saw on the ground.

EARLY CAREER

In 1949, John Spears was conscripted into the Kings African Rifles and was posted to Kenya, where he served in the Camel Corps on the Laikipia Plateau. He returned to Britain when his 18 month mandatory conscription period ended, and earned a degree in forestry at the University of Wales, in Bangor. He joined the Colonial Forest Service in 1952, after completing a 1-year compulsory post-graduate course at the Commonwealth Forestry Institute at the University of Oxford. And then he headed back to Kenya, a country for which it could be said he had a lifelong passion.

KENYA: 1953–66

Some of the themes which emerged from John's time in Kenya, which straddled the country's immediate pre- and post-independence periods, were recurrent throughout his life: the importance of working with smallholders to incorporate trees into their farming systems, the value of developing forest plantation resources to meet growing demands for industrial roundwood, the potential for working with the private sector, and the challenge of reconciling demands for agricultural land with the need for forest land.

Spears worked for the Kenya Forest Department from 1953 to 1966 in various roles, taking time off to complete a Masters in Forestry at the University of British Columbia in 1962. He worked mostly in Western Kenya where he observed that African farmers knew pretty well how to grow things that they needed or could sell. What he could do as a District Forest Officer was to provide them with seeds – tree seeds of the fastest growing thing around, eucalyptus. Particularly in central Kenya, black wattle was already a critically important cash crop – the only cash crop Africans in central Kenya were allowed to grow before Independence, and eucalyptus filled a similar role in Western Kenya. Eucalyptus became closely integrated into land-use changes which swept Western Kenya, as urban employment pulled people away from their farms, and created a demand for land uses which required less labour, such as tree crops (Bradley 1991, Dewees 1993).

The legal, political, social and economic reforms which swept Kenya in the period leading up to Independence in 1963 resulted in changes to land legislation which established the means for African land ownership in the Kenyan highlands, and land redistribution from European land owners to Africans through Roger Swynnerton's Million Acre Scheme (Thurston 1987). For those who thought to look forward, the 'winds of change' which were to bring independence to Kenya were also likely to bring new opportunities and challenges for the forest industry.

It must have been clear that Kenya's small, but growing, forest industry, would not be able to rely on indigenous forests to meet its raw material demands for too much longer.

---

[1] We should note that the authors who contributed to this Special Issue faced a particular challenge. As an international civil servant, Spears was not an 'academic' in the traditional sense of the word. He did not spend his days looking to publish, or struggling over how a particular text might be construed in the academic literature, or what peer reviewers might think. For those tenacious enough to explore his formally published written record, it is sparse. Some of these are included as references to this article, and there are several others for which he was an uncredited contributor (cf. World Bank 1978, World Bank 1981, WCFSD 1999). The bulk of his writing was in the internally generated, but often vast, grey literature which seeps through international bureaucracies, as well as in his frequent notes directed at his colleagues: seeking to make a point, to fine-tune an approach, to challenge a conventional wisdom, to move colleagues along, to encourage, to provoke. Anyone attempting to understand Spears' 'legacy' through his published writings will be sorely frustrated. This was the particular challenge faced by the authors who agreed to write articles for this Special Issue.

Only around a quarter of Kenya's 1.7 million ha of forests were thought to be 'productive' in the sense of being of much use to the timber industry. Yields were low. Production in the 1950s ranged from 60 to 80 thousand cubic meters per year and Kenya was a net forest products importer (World Bank 1969). The silviculture for restoring logged over indigenous forests was not well understood, and resulted in forests of low economic productivity. There was a perceived urgency to putting in place the means to sustainably supply the timber industry in to the future. Starting in 1945, Government adopted a policy of replacing logged-over indigenous forests with fast growing plantations of pine, cypress and eucalyptus which tended to grow extremely well in Kenya's equatorial conditions.

The need for a structural change in the forest industry, from a reliance on indigenous hardwoods to exotic softwoods, was also a reflection of the expectation that there would be even greater demand for timber products in the post-Independence period. Spears' role during the 1960s was in supporting plantation development and expansion, and in identifying options for the growing forest industry, as large volumes of timber were expected to become available starting in the mid-1970s. By 1966 when Spears left Kenya to join FAO, around 170,000 ha of softwood plantations, and another 20,000 ha of eucalyptus had been established. By the late 1970s, roundwood production from plantations was expected to total around 400,000 m^3 per year (World Bank 1977).

The impact on Kenya's indigenous forests of the change in the structure of the forest industry is difficult to assess. There was a widespread perception that indigenous forests were tremendously important for watershed catchment protection, and Sir Charles Pereira's catchment studies carried out by the East African Agriculture and Forestry Research Organization (EAAFRO) quantified their importance *vis-a-vis* other land uses in reducing runoff and in sustaining ground water resources (Pereira 1962) – a view later echoed in the World Bank's 1978 Forest Policy, to which John contributed extensively. Their primary value to local communities was assumed to be for traditional medicines, wild foods, woodfuel, and for grazing livestock. Biodiversity conservation in indigenous forests *per se* did not feature much in the discussion in Kenya until much later. The establishment of National Parks in the colonial and early independence period favoured areas of natural beauty where recreational opportunities and wildlife predominated, rather than in indigenous forests (the Aberdare and Mount Kenya National Parks perhaps being exceptions) (Chongwa 2012).

In the absence of effective systems of protection, conservation and management, indigenous forests in Kenya became the new frontier for agricultural expansion, and, in turn, produced enormous quantities of charcoal as a by-product of land clearance operations, especially in the 1970s and 1980s. Kenya was not an exception. The loss of tropical forests to agriculture happened – and continues to happen – throughout the tropics. There was certainly a school of thought dominant in the 1970s and 1980s which argued that the catchment functions of forest loss could be mitigated by tree crop establishment, but this was of little comfort to those who were concerned about contingent habitat losses, and emerging concerns about the loss of forest carbon and its impact on global warming (Stewart 1978).

It was clear that, by the mid-1970s, there was limited scope for continued expansion of plantations in forested areas, and Government chose to work with some of the large industrial agricultural estates in Western Kenya which provided land to support further growth (World Bank 1977). Inevitably, this particular trade-off between the demand for agricultural land and the need for land for plantation development brought into focus the need to find means of collaborating with the private sector, and this remained a theme of John's work long after he retired from the Bank.

FAO: 1966–76

In 1966, John was recruited by the UN Food and Agriculture Organization to improve the technical capacity of its so-called 'World Bank-FAO Cooperative Program' in the area of forestry. The Cooperative Program was established in 1964 as a joint effort by the Bank and FAO "for the common end of facilitating a greater flow of capital into priority agricultural projects and thereby increasing agricultural production." In 1966, John was one of 32 staff charged with supporting the identification, preparation, appraisal, supervision and evaluation of agriculture and rural development projects and programs. By then, the program had expanded to work with the African Development Bank and the Asian Development Bank as well, and in 1968 it was renamed the FAO Investment Centre (FAO 2014).

Spears' tenure at the Investment Centre started just as the Green Revolution was taking off in the late 1960s, the establishment of the Consultative Group on International Agricultural Research in 1971, the beginnings of the World Bank's shift under Robert McNamara to focus on investment lending geared at reducing poverty, rather than on the large infrastructure investments which had characterized its lending program until then, the Club of Rome's 1972 report on 'The Limits to Growth,' and the first energy crisis in 1973. At the same time, Jack Westoby, FAO's Director for Programme Co-ordination and Operations in its Forestry Department, began shifting the organization's focus inevitably toward the role of forests in rural development.

The nexus of concerns about food production, environmental protection and poverty reduction – the core of what came to be known as 'sustainable development' – emerged during this period. With the appointment of a leading agricultural economist, Monty Yudelman, to head the newly created Agriculture and Rural Development Department in 1972, McNamara signalled that the institution's priorities were about to significantly change (Kapur *et al*. 1997).

While support for smallholder agriculture came eventually to feature predominantly in the Bank's poverty-oriented lending program, at least until the mid-1970s, its forests investments stayed resolutely oriented toward industrial sector development for a while longer. By late-1975, for example, there had been 11 Bank-financed forestry operations. Four

were large scale industrial plantation projects, two supported the exploitation of indigenous forests in connection with land resettlement, two financed improved natural forest management for industrial production, one for large scale integrated forest industries development, one was for small scale private industrial development, and one for domestic wood production and employment generation.

But there was clearly a growing concern that the portfolio needed to shift much more aggressively toward the rural poor. Sidney Draper (one of the Bank's few foresters at the time), in a 1975 paper, was amongst the first to propose a broadened program of support with an emphasis on forest production for local consumption, especially for woodfuel production. ". . . .(T)here is an adverse widening gap between supply and demand which, if not redressed, will have significant depressive effects on the living conditions of the rural poor and involve substantial public costs through soil erosion and deteriorating water supplies" (Draper 1975).

In some analyses from the 1970s, demand was conceived of quite narrowly in terms of demand for woodfuel. Draper's 1975 paper, for instance, emphasized the need to meet future woodfuel demand. In India, for example, he posited that the woodfuel 'supply gap' was expected to increase by 100 to 200 million m³ per year over the next 20 years, but that this could be met by 10 million ha of new woodfuel plantations. This type of analysis, repeated many times through the 1970s and 1980s, suggested that a growing gap between supply and demand could only be met by massive planting programs. And though Draper acknowledged the difficulty of economically growing what was essentially a 'free good' collected from open access resources, it did not dissuade aid agencies – including the World Bank – from putting in an enormous amount of effort into increasing woodfuel supplies.

WORLD BANK: 1976–90

John was recruited by the Bank in 1976 to lead the expansion of its forestry lending, in a manner which was consistent with the overall McNamara-led policy of focusing on rural poverty reduction. Building on Draper's work, but expanding very considerably on it under the coordination of Graham Donaldson, John contributed extensively to charting the way forward in what became the Bank's 1978 Forestry Sector Policy Paper. The 1978 Policy Paper outlined a great expansion of support for forestry, in four areas:

- **environmental forestry** for the conservation of habitats and watersheds;
- **rural development forestry** for fuelwood and timber production, to establish shelterbelts to improve soil conservation, to support the planting of fruit trees, fodder resources, and fibre producing trees, and to encourage small scale forest industries to meet local demands;
- **institution building projects**, with an emphasis on training, education, and research; and
- **industrial forestry projects** "where they can continue to be justified within the framework of country programming priorities."

For the Bank, this was mostly uncharted territory, requiring a radical change in the Bank's approach to forestry development:

> ". . . New concepts, technologies, and institutional approaches will have to be developed. Bank activity in forestry projects is evolving rapidly, and its policy needs to be flexible and capable of further adaptation. Though approaches in some areas are still experimental, enough is already known for some conclusions to be drawn on what are to be its new directions." (World Bank 1978)

The Policy also made a very clear commitment that the objectives of Bank forestry lending must necessarily be aligned with the Bank's broader poverty reduction objectives. This theme has become far more important and dominant in Bank lending over time, and considerable thought has gone in to how lending can be shaped in a way to meet these objectives, the linkage between forests and poverty, and how performance in meeting poverty reduction objectives can be measured.

The Bank was not proposing these changes in isolation. Jack Westoby at the FAO as early as 1967 had been speaking passionately about how 'forestry is not about trees, it is about people,' and his keynote at the 1978 World Forestry Congress in Jakarta, with its theme of 'Forests for People,' helped to usher in new changed perspectives (Westoby 1987).

One of the outcomes of the Bank's new poverty orientation toward forests, the growing interest in agroforestry, and a perception that fuelwood shortages could best be addressed by tree planting measures, was support for social and community forestry. In the 1980s, the idea amongst aid agencies was relatively new, and there was only a weak understanding of how these initiatives could best be undertaken. The Bank supported a wide range of efforts to engage farmers in planting trees, but the approach was often highly technocratic, and failed to account for social and economic concerns related to land tenure, tree tenure, gendered rights of forest and tree access and use, and highly differentiated responses to woodfuel scarcity. Increasingly, with John's urging and support, social scientists were brought in to the discussion to help mitigate some of the negative impacts of these types of programs, and to better inform project development. (cf. Cernea 1985, Noronha 1981)

Tropical deforestation was a growing concern. The 1978 Policy noted that emphasis would be given in Bank operations to better understanding the environmental and ecological effects of forest loss, and to rural development strategies that would help low-income groups without, at the same time, leading to ecologically destructive patterns of development. But in one of its more now-controversial passages, the Policy also acknowledged that growing populations and the need for agricultural expansion would likely create significant pressures on tropical forests, and that if forest clearance and land

settlement were to take place in any event, it was important that it be undertaken in a 'phased approach' to understand the potential of forest soils to support intensified agriculture.

John later expanded on this theme. In a 1979 address to the Commonwealth Forestry Association, he asked the question, "Can the wet tropical forests survive?" In his address, he charted out the extent of deforestation, sought to identify its primary causes, considered the environmental impacts of tropical forest loss, posited what the alternatives might be, and – noting his intention to provoke a discussion – ultimately suggested that, as it would neither be prudent, practical or politically possible to stop agricultural encroachment altogether, it would be better to plan and monitor settlement projects to ensure the right technical approaches are taken (Spears 1979). Even so – after the provocation – he argued there were good reasons why governments should be strongly encouraged to favour settlement schemes only in non-forested areas.

In the same address, he raised a significant concern which was simply not addressed by the 1978 policy: the link between deforestation and global climate change. Philip Stewart had recently published an article on possible links between deforestation and climate change in the Commonwealth Forestry Review which John quoted extensively (Stewart 1978). But the science about the relationship between deforestation and atmospheric carbon was just emerging. Bert Bolin only a year before had argued for the first time that deforestation of the tropics, plus the decay of plant matter in soils damaged by agriculture, was releasing a very large net amount of CO_2 into the atmosphere – somewhere around a quarter of the amount added by fossil fuels (Bolin 1977). George Woodwell and Richard Houghton at the Woods Hole Institute had independently reached similar conclusions that year as well (Woodwell and Houghton 1977). John was prescient in saying that if these research findings were correct, then action to halt global warming might well require "international agency and, national government commitment to a global action programme of voluntary constraint on use of fossil fuels and uncontrolled burning of vegetation."

John was also deeply influenced by Norman Myers, the British environmentalist and scientist, on the costs of habitat loss, and he also noted this in his 1979 address to the Commonwealth Forestry Association.

> "Tropical wet forests, in particular, are rich in animal and plant life probably harbouring half, if not more, of the earth's species. Elimination of the wet tropical forest would automatically mean elimination of many species which would represent an irreversible loss of new unique resources. . . ."

He argued that, consistent with Myers' recommendations, it was the duty of foresters "to ensure the preservation of at least 10 per cent of unique moist tropical forest eco-systems and we should include provision in all forest development plans for the deliberate creation and protection of such reserves, wherever the experts in this field are convinced that a unique genetic pool resource exists."

The question of tropical forest loss and its relationship to the trade in tropical timber raised challenging questions about the potential for forest management. UNCTAD had launched discussions about the trade in tropical timber in 1976, and Japan tabled a proposal in 1977 for an international tropical timber trade agreement. The first negotiated agreement was completed in 1983, and the establishment of the International Tropical Timber Organization followed. As Douglas and Simula (2010) have noted, the basis for the ITTO was rooted in the recognition that on the one hand, tropical deforestation was happening on a worrying scale, while on the other hand, the countries where deforestation dominated were also critically dependent on the timber trade. The reconciliation of these two objectives is in many respects ITTO's raison d'etre, but it remained a challenge for a commodity organization because these typically have not had environmental conservation responsibilities. The Bank has not generally participated in ITTO discussions, though the 1978 policy framework committed the Bank to assisting timber exporting countries to develop appropriate timber trade policies in a way which would encourage local processing rather than log exports.

In addition to the areas which were to become priorities for Bank lending over the coming years, the 1978 Policy outlined an ambitious agenda to support research relevant to forests and rural development. John became a ferocious advocate for strengthening the international agricultural research centres (the so-called Consultative Group on International Agricultural Research, or CGIAR) to include forestry and agroforestry as research themes. Research into combined land-management systems of agriculture and forestry was central to the mission of the newly established International Council for Research in Agroforestry (ICRAF), which emerged out of a proposal by the International Development Research Center (IDRC) in 1976. Tropical forestry research though remained the mandate of national research institutions. In 1981, Spears on behalf of the Bank co-authored with FAO a paper for the 17th Conference of the International Union of Forest Research Organizations to lay out an agenda for research, recognizing the role of national research institutions, but proposing that a new international research centre should be established with the specific objective of addressing tropical forests (World Bank 1981). It was another 10 years before ICRAF would be incorporated into the CGIAR, and another 12 years before the Centre for International Forestry Research (CIFOR) would be established, also as part of the CGIAR.

The 1978 policy also gave priority to the development of national plans for forest investment. Typically, the Bank would carry out thematic reviews, which would assess the state of the sector, the sectoral policy, institutional, and legal framework, and then would propose priorities for investment. By the early 1980s, the Bank had launched a series of sectoral forest reviews to identify the scope for future investment. These did generate new lending operations by the Bank, but there was a sense that they were missing the bigger picture challenges associated with global forest conservation and management, and especially with tropical deforestation.

In the early 1980s, John began working closely with the newly established think tank, the World Resources Institute,

on an exercise called *The Global Possible*¸ to work through how to address pressing topics such as population stabilization, poverty alleviation, the conservation of biological diversity, agricultural development, and the control of tropical deforestation (Repetto 1985, Spears and Ayensu 1985). Specifically with respect to deforestation, it resulted in the creation of a multi-donor task force comprised of a group of donor agencies, the World Bank, UNDP, and a number of foundations and, in October 1985, produced a report called, "Tropical Forests: A Call for Action." At the same time, FAO had launched a parallel process to stimulate global action in the area of tropical forestry. FAO's framework *Tropical Forestry Action Plan* (TFAP), also released in October 1985, proposed that governments should address five priority areas as part of a common framework for tackling tropical deforestation: (*i*) forestry in land use, (*ii*) forest-based industrial development, (*iii*) fuelwood and energy, (*iv*) conservation of tropical forest ecosystems, and (*v*) institutions (FAO 1986).

Both of these initiatives converged in 1987, and a broader-based TFAP was eventually launched with the overall objective of overcoming the perceived lack of political, financial, and institutional support for combatting deforestation through a "common framework for action." Nonetheless, as Winterbottom (1990) observed, "different expectations of the TFAP persisted: FAO and various aid agencies viewed the TFAP primarily as a mechanism to harmonize development assistance in forestry, while WRI and others saw the TFAP as a vehicle to launch a broadly-based program to address the root causes of deforestation." There was also a perception that many of the institutions behind the TFAP, including the Bank, FAO, and UNDP, were more interested in simply generating new investments, rather than in dealing with the tough issues at the country level which make tackling tropical deforestation such a challenge. Civil society representation in TFAP's development and implementation both at the country and global levels was weak, and this was a point of contention which persisted.

Ultimately, the TFAP was not equipped to facilitate the establishment of a planning process which adequately accounted for local political realities, or for the need to assess trade-offs and to balance conflicting demands over the use of forest lands. It was not clear, for example, how a ramped up program of development assistance for forestry would at the same time protect the livelihoods and meet the needs of forest dependent local communities. Nor was it clear how increased wood production and intensified forest management would be reconciled with conserving forest resources, and maintaining the environmental services of tropical forests (Winterbottom 1990).

Arguably, the subsequent demise of the TFAP made space for a range of other initiatives, which were perhaps better placed to address its inherent weaknesses. The FAO's National Forest Program Facility, for example, gave an impetus for better and more inclusive national level planning, without the pressure of needing to deliver fully formed investment plans. The 1992 Convention on Biodiversity established much greater clarity that the conservation of biodiversity is "a common concern of humankind" and should be an integral part of the development process. There also came to be a more widely shared view of the need to explicitly address the rights of indigenous peoples.

For the Bank, two areas of the 1978 policy resulted in significant pushback from civil society: with respect to the Bank's support for industrial forestry projects, and its seeming support for agricultural settlement in tropical forest areas. By 1991, both of these approaches had basically been shelved, and Bank-lending came to be mediated by a broad range of 'safeguard policies,' including specific policies with respect to forests, indigenous peoples, natural habitats, and environmental assessment.

WORK FOLLOWING RETIREMENT FROM THE WORLD BANK

John retired from the World Bank in 1990. Almost immediately, he began advisory work for the Secretariat of the CGIAR, and led a task force which brought about the incorporation of ICRAF into the CG in 1991, and to the establishment of the Centre for International Forestry Research as one of the CG Centres in 1993. He also began to work closely with the IFC, to identify opportunities for private sector involvement in plantation development.

In 1997, John was appointed Secretary General of the World Commission on Forests and Sustainable Development.[2] He organized Regional Public Hearings on Forests throughout the world to obtain the widest perspectives on how global forests should be managed and for whose benefit. The Commission's 1997 Report "Our Forests Our Future" focused on a range of issues which had gained currency by then: stopping deforestation and bringing tropical forests under sustainable management for the benefit of the poor, involving people in decision making about the use of forests, improving an understanding about tropical forest use and management through research and improving forest education and information sharing. The Commission also focused on a number of areas which had not gained much attention: getting the price of forests right to reflect their full ecological and social values, developing new measures to assess forest capital so that we would be better able to assess whether the overall situation was improving or worsening, and taking a broader "landscapes" approach which considered forests as one dimension of land use.[3]

[2] The World Commission was initially conceived by a group of private citizens in 1992, and eventually was launched at the invitation of the InterAction Council of Former Heads of State and Government.

[3] As with many other initiatives Spears worked on, his written contributions to the work of the Commission is seldom formally credited. Those who worked with him during this period have noted that he was a key driving intellect behind the effort, and drafted extensive sections of the final report.

Corruption and governance were unspoken issues in the forests sector – and in the development business more generally – for a long time. In the World Bank, the problem of corruption was quietly acknowledged as a significant constraint to development, but it was never addressed through its lending operations. It was judged to veer too closely to the institution's prohibitions on "political activities" as outlined in its Articles of Agreement (Lateef 2016). In 1996, the then president of the World Bank, James Wolfensohn broke the silence at the Bank-Fund Annual Meetings, with a landmark address to the World Bank Board of Governors on the "cancer of corruption," citing it as a major burden on the poor in developing countries. The theme was also taken up by the World Commission, which saw the scale of corruption in the forest sector as almost intractable. The Commission advocated that governments should support greater transparency, equity, and sustainability in an effort to reduce illegality in the sector, and that these measures needed to be accompanied by efforts better to recognize the value of producing timber through sustainable management systems by supporting an independent third party system of verification.

Since then, of course, tackling illegal logging has featured prominently globally, and while it is no less intractable, some progress is being made through trade measures like the US Lacey Act, and the EU's Timber Regulation, which require that all timber sold in the US and Europe is produced from legal sources (cf EIA 2018).

After completing his tenure with the World Commission, and with the support of the Bank and the multidonor Program on Forests (PROFOR), Spears led a series of Forest Investment Fora, to bring together interests in the forest industry with investors, landowners, NGOs, and others to chart a way forward to boost investment in forests, especially in Africa. The first was convened in 2003, in Washington, which brought together 150 senior executives of domestic and multinational forest product companies, private and public sector financial institutions, and leading conservation agencies. The forum set out to identify opportunities for investments in environmentally and socially sustainable forestry in developing and economic transition countries, to consider actions needed to create an enabling environment for responsible private sector investment, and to support a process to develop clearly defined social, economic and environmental investment guidelines specific to the forest sector. John participated in the last in the series supported by PROFOR in May 2011 focused on landscape restoration, which brought together small and medium scale forest enterprise owners with landowners, NGOs, donor agencies, and investment groups (Dewees *et al.* 2011).

John continued to maintain an office at the World Bank, where he was a sought after source of advice and guidance. He was deeply committed to mentoring the new and the uninitiated, to help them to find their feet and to confidently operate in the rough-and-tumble world of international development. His love of mentoring was an expression of his broader approach to life – a willingness to listen to all people, to advise them when he thought it to be helpful, and to draw upon their ideas when they made sense.

John also gently provoked, often prefacing his thoughts with, "Just to test the waters, let's assume. . ." He provoked advocates who thought the Bank had a role in supporting sustainable forest management, and he provoked activists into thinking and speaking critically about what the Bank was trying to do. By doing so, he helped create a platform for dialogue and debate and further advocacy.

While this Introduction has focused mostly on aspects of John's career, it is worth noting that he maintained an amazing balance between his professional and personal lives. He played rugby for North Wales, was a lead in Gilbert and Sullivan operettas, produced musicals in Kenya and at FAO, sailed his boat across the Atlantic and was a very good pianist. It was this remarkable combination of the professional and the personal, and his ability to find a way to operate at a high level in both of these areas, which left an indelible impression on those who knew him and worked with him.

To honour John's legacy, we have invited a group of scholars and policy specialists, to reflect on some of the themes and approaches which emerged strongly during his career. The articles presented here cover a wide range of subjects – tropical forest conservation, biodiversity, forest governance, forest institutions, education and research, and so on – but also seek to capture some of John's own approach to these problems as a policy entrepreneur, an innovator, a master of the compelling narrative, and as a mentor.

We especially wish to thank the authors who have contributed to this Special Issue for their interest and willingness in drafting their wide ranging and thought provoking pieces, as well as the many peer reviewers who agreed to assess these rather atypical articles. We also want to acknowledge colleagues who helped construct this particular narrative of John's life and career, especially Chip Rowe, Hans Gregersen, Uma Lele, Lennart Ljungman, and Hosny el Lakany.

Finally, we gratefully acknowledge the contribution of the Program on Forests (PROFOR) and its multiple donors which funded Open Access publication of this Special Issue.

REFERENCES

BOLIN, B. 1977. Changes of land biota and their importance for the carbon cycle. *Science* **196**: 613–15.

BRADLEY, P.N. 1991. *Woodfuel, women and woodlots.* London, Macmillan.

CERNEA, M.M. 1985. *Putting people first: Sociological variables in rural development*. Oxford, Oxford University Press.

CHONGWA, M.B. 2012. The history and evolution of National Parks in Kenya. *The George Wright Forum,* (Special Issue on The Kenya Wildlife Service in the 21st Century: Protecting Globally Significant Areas and Resources) **29**(1): 39–42.

DEWEES, P.A. 1993. Trees, land and labour. Environment Department Technical Paper No.4. Washington, D.C., World Bank.

DEWEES, P.A., PLACE, F., SCHERR, S.J., and BUSS, C. 2011. Investing in trees and landscape restoration in

Africa – what, when and how. Washington, D.C., World Bank and the Program on Forests (PROFOR). http://documents.worldbank.org/curated/en/561091468008110938/Investing-in-trees-and-landscape-restoration-in-Africa-what-when-and-how

DOUGLAS, J. and SIMULA, M. 2010. *The future of the world's forests: Ideas vs ideologies* (World Forests Book 7). Berlin, Springer.

DRAPER, S. 1975. Forestry in rural development. Rural Development Working Paper 2. Agriculture and Rural Development Department. Washington, D.C., World Bank.

EIA. 2018. A tale of two laws: Using existing EU and US laws to strengthen action on illegal timber trade. February. London, Environmental Investigation Agency UK., Ltd.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. 1986. FAO's Tropical Forestry Action Plan. Unasylva Vol. 38. http://www.fao.org/3/r7750e/r7750e06.htm#fao's%20tropical%20forestry%20%20%20action%20plan. Accessed March 6, 2019.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. 2014. FAO Investment Centre. An overview. 1964–2014. Rome, FAO.

GREGERSEN, H.M., ORAM, P. and SPEARS, J. (eds) 1992. Priorities for forestry and agroforestry policy research: Report of an international workshop. Washington, D.C., International Food Policy Research Institute.

KAPUR, D., LEWIS, D.P., and WEBB, R.C. 1997. *The World Bank: Its first half century* (Vol. 1). Washington, D.C., Brookings Institution.

LATEEF, K.S. 2016. Evolution of the World Bank's thinking on governance. Background paper for the 2017 World Development Report, *Governance and law.* Washington, D.C., World Bank.

LELE, U., LJUNGMAN, L., KISHOR, N., DEWEES, P., ROWE, C., ROBERTS, R., EL LAKANY, H. and GREGERSEN, H. 2019. Obituary, John Spears. *International Forestry Review* **21**(1): 128–129.

NORONHA, R. 1981. Why is it so difficult to grow fuelwood? *Unasylva* **33**(131): 4–12.

PEREIRA, H.C. (ed.) 1962. *Hydrological effects of changes in land use in some East African catchment areas*. Nairobi, East African Agriculture and Forestry Research Organization.

REPETTO, R. (ed.) 1985. *The global possible.* Binghamton, World Resources Institute and Yale University Press.

SPEARS, J. 1979. Can the wet tropical forest survive?. *Commonwealth Forestry Review* **58**(3): 1–16.

SPEARS, J. 1980. Can farming and forestry coexist in the tropics. *Unasylva* **32**(128): 2–12.

SPEARS, J. 1987. Agroforestry: A development-bank perspective. In Steppler, H. and Nair, P.K.R (eds.). *Agroforestry: A decade of development*. International Council for Research in Agroforestry. pp. 53–66.

SPEARS, J. and AYENSU, E. 1985. Resources, development, and the new century: forestry. In, Repetto, R. (ed.) *The global possible*. World Resources Institute. pp 299–335.

SPEARS, J., ORAM, P., BYRON, N., SCHERR, S. and IZAC, A. 1994. A review of tropical forestry and agroforestry problem areas and policy research needs and the planned response of the CGIAR system. Working Paper 5. Bogor, Center for International Forest Research.

SPEARS, J. and YUDELMAN, M. 1979. Forests in development. *Finance and Development* **16**(4): 41.

STEPPLER, H. and NAIR, P.K.R. (eds.). 1987. *Agroforestry: A decade of development*. Nairobi, International Council for Research in Agroforestry.

STEWART, P.L. 1978. Forestry for carbon dioxide fixation *Comm. For. Rev.* **57**(4): 263–266.

THURSTON, A. 1987. *Smallholder agriculture in colonial Kenya: The official mind and the Swynnerton Plan.* Cambridge, African Studies Centre.

WESTOBY, J. 1987. *The purpose of forests*. Oxford, Basil Blackwell.

WINTERBOTTOM, R. 1990. Taking stock: The Tropical Forestry Action Plan after 5 years. World Resources Institute, Washington DC.

WOODWELL, G.M. and HOUGHTON, R.A. 1977. Biotic influences on the world carbon budget. In Stumm, W. (ed.). G*lobal chemical cycles and their alterations by man.* (Report of Dahlem Workshop, Berlin, Nov. 1976), pp. 61–72. Berlin, Abakon.

WORLD BANK. 1969. Forest plantations project, Kenya. Staff appraisal report. Agricultural Projects Department. Report PA-14. September 22.

WORLD BANK. 1977. Kenya forest plantations project. Project performance audit report. Operations Evaluation Department. Report 1485. March 1.

WORLD BANK. 1978. *Forestry. Sector policy paper*. Washington, D.C., World Bank.

WORLD BANK. 1981. Forestry research needs in developing countries – time for a reappraisal? Washington, DC: World Bank. http://documents.worldbank.org/curated/en/124641492710409733/Forestry-research-needs-in-developing-countries-time-for-a-reappraisal

WCFSD. 1999. *Our forests our future. Summary report of the World Commission on Forests and Sustainable Development.* Winnipeg, International Institute for Sustainable Development. https://www.iisd.org/sites/default/files/publications/wcfsdsummary.pdf

Broadening ambition of forest policies: the Spears legacy

R.N. BYRON[a] and J.A. SAYER[b]

[a]*Institute of Applied Ecology, University of Canberra, Canberra ACT Australia*
[b]*Department of Forest and Conservation Sciences, Faculty of Forestry, University of British Columbia, Vancouver BC Canada*

Email: Neil.byron@canberra.edu.au, jeffrey.sayer@ubc.ca

SUMMARY

Tropical forests rose to prominence in international conservation in the late 1970s. Fifty years have now elapsed during which forest conservation has remained a subject of continuous debate and controversy. There have been multiple forest conservation initiatives and a diversity of proposals made to define what human societies require of forests and how to sustain those requirements. The debate about tropical forests has suffered from the phenomenon of issue cycles – compelling ideas that have succeeded one another as the focus of attention – none of which alone would make a significant difference to outcomes on the ground. Some of the issues that received attention and funding appear today quite improbable.

John Spears played a pivotal role in the evolution of international policies and programmes throughout this 50-year period. Spears was committed to a broad and inclusive vision for conserving and sustainably managing forests. Spears had a profound impact by building coalitions and weaving together the multiple conflicting discourses on sustainable forest management. He convened people from widely different interest groups and made valuable contributions in bridging the silos that separated different communities.

Activists and advocates, who often lack the deep subject area competence of Spears, are today having profound influence on forest policies and programmes. An integrated understanding of the social, economic and ecological underpinnings of tropical systems is rare. Better future outcomes require that the pragmatism and on-the-ground experience epitomised by Spears play a greater role in guiding the improvement of global forest governance.

Keywords: tropical forests conservation, forest policy innovation

L'elargissement de l'ambition des politiques forestières: l'héritage Spears

R.N. BYRON et J.A. SAYER

Les forêts tropicales ont pris une place importante dans la conservation internationale vers la fin des années 1970. Cinquante ans se sont maintenant écoulés, au cours desquels la conservation forestière est demeurée un sujet de débats et de controverses continuels. De multiples initiatives de conservation forestière ont vu le jour, ainsi qu'une diversité de propositions avancées pour définir ce que les sociétés humaines requièrent des forêts et comment ces requêtes peuvent être soutenues. Le débat sur les forêts tropicales a souffert du phénomène des cycles de problematiques. Des idées captivantes se sont succédées les unes aux autres, formant le centre d'attention du moment, sans qu'aucune d'entre-elles soient à même de résulter en une différence importante dans les résultats sur le terrain. Certaines des questions ayant reçu attention et soutien financier semblent aujourd'hui assez improbables.

John Spears a joué un rôle pivot dans l'évolution des politiques et des programmes internationaux au cours de ce demi-siècle. Spears s'etait investi dans une vision large et inclusive de la conservation et de la gestion durable des forêts. Il a eu un impact profond en formant des coalitions et en tissant un discours unifié à partir des multiples discours conflictuels sur la gestion forestière durable. Il réunit des personnes provenant de groupes d'intérêt très épars et offrit une contribution de grande valeur en comblant les silos qui séparaient les différentes communautés.

Les activistes et les défenseurs, qui manquent souvent la compétence en profondeur sur le sujet qui était le propre de Spears, ont aujourd'hui une profonde influence sur les politiques et les programmes forestiers. Une compréhension intégrée des fondements sociaux, économiques et écologiques des systèmes tropicaux est rare. De meilleurs résultats futurs vont dépendre de l'octroi d'un rôle plus grand du pragmatisme et de l'expérience sur le terrain, parfaitement illustrés par Spears. Spears nous a montre le chemin a suivre pour parvenir a un meilleur amenagement des forets a l'echelle globale.

Ensanchando los horizontes de las políticas forestales: el legado de Spears

R.N. BYRON y J.A. SAYER

Los bosques tropicales pasaron a ocupar un lugar destacado en la conservación internacional a finales de la década de 1970. Ya han transcurrido 50 años, en los que la conservación de los bosques ha seguido siendo objeto de continuo debate y polémica. Han existido múltiples iniciativas de conservación de los bosques y se han formulado propuestas diversas para definir lo que las sociedades humanas exigen de los bosques y cómo hacer que esas exigencias sean sostenibles. El debate sobre los bosques tropicales ha sufrido el fenómeno de ciclos temáticos, en forma

de ideas convincentes que se han ido reemplazando unas a otras como centro de atención, pero que ninguna de ellas, por sí sola, ha marcado una diferencia significativa en los resultados sobre el terreno. Algunas de las cuestiones que recibieron atención y financiación parecen hoy en día impensables.

John Spears desempeñó un papel fundamental en la evolución de las políticas y programas internacionales a lo largo de estos 50 años. Spears se entregó por completo a una visión amplia e inclusiva para la conservación y la gestión sostenible de los bosques. Spears tuvo un impacto profundo mediante el logro de coaliciones y la urdimbre de los múltiples discursos diferentes sobre la gestión sostenible de los bosques. Reunió a personas de grupos con intereses muy diversos e hizo contribuciones valiosas para tender puentes entre los silos que separaban a las diferentes comunidades.

Los representantes del activismo y la incidencia política, que a menudo carecen del profundo conocimiento temático de Spears, están teniendo hoy en día una profunda influencia en las políticas y programas forestales. Es rara la existencia de una comprensión integral de los fundamentos sociales, económicos y ecológicos de los sistemas tropicales. Para un futuro mejor, será necesario que el pragmatismo y la experiencia sobre el terreno, personificados en Spears, jueguen un papel más importante para asesorar el mejoramiento de la gobernanza forestal mundial.

SOCIETIES' CHANGING FOREST VALUES

Tropical forest conservation and sustainable use have been central issues on the policy agendas of inter-governmental and national policy processes for five decades. Interest in forests continues to intensify and hardly a day goes by without new and startling figures on the destruction of forests and their biodiversity. New studies emerge to argue that humanity faces grave consequences if forests continue to be misused. Recent dramatic fires in the Amazon and Australia have once more brought forests to the forefront of public attention.

Forests have been contested resources since time immemorial. There have been persistent tensions between elites, in Britain for example – who valued forests for timber for their ships and as exclusive hunting grounds and commoners who valued them for daily subsistence products. Some have argued that the struggle for control of forests has been one of the defining characteristics of human societies (Harrison 2009). Recent decades have seen an intensification of the struggles between local forest users, industrial users of forest lands and those who wish to protect forests as a global resource (Sayer 2007). John Spears' professional career spanned a period from the last third of the 20th century and the beginning of the 21st century when the intensity of debate over forestland use has been extraordinarily high. Spears was a central figure in struggles over forests, first from his position as a field forester in East Africa and later as a pivotal figure in international organisations and initiatives.

When John Spears began his career in East Africa colonial forest departments managed forests primarily for domestic timber needs and local subsistence use. Forest management focussed on sustaining yields of timber but also aimed to maintain biodiversity and other environmental services and to meet the needs of local people. Management of forests was primarily for the needs of national and local forest users. The scope of concern for forests has now increased dramatically. Tropical forests are now an icon of global conservation; they are on the agenda of meetings of heads of state and attempts to conserve them attract very large sums of money. A marked tension has emerged between management for local values versus management for global values. In the various positions that Spears held in international organisations he found himself at the centre of this shift in emphasis in forest management objectives.

Until the late 1970s, tropical forests remained mainly the concern of foresters and, generally, attention centred on the need to ensure that industrial exploitation did not compromise timber yields in future harvesting rotations. Concerns about the broader values of tropical forests only become prominent in the environment and development discourse in the late 1970s (Spears and Yudelman 1979). In the 1960s and 70s environmentalists had focussed on species and protected areas. Desertification and the protection of large mammals of African Plains were of greater concern than forests (Myers 1979, Sayer 1995). Westoby (1962) encouraged tropical developing countries to increase commercial logging for export as well as for domestic needs. By the mid 1970s, most countries were engaged in commercial exploitation of their natural forests (and if they had few such resources, governments started establishing timber plantations). Official interest in the conservation of flora and fauna or the wellbeing of indigenous people was less evident – a matter that Spears was among the first to observe and act on (Spears 1979, Spears and Yudelman 1979).

There were shifts in perspectives and priorities for dealing with tropical forests. As a broader range of stakeholders began to engage with conservation it became clear that there was no uniform view of what the objectives of forest conservation and management should be. Tropical silviculture had emerged as a science in the mid-19th century and was always concerned with the maintenance of the forest system including its biodiversity and its people. The job of foresters was to maintain those broad values whilst meeting economic goals for timber production. As pressures from population growth and demand for land and forest products grew, other concerns began to dominate the debate about forests. Westoby (1975) predicted that, one day, logs would be a secondary product to forest conservation, a prediction that is finally being realised today. Advocates for biodiversity, other environmental services and local livelihoods have gradually gained influence. Forest management and conservation have taken on the mantle of a "wicked problem" where even reaching agreement on the nature of the challenge proves difficult (Balint *et al*. 2011).

Spears took up the position of forestry advisor to the World Bank in 1976. He played a central role in the development of the 1978 World Bank Forest Policy (Dewees, this volume). The 1978 World Bank policy was a landmark document. The policy for the first time recognised the importance of conserving forest ecosystems, emphasised the role of forests in poverty alleviation and drew attention to the significance of deforestation as a driver of climate change. The World Forestry Congress in Jakarta in 1978 moved rural development to the centre of the forestry debate. A resolution passed at the Congress called for the establishment of an international centre for forestry research. Spears was central to all of these initiatives and they were drivers of his professional activities during the decades that followed.

The international discourse on tropical forests that has developed since the 1970s has often been contradictory, confused and driven by anecdotes and activism unsupported by rigorous analysis. The people and processes that have shaped opinion and influenced plans and programmes represented highly diverse interest groups. A schism has developed between those concerned with the global public goods values of forests and local, private values. Scientific analysis has struggled to keep up with this diversity of values and interests. International plans, policies and programmes have rarely been "evidence based" – they have emerged through complex processes of lobbying, debate and negotiation. Spears was central to the development of policies and programmes during the closing decades of the 20th century and the beginning of the 21st century. He contributed a voice of pragmatism and comprehensive knowledge of the issues based upon long periods of his life working in forests in Africa and in both FAO and the World Bank. He spanned the spectrum of interests from the forest dweller to the international decision maker.

FIVE DECADES OF DEBATE ON FORESTS

A major impetus driving concern for tropical forests came from the initiative of American President Jimmy Carter with his *Global Possible* study, which canvassed threats to global environmental security and possible solutions. Spears was involved, highlighting the issues facing forests and looking at forests from a broad perspective (Spears and Ayensu 1985). Even at this early stage of the emergence of environmental concerns, scholars were drawing attention to the broader values of tropical forests (Poore 1976).

Spears had been one of the earliest to warn of the bigger threats to tropical forests (Spears 1979, Spears and Yudelman 1979). Until the 1990s the conventional wisdom was that the main driver of deforestation was clearance for slash and burn agriculture (Gibbs *et al.* 2010, Myers 1992, Spears 1980). Influential thinkers contended that such clearance was a problem because forests were a resource whose sustainable exploitation should drive the development of newly independent tropical nations (Westoby 1962, 1975).

In the early 1980s, Spears led the World Bank to collaborate with Gus Speth at the newly established World Resources Institute in Washington to establish a task force for the development of a Tropical Forestry Action Plan. Spears brought together leading development economists, ecologists and forest peoples' activists for a series of meetings that led to the production of a landmark document "Tropical Forests: A Call for Action" – popularly known as the TFAP. WRI, FAO and the World Bank launched the TFAP at the World Forestry Congress in Mexico City in 1985. Spears and Chuck Lancaster, the forestry advisor at UNDP, subsequently led the formation of a Tropical Forestry Advisors Group to ensure implementation of the TFAP. The advisory group comprised representatives of aid agencies and international conservation, development and indigenous peoples' NGOs. Spears from his position at the World Bank was an influential member of the TFAP advisors. The mission of the TFAP and of the advisory group was to coordinate and greatly increase the international aid flows to support conservation and sustainable management of tropical forests. The TFAP was regarded by some environmentalists as excessively focussed on exploitation and not enough on conservation (Winterbottom 1990). Duncan Poore, an ally and friend of Spears, documented the progress of the TFAP. Poore was a senior advisor on forest issues to both the International Union for Conservation of Nature (IUCN) and the International Institute for Environment and Development (IIED). Poore himself was heavily involved in the preparation and implementation of the TFAP (Poore 2012).

The World Commission on Environment and Development (The Brundtland Report 'Our Common Future'; Keeble 1988) gave further impetus to the challenges of sustainably managing the world's forests. A move to develop an international convention on the conservation and sustainable development of forests emerged at around the time of the Brundtland Commission report. A preparatory committee was established and met on several occasions. The TFAP forestry advisors who were working with Spears on the implementation of the Tropical Forestry Action Plan were heavily involved. Developing countries saw such a convention as a potential threat to their sovereign right to take decisions on the use or protection of their forests and there was no consensus on the draft convention when the UN Conference on Environment and Development (UNCED) met in Rio de Janeiro in 1992. The Rio summit adopted a non-binding statement of principles on the conservation and sustainable use of forests and Spears was at the negotiating table (Kunzmann 2008). In the follow-up to the Rio summit, an Intergovernmental Panel on Forests emerged in 1995. The panel evolved into the United Nations Forum on Forests (UNFF) in 2000. The UNFF remains today a focus for inter-governmental discussions on forests – a role it shares with the FAO Commission of Forestry. Government forestry agencies dominate the UNFF but are widely criticised for their focus on conventional forestry rather than the broader issues of forests and land use (Humphreys 1996, 2015, Singer and Giessen 2017).

The period from 1980 to 2010 saw a proliferation of initiatives to develop international legal instruments to govern forests. Spears was involved with many, if not all, of them (Humphreys 2006, Chaytor 2001).

Spears was pivotal in the debate that led to the conclusion that the fundamental driver of tropical deforestation was not commercial timber extraction. The alternative hypothesis was that the driver of forest clearance was agricultural. New technologies for estate crop plantations provided further impetus and new opportunities for the use of previously forested lands in developing countries. The persistent obsession with forest harvesting as a threat to forest systems – in the face of compelling evidence that competition for land is frequently the real underlying problem – is one example of an issue that required "subject area competence" to resolve (Bowles *et al*. 1998). Spears had that deep understanding of forest and land use issues.

The TFAP advisory group became a major focus of international debate on forest issues and was influential in directing aid agency funds to conservation and sustainable use of forests. Spears played a pivotal role throughout the two decades that this group continued to meet. Countering the perceived threat to forests of clearing for slash and burn agriculture led to expanded interest in agroforestry. Spears was again in the forefront of the debate (Palm *et al.* 2005, Spears 1987). Spears, then senior forestry advisor at the World Bank, led the movement in the early 90s to integrate the International Center for Research on Agroforestry into the Consultative Group for Agricultural Research (CGIAR) (Gregersen *et al*. 1992, Spears *et al.* 1995, Oram *et al*. 1994). That committee included people from developing countries that attests to Spears' passion for introducing young scientists from developing countries to the international arena. Some of them, like Dr Hosny El-Lakany, subsequently became leaders of international forestry institutions.

Spears played a key role in the development of the ideas for a CGIAR centre specifically focused on forests. He was heavily involved in the late 1980s when the plans for a centre were incubating. He switched from Senior Forestry Adviser at the World Bank to become the forestry advisor in the CGIAR Secretariat (housed in the World Bank) at the time that decisions were made on the establishment of what became the Center for International Forestry Research (CIFOR). He worked closely with the team from the Australian Centre for International Agricultural Research who managed the startup of CIFOR, negotiated its host country agreement with Indonesia and recruited the first Director General. Spears continued to be a strong supporter of CIFOR during its early years.

FORESTS IN THE POST-UNCED PERIOD

Advocates of a forest convention were amongst those who established the World Commission on Forests and Sustainable Development (WCFSD) in the follow-up to UNCED. The Commission was led by Indonesian economist and environmentalist Professor Emil Salim and former Swedish prime minister Ola Ullsten (Salim and Ullsten 1999). Spears headed the secretariat of the commission. Like others, he was clearly conscious of the neglect of extra-sectoral issues and the livelihoods of forest-dependent people. When the Commission presented an interim report at a meeting of the TFAP forestry advisors at FAO in Rome, one of the main conclusions was that a legally binding, inter-governmental convention on forests was still needed, notwithstanding some contrary views (Gluck *et al*. 1996). The final commission report (Salim and Ullsten 1999) did not explicitly call for a convention but it did include a set of recommendations which those familiar with the process will recognise as heavily influenced by Spears' thinking.

A gradual shift was occurring during the 1990s towards a people-centred approach to forest issues – indigenous peoples' advocates began to have a significant impact on forest policies and programmes (Colchester and MacKay 2006). The issues around local people and forests were complex and it was easy to allow emotion to dictate responses. A more balanced view of the issues was needed and a number of international events began to unravel the complexity of the interests of local forest-dependent people (Byron and Arnold 1999). Spears always ensured that forest peoples' advocates had a seat at the decision-making table.

FIGURE 1 *Recommendations of the World Commission on Forests and Sustainable Development.* "*Our Forests. . . Our Future*" (Salim and Ullsten 1999)

Summary Recommendations

- Stop the destruction of the earth's forests: their material products and ecological services are severely threatened.
- Use the world's rich forest resources to improve life for poor people and for the benefit of forest-dependent communities.
- Put the public interest first and involve people in decisions about forest use.
- Get the price of forests right, to reflect their full ecological and social values, and to stop harmful subsidies.
- Apply sustainable forest management approaches so we may use forests without abusing them.
- Develop new measures of forest capital so we know whether the situation is improving or worsening.
- Plan for the use and protection of whole landscapes, not the forest in isolation.
- Make better use of knowledge about forests, and greatly expand this information base.
- Accelerate research and training so sustainable forest management can become a reality quickly.
- Take bold political decisions and develop new civil society institutions to improve governance and accountability regarding forest use.

The Commission report was prescient in focussing attention on issues that have since become central to the international forest conservation debate. The recommendations gave prominence to forests as a resource, and to sustainable management; it was the first inter-governmental document to refer to "landscapes" and recognised *institutions* and *knowledge* as key needs. Meanwhile, international debate on forests was shifting to the conferences of the parties of the Rio conventions, notably the UN Convention on Climate Change and the Convention on Biodiversity. The report of the WCFSD contained much good analysis but it achieved little traction as attention shifted to climate change, desertification and biodiversity (Humphreys 2006). The call for a convention did not elicit any reaction.

Even before the UNCED summit in Rio, the international debate on forests had focussed on a succession of interventions aimed at sustainable management of forests. International attention and funding followed these fashions in what Bull *et al*. (2018) described as a "Whack a mole" syndrome. A tension emerged between advocates of "silver-bullet" solutions and those who recognised the need for integrated, holistic approaches to forests and land use. Spears aligned with the latter community.

International forest policy negotiations have been heavily influenced by so-called SIFs – Single Issue Fanatics – this term was originally used by the British journalist and historian Bernard Levin to describe narrowly focussed activists who profoundly influenced British politics. The term is now applied to some aspects of medicine where practitioners focus excessively on a single procedure to solve a medical problem (Barraclough 2013). To a polymath like Levin, SIFs were particularly annoying. He found them "tedious, offensive and dangerous. They were simply bores, organised into armies." (http://lastditch.blogspot.com/2005/04/bernard-levin-and-single-issue-fanatic.html). We contend that the influence of SIFs on policy decisions on forests has brought new issues to prominence but has had a negative impact in the sense that it has led to excessive influence of simplistic populism. We believe that Spears would have agreed with our view and would have shared our belief in addressing forest issues in their full complexity.

There are many examples of initiatives led by armies of SIFs that claimed to have identified a pathway to forest conservation and sustainable use. Studies of forest use in the Amazon led to claims that the values of non-timber products to local people was sufficiently great to make forest conservation a financially legitimate reason for preserving forests (Godoy and Bawa 1993, Peters *et al*. 1989). Comprehensive assessments of the real contribution of non-timber forest products (NTFPs) to development in tropical countries showed that NTFPs were indeed of great importance for rural livelihoods but that they often did not provide a basis for significant economic growth and provided less livelihood benefits as economies advanced (Belcher *et al*. 2005).

Biodiversity advocates have often argued that the potential economic and medical benefits obtained from rainforest plants and animals provided a further justification for conservation. One pharmacological corporation, Merck, launched a major initiative to exploit such resources and proposed to reinvest the profits into conservation. Merck invested in a highly visible initiative in Costa Rica which received much international attention (Gámez 2012). Prospects for replicating such schemes on a large scale to fund forest conservation were greeted enthusiastically (Garrity and Hunter-Cevera 1999). However the results of such initiatives were disappointing (Firn 2003) and the major multi-national companies were accused of duplicity and bio-piracy (Shiva 2007).

Forest professionals had long argued that that logging was not a cause of tropical deforestation but environmental groups and political leaders persisted in focussing their attention on the need to control timber extraction (Bowles *et al*. 1998). Negotiations to establish a tropical timber cartel began in the early 1980s and led to the establishment of the International Tropical Timber Organization (ITTO) in 1983. The underlying aim of the ITTO was to encourage forest industries to incorporate the environmental values of forests in their balance sheets. The intention was to reinvest profits from timber harvesting in sustainable forest management (Poore 2012). The meetings of the ITTO became a major point of contact between timber industries and environmentalists who opposed logging. The ITTO invested in projects to demonstrate improved timber harvesting (including "reduced impact logging") and in the development of guidelines for best practice (Poore 2013). It also conducted surveys of the extent of tropical timber harvesting and assessed the degree to which operations were sustainable (Blaser *et al*. 2011). ITTO pursued its mission during a period when attention was shifting away from logging as the problem towards a different view – that investors were less interested in timber and were focussing on agricultural crops. Harvesting timber from tropical forests has declined as i) readily accessible resources were depleted, ii) environmental and trade regulations increased costs and iii) alternative uses of tropical forest lands became more attractive (Poore and Sayer 1991).

Both the ITTO and NGOs took great interest in the concept of forest certification. Certification began from a recognition that not all logging was destructive and unsustainable, and sought to create market differentiation (hence improved market access and perhaps a price premium) for wood from forests certified as "sustainably managed". Again, Spears was involved and led the production of a Forest Certification Assessment Guide for the World Bank. Spears also saw the need for a stepwise process to move small-scale producers up the certification ladder. Like so many other initiatives, the impacts of certification on the fate of tropical forests have been much more modest than was expected (Putz and Romero 2015).

Running in parallel to all the international debates were numerous local initiatives to address forest conservation. Integrated Conservation and Development Projects enjoyed their day in the sun (McShane and Newby 2004). Ecosystem approaches initially developed to reconcile forest harvesting with environmental protection in the Pacific Northwest of the USA and Canada (Kohm and Franklin 1997) were succeeded by landscape approaches as models for more inclusive forest conservation (Sayer *et al*. 2005).

The potential of making payments to communities for the environmental services provided by their forests has been a continuing background theme of the conservation movement. Payments for environmental services will one day be needed, but have progressed slowly in poor countries (Wunder *et al*. 2008). The latest iteration of payment for ecosystem services (PES) has been 'Reducing emissions from deforestation and degradation plus (REDD+)' (Clements *et al*. 2010). The pros and cons of REDD+ have generated a considerable literature but action on the ground has been generally disappointing (Angelsen *et al*. 2012). Ultimately it would seem essential that people be paid for benefits that they forgo in order to protect public goods values of forests but after decades of attempts such programmes have achieved little traction in the tropical developing world (Wunder *et al*. 2008).

Spears' influence at the World Bank came at a time when the "Washington Consensus" (Pettinger 2017) was strongly advocating free markets, reduced regulation and globalised economies. Spears weathered the storms of Reaganomics and Thatcherism that might have taken the forest agendas of Washington institutions in a quite different direction from that steered by Spears. Even after his official retirement, he continued his involvement as a volunteer resource person to the Advisory Group on the World Bank Forest Strategy in the early 2000s. He was instrumental in developing "Safeguards for the Bank-funded forest projects in the tropics". The "Safeguards" had the unintended consequence of severely limiting the ability of the World Bank to lend for forestry investments. With a very small number of like-minded people in Washington, Spears had a profound influence on the emergence of today's global environmental agenda. Their influence came from their ability to build strong coalitions and relate global policy agendas to the harsh realities of life in rural areas in developing countries.

CONCLUSIONS

There were expectations and fears in the 1970s and 80s, of headlong destruction of all the world's tropical forests. Such fears were well justified at the time. This review is a brief summary of some of the major events that have determined international policies and programmes on forests. John Spears played a pivotal role in many of the international debates over the past five decades. In retrospect, it now seems clear that there was never just one single cause of tropical deforestation, or one single, simple remedy that would be effective for all countries.

"Fake news" and simplistic populist claims about forests derailed many global conservation initiatives. Spears navigated his way through the cacophony of conflicting views and retained his focus on a balanced pathway that responded to multiple conflicting interests and agendas. Spears was part of a small but very influential group who were continually searching for solutions. He had the capacity to assimilate the lessons from international interventions in diverse areas. Spears was central to initiatives to control tropical logging, develop alternatives to slash and burn agriculture, encouraging appropriate and sustainable estate crops, making aid agencies and particularly the World Bank recognise the importance of integrated approaches to forest and land management. Spears made significant contributions through exerting the influence of the World Bank in policy reforms that favoured sustainable forestry. He was a strong advocate for increased forest research, education and capacity building, and supporting young scientists from developing countries.

Spears did not publish extensively in the academic literature but those papers that he did publish carried weight. His legacy is not found in libraries, but in practical attempts to deliver the highest standards of forest management for people and the environment. The greatest strength of Spears' contribution was to be rooted in the real life experience he gained during his time as a forest officer in Kenya. Contemporary negotiations on forest issues take place amongst diplomats and politicians who do not have "skin in the game" (Taleb 2018). There is a disconnect between global forest discourses and local forest realities (Bull *et al*. 2018). Much elite research strives to produce global generalizations when local contexts and realities are more important (Boedhihartono *et al*. 2018). Spears was one of few individuals who was able to operate at the highest political levels whilst retaining the pragmatism that came from deep engagement on the ground and an insatiable curiosity to search out pragmatic, realistic solutions.

We fear the contemporary organisation and funding of academia, activism and forest practice could make it unlikely that others will emerge with the breadth and depth of knowledge and the capacity for influence that enabled Spears to have such far-reaching impact on the forests that will exist as the 21st century progresses. Spears was a policy entrepreneur (Faling *et al*. 2019). He was constantly building coalitions to explore and promote meaningful policies. Spears led the generation, implementation and introduction of new ideas into the international forest policy debate (Mintrom and Norman 2009) and as such has had a huge influence on forest policy during recent decades.

Our review of the factors that have influenced the global debate on forests suggests that scientific papers in elite journals have had relatively little direct influence. Studies suggesting single factor remedies to the forest problem did not guide decision makers towards actions. There was a need for pragmatic "joined-up" thinkers who could assimilate science and practice and package them in a form that was useful in the policy process. We believe that throughout the period from 1980 to 2010 Spears was one of a very small number of people who played this role very effectively. Today the number of publications and conferences addressing global forest issues has increased dramatically but it is often difficult to measure their impact on real-life decision-making. Spears had the unique intellect, tolerance and human qualities that were needed to weave together plausible ways forward during his period of involvement. Today we fear that the debate on forests is becoming more and more detached from on-the-ground realities.

Spears recognised that as human populations in tropical countries grow, their economies will expand and pressures on land will increase. The area and condition of forests is

therefore likely to decline unless there is careful, wise and prolonged management. Spears was always searching for initiatives that might deliver such smarter, more-effective management on the ground. Much of the decline may be inevitable – numerous well-intended international and national conservation initiatives have failed to stem changes – but Spears' legacy may be to keep searching for options that deliver real outcomes. In researching this paper, we have sought the views of many who were involved in forest policy discussions during recent decades. Many of his contemporaries would agree with Ken MacDicken who – in reviewing an early draft of this paper – expressed the opinion that "Spears' presence in meetings almost always resulted in a higher-level of discussion".

Spears was incontestably a "connected up thinker" he was not aligned with any single doctrine about forests. Spears brought together diverse interest groups and facilitated thoughtful and progressive processes. The world needs fewer SIFs and more people like Spears who can understand and interpret the full complexity of the many "wicked problems" that confront the world of forests.

ACKNOWLEDGEMENTS

We recognise the role that John Spears played in teaching us about the challenges of sustainably managing forests. We have benefitted from discussions with many of John's contemporaries in writing this paper. We would like especially to thank Hosni El-Lakany, Jim Douglas, Hans Gregersen, David Kaimowitz, David Cassells and Peter Dewees. Katherine McNamara and Nathalie Spears provided valuable insights in our quest to review John Spears' contributions.

REFERENCES

ANGELSEN, A., BROCKHAUS, M., SUNDERLIN, W.D. and VERCHOT, L.V. 2012. (eds) *Analysing REDD+: challenges and choices*. CIFOR, Bogor, Indonesia.

BALINT, P.J., STEWART, R.E., DESAI, A. and WALTERS, L.C. 2011. *Wicked environmental problems: managing uncertainty and conflict*. Island Press, Washington D.C.

BARRACLOUGH, K. 2013. Beware the influence of the "SIF" (single issue fanatic) in clinical guidelines. *BMJ* **347**: f4719.

BELCHER, B., RUÍZ-PÉREZ, M. and ACHDIAWAN, R. 2005. Global patterns and trends in the use and management of commercial NTFPs: implications for livelihoods and conservation. *World Development* **33**(9): 1435–1452.

BLASER, J., SARRE, A., POORE, D. and JOHNSON, S. 2011. Status of tropical forest management 2011. *ITTO Technical Series* **38**(June): 376–384.

BOEDHIHARTONO, A.K., BONGERS, F., BOOT, R.G., VAN DIJK, J., JEANS, H., VAN KUIJK, M., KOSTER, H., REED, J., SAYER, J. and SUNDERLAND, T. 2018. Conservation science and practice must engage with the realities of complex tropical landscapes. *Tropical Conservation Science* **11**: 1–7 [https://doi.org/10.1177/1940082918779571]

BOWLES, I.A., RICE, R.E., MITTERMEIER, R. and DA FONSECA, G.A. 1998. Logging and tropical forest conservation. *Science* **280**(5371): 1099–1200.

BULL, G., BOEDHIHARTONO, A., BUENO, G., CASHORE, B., ELLIOTT, C., LANGSTON, J., RIGGS, R. and SAYER, J. 2018. Global forest discourses must connect with local forest realities. *International Forestry Review* **20**(2): 160–166.

BYRON, N. and ARNOLD, M. 1999. What futures for the people of the tropical forests? *World Development* **27**(5): 789–805.

CHAYTOR, B. 2001. *The development of global forest policy: overview of legal and institutional frameworks*. International Institute for Environment and Development (IIED) and the World Business Council for Sustainable Development (WCBSD), London.

CLEMENTS, G.R., SAYER, J., BOEDHIHARTONO, A.K., VENTER, O., LOVEJOY, T., KOH, L.P. and LAURANCE, W.F. 2010. Cautious optimism over Norway-Indonesia REDD Pact. *Conservation Biology* **24**(6): 1437–1438.

COLCHESTER, M. and MacKAY, F. 2006. Forest peoples, customary use and state forests: the case for reform. Paper to 11th Biennial Congress of the International Association for the Study of Common Property, Bali, Indonesia, 19–22 June 2006.

FALING, M., BIESBROEK, R., KARLSSON-VINKHUYZEN, S. and TERMEER, K. 2019. Policy entrepreneurship across boundaries: a systematic literature review. *Journal of Public Policy* **39**(2): 393–422.

FIRN, R.D. 2003. Bioprospecting–why is it so unrewarding? *Biodiversity and Conservation* **12**(2): 207–216.

GÁMEZ, R. 2012. The link between biodiversity and sustainable development: Lessons from INBio's bioprospecting programme in Costa Rica. In McMANIS, C. (ed.) *Biodiversity and the Law*, Routledge, U.K., 77–90.

GARRITY, G.M. and HUNTER-CEVERA, J. 1999. Bioprospecting in the developing world. *Current Opinion in Microbiology* **2**(3): 236–240.

GIBBS, H.K., RUESCH, A.S., ACHARD, F., CLAYTON, M.K., HOLMGREN, P., RAMANKUTTY, N. and FOLEY, J.A. 2010. Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s. *Proceedings of the National Academy of Sciences* **107**(38): 16732–16737.

GLÜCK, P., TARASOFFSKY, R., BYRON, R. and TIKKANEN, I. 1996. Options for strengthening the international legal regime for forests: a report prepared for the European Commission under the study contract B7-8110/96/000221/D4. (Proposal for a legally binding instrument on forest).

GODOY, R.A. and BAWA, K.S. 1993. The economic value and sustainable harvest of plants and animals from the tropical forest: assumptions, hypotheses, and methods. *Economic Botany* **47**(3): 215–219.

GREGERSEN, H.M., ORAM, P. and SPEARS, J. 1992. *Priorities for forestry and agroforestry policy research: report on an international workshop.* International Food Policy Research Institute, Washington, D.C.

HARRISON, R.P. 2009. *Forests: The Shadow of Civilization*, University of Chicago Press.

HUMPHREYS, D. 1996. The global politics of forest conservation since the UNCED. *Environmental Politics* **5**(2): 231–257.

HUMPHREYS, D. 2006. *Logjam: deforestation and the crisis of global governance*. Cambridge University Press, Cambridge.

HUMPHREYS, D. 2015. Negotiating the future under the shadow of the past: the eleventh session of the United Nations Forum on Forests and the 2015 renewal of the international arrangement on forests. *International Forestry Review* **17**(4): 385–399.

KEEBLE, B.R. 1988. The Brundtland report: 'Our common future'. *Medicine and War* **4**(1): 17–25.

KOHM, K.A. and FRANKLIN, J.F. 1997. *Creating a forestry for the 21st century: the science of ecosystem management*. Island Press, Washington D.C.

KUNZMANN, K. 2008. The non-legally binding instrument on sustainable management of all types of forests- towards a legal regime for sustainable forest management? *German Law Journal* **9**(8): 981–1006.

McSHANE, T.O. and NEWBY, S.A. 2004. Expecting the unattainable: the assumptions behind ICDPs. In: McSHANE, T.O. and Wells, M.P. (eds) *Getting biodiversity projects to work: towards more effective conservation and development.* Columbia University Press, New York, 49–74.

MINTROM, M. and NORMAN, P. 2009. Policy entrepreneurship and policy change. *Policy Studies Journal* **37**(4): 649–667.

MYERS, N. 1979. *The sinking Ark. A new look at the problem of disappearing species*. Pergamon Press, Oxford.

MYERS, N. 1992. *The primary source: tropical forests & our future*. WW Norton & Company, Inc, New York.

PALM, C., VOSTI, S.A., SANCHEZ, P.A. and ERICKSEN, P.J. (eds) 2005. *Slash-and-burn agriculture: the search for alternatives*. Columbia University Press, New York.

PETERS, C.M., GENTRY, A.H. and MENDELSOHN, R.O. 1989. Valuation of an Amazonian rainforest. *Nature* **339**(6227): 655.

PETTINGER, T. 2017. *What Would Keynes Do?* Octopus Press UK.

POORE, D. 1976. *The values of the tropical moist forest ecosystems and the environmental consequences of their removal.* Forestry Department, Committee on Forest Development in the Tropics-4. Session. Rome, 15 Nov 1976. FAO, Rome.

POORE, D. 2012. *Changing landscapes: the development of the International Tropical Timber Organization and its influence on tropical forest management*. Routledge, U.K.

POORE, D. 2013. *No timber without trees: sustainability in the tropical forest.* Routledge, U.K.

POORE, D. and SAYER, J. 1991. *The management of tropical moist forest lands. Ecological guidelines*. IUCN, Gland, Switzerland.

PUTZ, F.E. and ROMERO, C. 2015. Futures of tropical production forests. CIFOR Occasional Paper No 143, Bogor, Indonesia.

SALIM, E. and ULLSTEN, O. 1999. *Our forests, our future: report of the World Commission on Forests and Sustainable Development*. Cambridge University Press, Cambridge.

SAYER, J.A. 1995. Science and international nature conservation. CIFOR Occasional Paper No. 4, Bogor, Indonesia.

SAYER, J. 2007. The peoples' forest: balancing local and global values. Doctoral thesis, Universidad Autónoma de Madrid.

SAYER, J.A., MAGINNIS, S. and LAURIE, M. (eds) 2005. *Forests in landscapes: Ecosystem approaches to sustainability*. IUCN, Forest Conservation Programme, Earthscan, London.

SHIVA, V. 2007. Bioprospecting as sophisticated biopiracy. *Signs: Journal of Women in Culture and Society* **32**(2): 307–313.

SINGER, B. and GIESSEN, L. 2017. Towards a donut regime? Domestic actors, climatization, and the hollowing- out of the international forests regime in the Anthropocene. *Forest Policy and Economics* **79**: 69–79.

SPEARS, J.S. 1979. Can the wet tropical forest survive? *The Commonwealth Forestry Review* **58**(3 (177): 165–180.

SPEARS, J.S. 1980. Can farming and forestry coexist in the tropics. *Unasylva* **32**(128): 2–12.

SPEARS, J. 1987. Agroforestry: a development-bank perspective. In: STEPPLER, H.A. and NAIR, P.K.R. (eds) *Agroforestry: a decade of development*. ICRAF, Nairobi, 53–66.

SPEARS, J. and AYENSU, E.S. 1985. Resources, development and the new century: forestry. In: REPETTO, R. (ed.) *The global possible. Resources, development and the new century*. Yale University Press, New Haven, 299–335.

SPEARS, J., ORAM, P., BYRON, N., SCHERR, S. and IZAC, A. 1995. A review of tropical forestry and agroforestry problem areas and policy research needs and the planned response of the CGIAR system. CIFOR Working Paper No. 5, Bogor, Indonesia.

SPEARS, J. and YUDELMAN, M. 1979. Forests in development. *Finance and Development* **16**(4): 41.

TALEB, N.N. 2018. *Skin in the game: hidden asymmetries in daily life*. Random House, New York.

WESTOBY, J.C. 1962. Forest industries in the attack on economic underdevelopment. *Unasylva* **16**(4): 168–201.

WESTOBY, J.C. 1975. Making trees serve people. *The Commonwealth Forestry Review* **54**(3/4/161–2): 206–215.

WINTERBOTTOM, R. 1990. *Taking stock: the tropical forestry action plan after five years*. World Resources Institute, Washington, D.C.

WUNDER, S., CAMPBELL, B., FROST, P.G.H., SAYER, J.A., IWAN, R. and WOLLENBERG, L. 2008. When donors get cold feet: the community conservation concession in Setulang (Kalimantan, Indonesia) that never happened. *Ecology and Society* **13**(1): 12 [online].

Forest communities in control: are governments and donors prepared to help them thrive?

G. SEGURA WARNHOLTZ[a], A.A. MOLNAR[b] and N. AHUJA[a]

[a]*The World Bank, 1818 H. Street, NW, Washington, D.C. 20433*
[b]*Independent anthropologist specialized in natural resource management*

Email: molnara@mac.com, gsegura@worldbank.org, nahuja@worldbank.org

SUMMARY

John Spears, a visionary forest advisor to the World Bank in the 1970s, was an early advocate of the idea that communities could be good stewards of forest lands as well as providers of forest products and environmental services. At that time, most developing countries followed colonial policies claiming ownership and control of forests as national assets. The 1978 World Bank forest strategy stimulated a dialogue for a future where communities would have statutory rights over land and forests. Community-based forest management is now expanding, underpinned by a very different body of law, policy, and regulation. More developing countries now recognize locally-controlled forestry as an economic engine, providing multiple economic, social and environmental benefits. What has contributed to this policy shift and endorsement of collective rights? How has secure tenure contributed to make Community Forest Enterprises successful? What are the expectations on delivery of sustainable development goals? How do communities intersect with commercial value chains for forest resources and environmental services? This paper explores answers to some of these questions, and discusses some challenges currently faced by communities and their enterprises, and the options governments and donors have to help them succeed.

Keywords: forest tenure security, community forestry enterprises, locally-controlled forestry, community governance, customary tenure

Communautés forestière à la barre: les gouvernements et les donateurs sont-ils prêts à leur permettre de prospérer?

G. SEGURA WARNHOLTZ, A.A. MOLINAR et N. AHUJA

John Spears, un conseiller forestier visionnaire de la Banque mondiale dans les années 70 était un promoteur de la première heure de l'idée que les communautés pourraient devenir de bons intendants des terres forestières ainsi que des fournisseurs de produits forestiers et de services environnementaux. Durant cette époque, la plupart des pays en voie de développement suivaient les politiques coloniales qui faisaient de la propriété et du contrôle des forêts des atouts nationaux. La stratégie forestière de la Banque mondiale stimulait un dialogue faisant du futur un monde où les communautés possèderaient des droits statutaires sur les terres et les forêts. La gestion forestière communautaire est actuellement en pleine expansion, soutenue par des corps bien différents de loi, de politique et de régulation. Davantage de pays en voie de développement reconnaissent à présent la foresterie contrôlée au niveau local comme un engin économique fournissant de multiple bénéfices économiques, sociaux et environnementaux. Qu'est-ce qui a contribué à ce glissement de politique et à cette adoption des droits collectifs? Comment le régime foncier sûr a-t-il contribué au succès des entreprises de foresterie communautaires? Quels sont les espoirs d'atteindre les buts de développement durable? Comment les communautés croisent-elles les chaînes de valeurs commerciales des ressources forestières avec celles des services environnementaux? Ce papier explore des réponses à certaines de ces questions et examine quelques défis auxquels font actuellement face les communautés et leurs entreprises, et les options dont disposent les gouvernements et les donateurs pour les aider à y parvenir.

Las comunidades forestales en control: ¿están los gobiernos y los donantes preparados para ayudarlas a prosperar?

G. SEGURA WARNHOLTZ, A.A. MOLNAR y N. AHUJA

John Spears, un asesor forestal visionario del Banco Mundial en la década de 1970 fue uno de los primeros defensores de la idea de que las comunidades podían ser buenas gestoras de las tierras forestales, así como proveedoras de productos forestales y servicios ambientales. En esa época, la mayoría de los países en desarrollo seguían políticas coloniales que reivindicaban la propiedad y el control de los bosques como bienes nacionales. La estrategia forestal del Banco Mundial de 1978 estimuló un diálogo hacia un futuro en el que las comunidades tendrían derechos legales sobre la tierra y los bosques. La gestión forestal comunitaria se está expandiendo ahora, sustentada por un acervo muy diferente de leyes, políticas y reglamentos. Cada vez son más los países en desarrollo que reconocen ahora que la silvicultura controlada localmente es un motor económico que proporciona múltiples beneficios económicos, sociales y medioambientales. ¿Qué ha contribuido a este cambio de dirección en

las políticas y al respaldo de los derechos colectivos? ¿Cómo ha contribuido la seguridad de la tenencia al éxito de las Empresas Forestales Comunitarias? ¿Cuáles son las expectativas en cuanto al cumplimiento de los Objetivos de Desarrollo Sostenible? ¿Cómo se entremezclan las comunidades con las cadenas de valor comercial de los recursos forestales y los servicios ambientales? En este artículo se examinan las respuestas a algunas de esas preguntas y se analizan algunos de los retos a los que enfrentan actualmente las comunidades y sus empresas, así como las opciones de que disponen los gobiernos y los donantes para ayudarlas a tener éxito.

INTRODUCTION

John Spears, a World Bank forest advisor for over a decade in the 1970s, pioneered ideas about the role of forests and forestry in rural development that continue to be as relevant as they were more than 40 years ago (World Bank 1978). Spears was interested to move away from an exclusive focus on forestry as an economic sector, perceiving forestry's contribution to development in its much broader sense, particularly for poor, rural areas. He understood the multifunctional role that forest ecosystems have in generating goods and services at different geographical and temporal scales, and the benefits they provide to different segments of society. He also understood the substantial interactions that forests have with food production and food security, and the fact that the most affected and vulnerable of all stakeholders to limited and inefficient forest policies were the local, in the majority poor, communities in these areas. He was one of the first to recognize the need for a paradigm shift to increasing the share of forest benefits to local communities and small farmers for a more equitable rural development in forest landscapes still generating goods and services for the nation. What he did not realize at the time, is how important recognition of forest community ownership is to achieve and sustain forests as a source of livelihoods and other benefits.

Many of the challenging trends of the 1970's, revisited by Spears and others in the late 1990's (World Commission on Forests and Sustainable Development 1999), not only continue to be valid today, but also many have sharpened, particularly affecting the rural poor. In 2014, an estimated 1.3 billion people depended on forests for some aspect of their livelihoods (FAO 2015). Many forest landscapes inhabited by communities in the developing world have a strong geographical coincidence with areas of high and extreme poverty worldwide (Sunderlin *et al.* 2007 and Sunderlin *et al.* 2005) and in 2008 an estimated 1.2 billion forest-dependent people were living in extreme poverty (PROFOR 2008). This coincidence has continued to increase, as rural populations grow with a continued dependency on increasingly scarce forest products, including wood for fuel and house building materials.

Forest landscapes are inhabited by many local communities and are prominently governed through community-based tenure systems, estimated broadly to involve 3 billion people globally, mainly in developing countries (Alden Wily 2018). Limited legal recognition and support for community-based tenure rights in these areas has led to tenure insecurity. In the last three decades, however, several factors have converged to prompt a shift in the legal ownership and the control of forest lands to local communities mainly under collective tenure arrangements. These shifts in tenure paradigms have resulted in significant changes to legal frameworks and the area of land formally held by peoples and local communities under collective tenure (Alden Wily 2018, 2019).

Although the positive trend toward tenure recognition is expected to continue, issues of competing interests, lack of political will for reforms, limited government capacity, and/or lack of coordination across land and other ministries hinder effective protection to tenure rights of local communities (RRI 2018 and Segura Warnholtz *et al.* 2017). At the same time, global demand for agricultural commodities and natural resources has prompted governments to allocate land to large-scale industrial concessions, including in places where smallholders and communities maintain customary claims (Anseeuw *et al.* 2012, Molnar *et al.* 2011, Roth 2013 and The Land Matrix, 2011), thus increasing pressures on land across the rural, forested landscapes of many developing countries. Despite significant progress, gaps remain both in the extent of legal reforms and in their effective implementation (RRI 2014). The combination of unfinished tenure reforms and these new pressures risk undermining progress towards achievement of the human rights, rural development, and environmental objectives that have motivated many of these initiatives to date (Forest Peoples Programme 2017, United Nations 2016).

The role of governments, development partners and conservation organizations continue to be highly relevant in this emerging paradigm to promote rural development by local stakeholders in forest landscapes. For this paradigm to succeed, a different approach of how governments and development partners interact and negotiate with local communities and their organizations is needed. Local communities need to be recognized as the key players in their rural space, and the support brought to them must respond to local conditions, needs and traditional forms of government. Communities conducting commercial forestry will also need assistance to ensure a fair and competitive access to markets (Johnson 2016, Macqueen and Mayers 2019, Scherr *et al.* 2004,) For those whose forests do not have commercial potential, alternatives can be found that compensate for their contribution to conserve biodiversity and other environmental services.

This essay comments on some of the issues and new challenges confronting community forestry. More than an exhaustive review, this work reflects on some of the visionary ideas developed by John Spears more than 40 years ago. The authors have spent most of their careers seeking ways to enable forest communities to maximize their locally-controlled forestry and related enterprise. The essay presents some reflections on that experience and notes relevant academic contributions to these issues.

TRENDS IN FOREST TENURE

Significant changes in land and forest ownership have occurred since John Spears oversaw the 1978 World Bank forest policy (World Bank 1978). While most forests continue to be in the hands of governments, informal, customary and modified customary systems of land tenure prevail in most developing countries. Estimates range widely, but perhaps as much as 65 percent of the world's total land area is managed under some form of these systems. The land area held by Indigenous Peoples and Local Communities (IPLC)[1] under statutory laws was estimated at 18 percent of the world's land in 2015 (RRI 2015). The comparable figure for forest lands held by local communities under statutory laws is about 16 percent of the world's forests (RRI 2014). As evidence continues to grow as to the positive outcomes of supporting community-based tenure that empowers local communities as forest stewards (e.g. FAO 2016, Persha *et al.* 2011 and Seymour *et al*. 2014), it is expected that this shift in tenure will continue to expand in many developing countries.

Within specific regions, over 90 percent of Africa's rural populations access land through customary or formalized new-customary institutions, and a quarter of the sub-Saharan continent's land area – some 740 million hectares – is made up of communal property, such as forests, rangelands, swamps and deserts (Blomley 2013). Approximately 40 percent of Amazon region forests fall within customary lands of indigenous peoples (Alcorn 2014). Across the Asia region, 34 percent of total forest area is estimated to fall under community forestry schemes (Gilmour 2016). A study focusing specifically on Indigenous Peoples concludes that indigenous peoples have rights to and/or de facto manage over 25 percent of the world's land surface (Garnett *et al.* 2018)[2].

In practice, government's reach in the forests in developing countries is often on paper and most forest landscapes continue to be governed through formal or informal customary systems globally (Agrawal 2007 and Robinson *et al.* 2017b). In many developing countries statutory recognition of communal lands is now becoming an accepted element of property relations and, increasingly considered a lawful class of property. For all the progress, there can still be considerable confusion on the ground where customary systems are the de facto reality, but where multi-layers of authority and regulations at different government levels can either support customary actors or stymie their efforts in forest management and conservation (Client Earth 2019, Faure *et al.* 2019 and Hajjar and Molnar 2016).

An assessment in 41 countries representing over 93 percent of the world's forests shows that two-thirds of the further shift in community tenure between 2013–2017 was related to increases in community ownership, with over 90 percent of this progress occurring in developing countries (RRI 2018). Governments in these countries have legally designated rights to IPLC in an area over 521 mha (15.3 percent). In contrast, 2,473 mha (70 percent) continue to be formally administrated by governments, and approximately 407 mha (12 percent) privately owned by individuals and firms (excluding concessions) (RRI 2018).

Another recent study found that 73 of 100 countries surveyed had adopted legislation allowing for the formal recognition of community-based land rights (Alden Wily 2018). Several governments now recognize ancestral or traditional communal property rights, without requiring formal registration; and others have devised new registration processes for formalizing existing rights (Alden Wily *et al.* 2016).

Important international processes have also stimulated the recognition of customary rights. The International Labour Organization, Indigenous and Tribal Peoples Convention (ILO No. 169 adopted in 1989), followed by the United Nations Permanent Forum on Indigenous Issues (UNPFII) established in 2000; and culminating with the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) of 2007 have been key milestones and guides for advocacy. The Millennium Development Goals of 2000, and their expansion to the current 17 goals of the Sustainable Development Agenda of 2015, have promoted recognition of customary systems. Tenure security is increasingly recognized as a basic human right (United Nations 2016 and Forests and Peoples Program 2017). The Sustainable Development Goals (SDGs) have provided a sound framework to address the role of forest lands and their tenure through targets for poverty reduction, food security, inclusive and sustainable economic growth, gender equality, forest sustainability, and combating climate change.

Multiple interests and competing land uses influence the integrity of customary lands and forests held by IPLC. These may include concessions for various types of commercial investment (extractives, forest, agribusiness, infrastructure, etc.) or state-designated protected areas for conservation. Historically, commercial and state interests have justified expropriation of community land and/or severely restricted resource use and continue to compete for such lands and resources (Cotula *et al.* 2009 and Messerli *et al.* 2015). Without higher and improved standards for recognizing and respecting existing rights, states will further displace rights-holders, undermining a key foundation for livelihoods, development and environmental protection. Successful reforms are those that clearly define what rights are being transferred, and what development outcomes are expected. Where outside actors seek to make (economic or conservation-related) investments potentially affecting customary lands, Free, Prior and Informed Consent (FPIC) is helping to reduce conflict and foster reliable community-company partnerships and new community-based approaches to conservation (Segura Warnholtz *et al.* 2017). Adequate legal provisions have also

---

[1] This term includes, but is not limited to, the concept of "Indigenous Peoples and Sub-Saharan African Historically Underserved Traditional Local Communities"; which was adopted by the World Bank in its Environmental and Social Framework.

[2] Around 521 Mha of forest land is estimated to be legally owned, recognized, or designated for use by IPLC as of 2017 (RRI 2018), predominantly in Latin America, followed by Asia and Africa.

guided a more free and equitable sharing of benefits (Kishor and Rosenbaum 2012 and World Bank 2013).

The agricultural literature substantiates that recognizing property rights of communities and smallholders can be a source of agricultural growth, structural transformation, and poverty reduction (de Janvry *et al.* 2018). This desirable outcome, however, requires that land reforms be complete; both providing access to secure property titles, and to opportunities to use assets productively and competitively (Warriner 1969). A similar finding is true for community forests: that the natural capital – forests – and access to markets are key for successful forest communities and their productive enterprises (Ostrom and Schlager 1992). Reforms that transfer only degraded lands and forests, or that limit the management decision-making and ability to control outsiders, can hardly help reduce poverty or conserve biodiversity.

LOCALLY-CONTROLLED FOREST MANAGEMENT AND CONSERVATION

The current trends of recognition and devolution of tenure rights to IPLC were presaged by John Spears in the 1978 forest policy. What few country governments realized then was the extent to which locally-controlled forestry (private and community owned) already formed the backbone of forest industry in higher-income countries – e.g., USA and northern Europe--nor that this trend would grow.

Small is indeed big, as some authors have often noted (Mayers *et al.* 2016 and Verdone 2018). In contrast to the domination of forest industry in lower-income countries by concessions, the forests generating commercial products in the USA are mostly owned by smallholder farmers, as well as private individuals or corporations that do not operate wood-processing plants (Indufor Group 2017). As noted by these authors, such non-industrial private forests make up 59% of the total timberland in the USA and contribute nearly 50% of US timber. There are 7 million non-industrial forest owners, though only about 600,000 have holdings larger than 40 ha (contributing 80% of the non-industrial harvest). Their productivity is equally noteworthy. A study by the US Forest Service found that these private forests contributed US$277/ per acre more to GDP on average than the public lands (US$318 vs US$41) in 2009 (Forest2Market 2016).

Small private or family forestry business are also a major supplier of commercial forest products in Europe. In Finland, Sweden and Norway private ownership covers 60–70% of the land. Outgrower and government-incentivized schemes are also expanding in Asia, Latin America, and East Africa – where there has long been a tradition of tree farming adapted to market opportunities. Following this trend, a comprehensive policy reform in China has devolved vast government forest plantations areas to collective responsibility forests (managed by individuals within the collective unit) to more efficiently supply the pulp, paper and wood industry than the state plantations being replaced (Xie, L. *et al.* 2016)

The potential benefits of giving communities a more prominent role in forest management and conservation, including their use of tropical forests for desired ends and intangible benefits, while conserving the forest has ever more evidence (Gannett *et al.* 2018). An analysis of 80 forest commons across 10 countries links rule-making autonomy at the local level with greater forest carbon storage and higher livelihoods benefits (Hayes and Persha 2010, Persha *et al.* 2011). Success in community forestry has also been associated to different forms of social capital (e.g. internal and external to the collective group), and factors such as governance cohesiveness, security of property rights, member equality, benefits to community members, and government support (Baynes 2015).

Local forest enterprises can create important incentives for sustaining community forests. Enterprises dependent on secure tenure are expanding into new countries and subregions and gaining efficiencies in countries that pioneered support for such enterprises. Some expansion relates to decentralization whereby forest authority and responsibility have been decentralized to local governments (Hajjar and Molnar 2016). Pioneering experiences are found in Mexico, Guatemala, Peru, Bolivia, Nepal, Tanzania, Zambia, and the Philippines. Community-managed forests have expanded in China, Indonesia, the Mekong region, Mali and Canada. Locally-controlled forestry is also evolving as part of broader territorial management by indigenous peoples in the tropics of Central Africa, Central America, South America, and Southeast Asia (Larson and Dahal 2012); e.g. Indonesia's recent constitutional reform is now a major impetus for community forestry and related enterprise despite continued challenges (Savitri 2016).

THE ROLE OF GOVERNMENTS

National governments, while historically claiming ownership rights over vast forest lands, have repeatedly failed to sustainably manage and conserve these resources, either the biodiversity they contain or the goods and services they provide to rural inhabitants and society at large. They failed to honour traditional tenure and use rights or develop livelihood opportunities for the local communities concerned. Today some governments have recognized their own limitations and begun to transfer or devolve forests to local communities for management (Lawry *et al.* 2012, Gilmour and Fisher 2011).

Many governments, particularly during the colonial era, asserted legal ownership over forests and other lands that were traditionally held by IPLC – either to control forest revenues, ignore customary tenure systems, and/or judging customary, collective management as backward or inefficient (Larson and Springer 2016). State legal control over forest landscapes often failed to replace traditional tenure systems with anything more effective (Bromley and Cernea 1989). Instead, state agencies leased extensive forest lands to private interests for timber and/or agricultural production fostering widespread deforestation and forest degradation and social conflict (Poffenberger 2001, Hecht and Cockburn 1990).

Government declaration of protected areas without attention to customary rights of IPLC has often contributed to

displacement in forest landscapes without returns (Colchester 2003). Where IPLC have maintained attachments to and governance of ancestral lands, there can be a complex overlapping of authorities *(*Freudenberger 2013*).* While in some regions, e.g., much of Europe, tenure is relatively uncontested, this overlap of customary and statutory tenure creates conflicts across large areas of forest land, in lower as well as in some middle- and high-income countries (Gilmour 2016).

Forest communities in most developing countries continue to navigate a situation in which governments remain as the large statutory forest owner. Governments formally administer more than two-thirds of forest lands, while 5.1 percent are privately owned by individuals and firms (RRI 2018). Although private ownership increased by about 113 Mha between 1990 and 2005, most transfers occurred in a handful of countries (e.g. China, Colombia) and primarily benefitting persons or private corporations (RRI 2018). Central governments therefore continue to drive development decisions over a vast rural area; but are they equipped to take on and overcoming the resulting challenges?

Since Spear's policy paper was written, government forestry agencies have been mandated with more responsibilities, including improving rural livelihoods – moving from a model of command-and-control in the forest landscape to *collaborate-and-connect*. In the early 70s, many forest agencies in the then, lower-income countries were recently formed and modelled on German and American agencies that were strongly timber- and large industry-centric. The new agencies lacked experience, managed restricted budgets, and carried out limited training. In many developing countries, the political influence of forest agencies has been only as great as their revenue stream and territorial control, further encouraging state ownership rather than building alliances with citizens and communities as stewards and beneficiaries.

The limitations and poor performance of forestry agencies continue to be a challenge several decades later. Hierarchical structures continue, with too-limited budgets or capacity for planning and regulation of forest management, limited experience in economic planning and land use strategies, and consequently a marginal influence on broader rural and agriculture sector policy (Larson and Pulhin 2012, Smyle *et al.* 2016). Between 1990–2015, for example, public expenditure in forestry increased dramatically, while income grew marginally, and forest employment remained constant at about 12.7 million jobs (Whiteman *et al.* 2015).

These limitations are exacerbated by the silo nature of government agencies, whereby coordination with other rural authorities is made impossible by strongly centralized mandates. Overlapping policies and institutions foster competing economic interests in land administration and territorial planning, environmental management and conservation, agriculture, transport, and development of energy and extractives. Such inter-institutional conflict creates incentives for corruption as well. Creation of parallel power structures with overlapping forestry management functions in rural forest landscapes, such as in India, fosters administrative conflicts at the village level (Ahuja 2014). This also marginalizes district and municipal government and communities, in decision-making and access to benefits.

Restricting governance of forest lands and public protected areas to forestry, environmental and conservation agencies miss opportunities for local peoples' positive contributions. Tenure reform and recognition of customary rights constitutes one important step toward better management of forests, and improved local livelihoods. Without commensurate reform of outdated regulations, countries fail to adapt IPLC traditional resource knowledge for blended systems that are more sustainable and cost effective (Pacheco *et al.* 2012).

Even when communities are granted permission to engage in commercial logging, central agencies often continue to prescribe complex and counterproductive, top-down practices. In India, for instance, communities prepare micro-plans for Joint Forest Management (JFM) areas, but these micro-plans must comply with competing working plans of the state's Forest Department. More confusing, the legal status of JFM Committees or groups and their autonomy varies by state (Sarin *et al.* 2003). The JFM regime itself is not grounded in a legal right but a product of a 1990-issued executive order linked to a 1927 Forest Act never revised since the colonial era. This order can be rescinded at the discretion of government authorities (Government of India 2010). State-level JFM resolutions derived from the 1990 circular therefore lack the force of law, perpetuating continued authority of forest departments over community-level groups and undermining their incentives for participation (Upadhyay 2003). Forest department rules empower contractors and forest departments themselves to acquire a lion's share of timber benefits from JFM communities (Kallur *et al.* 2003).

By contrast, good practice in countries with successful locally controlled forestry, such as Sweden, focus on a model of accountability combined with regulations that are better focused on desired outcomes, rather than prescribed inputs (Elson 2012). Government investment in research and development, often in partnership with associations and the industrial private sector, and emphasis on training and smallholder capacity, can have better positive results (Segura Warnholtz 2014).

Decentralization of forestry and conservation related responsibilities to regional and local elected officials and forest tenure holders is, of course, not without challenges (Segura Warnholtz 2017). There is often a lag in clarifying authorities between central and local government levels, persisting, outmoded regulations, and a lag in organizational and technical capacity-building for both district or municipal governments and community organizations. Where these issues are addressed more systematically, assessing local capacities, financial needs, inter-sectoral coordination, and management scales, the results can be impressive (Sikor *et al.* 2013 and Torres Rojo *et al.* 2019).

On a positive note, the last two decades have seen a trend to empower communities in their role of tenure holders and managers of forest lands. Several factors are converging to prompt a shift in legal ownership and control of forest lands back under community-based tenure arrangements. Mobilization of social justice movements for the recognition of customary land rights, for example, has been particularly prominent in Latin America (Gonçalves and Telles do Valle

2014 and Yashar 1998). Also relevant is the increased knowledge and understanding of collective tenure and governance systems. As brought to prominence by Elinor Ostrom's work on governance of the commons (Ostrom 1990), lands and resources are often governed effectively by local institutions for collective action. The downsides of state control are better understood, as a result of stronger documentation of the livelihoods benefits from locally-controlled land and forest resources (e.g. Bray *et al.* 2003 and RECOFTC 2013). Starting in the 1990s, democratization processes in countries with a strong agrarian sector increased citizen and community demand for devolution and more inclusive governance. Government policies are increasingly shaped by international and regional initiatives for legal and sustainable wood supply and climate change mitigation through forest carbon sequestration. These pressure governments to control illegal logging and trade, and deforestation from large-scale agriculture and to empower local forest enterprises. The REDD+ forest climate initiative has also generated new public and private finance flows for communities and farmers, making community-friendly laws and policies more attractive to governments.

While governments have progressed in transferring rights and the control of forest resources to local communities, outcomes will disappoint if use and management rights continue to be based on limited tenure and top-heavy regulation. Smarter, more creative solutions can empower local forestry stakeholders and encourage them to manage the consequences of their own decisions (Larson and Pulhin 2012, Macqueen *et al.* 2018, Porter-Bollard *et al.* 2012 and Seymour *et al.* 2014). It is time for this alternative model of rural development, already providing a diversity of environmental and socio-economic benefits, to expand at scale and more quickly.

COMMUNITY GOVERNANCES AND THE FOREST COMMONS

Successful local institutions operate and evolve best in an environment of collective action that is inclusive, transparent and accountable (Agrawal 2007 and Robinson *et al.* 2017b). Governments and development partners have often poorly understood, ignored, or undermined the role of customary institutions, missing chances to strengthen social capital, particularly when tenure remains precarious.

There are many options. Collective forest lands may be managed as commons and/or allocated individually. Many community lands combine common, collective property with secured, individual landholdings (Alden Wily 2018, Fitzpatrick 2005 and RRI 2015). In fact, many smallholders across forest and agricultural landscapes hold their lands within community-based tenure systems, recognizing significant economic and social advantages from participating in a collective (de Janvry *et al.* 2018). Stronger community governance helps address the wider social and political dimensions of poverty. Joint decision-making on natural resource governance strengthens grassroots democracy (RECOFTC 2013), and builds social cohesion needed for resilience in the face of natural and human-induced disturbances (Gilmour 2016). Social or community forestry enterprises are also driving innovation and solving social, economic and governance challenges that neither governments nor markets are being able to address (Gnych 2020).

Community institutions must have the autonomy to make locally appropriate decisions about allocation and management of lands and resources, productive use, management rules and sanctions, and benefit-sharing. When all members are involved in decision-making, communities can avoid elite capture and adequately favor vulnerable groups (McDermott *et al.* 2013 and Segura Warnholtz 2014). Inclusion of women in governance and decision-making processes is critical for sound rule-making and social inclusiveness and enabling wider development benefits. While social norms traditionally underrepresent women in governance systems, women's groups have notably increased their participation over time (RRI 2017). Sometimes government law or policy mandates have helped to strengthen women's membership and collective decision-making. A growing body of literature shows a strong link between gender equity, particularly women's land and forest rights and their power to shape household decision making on food, education, and family investment (Meinzen *et al.* 2017). There are often strong gender biases against women's land or forest holding and participation and favoring of commercial forest activities at the cost of women's desired use of common property resources. These undermine household and community well-being (FAO 2011). Land rights can be a precondition for women to exercise participation in community institutions (FAO 2012, IDLO 2013 and Ingram *et al.* 2015).

Research networks such as the International Association for the Study of the Commons (IASC) and the International Forestry Resources and Institutions (IFRI) network have documented the knowledge and practices used by customary tenure systems and their effectiveness over time. Effective collective action can protect community interests in their engagement with outsiders, even in the face of higher land values and increased land and resource demands (Byamugisha 2013, Deininger and Byerlee 2011 and FAO 2016b). When communities have strong internal cohesion, consultation processes for investments on or affecting community lands are effective (Anaya 2013 and Feiring 2013). Dispute resolution processes for tenure conflicts and access to legal counsel and courts are also stronger (Byamugisha 2013, FAO 2016a).

Community-defined rules and/or plans for land governance are linked to positive outcomes for forests and livelihoods (Persha *et al.* 2011). Many communities choose to develop holistic land or territorial governance plans, such as the *life plans* developed in South America. These plans articulate a broadly shared community vision for the stewardship of their lands, territories, forest and other resources, in accordance with community values. Such plans provide useful grounding for monitoring and enforcement of agreed uses, both within the community and with outsiders. Maps and spatial plans are often central to governance plans, enabling geographical visualization of resources, uses, and management choices.

As communities establish and grow their governance systems, new challenges will arise, particularly vis-a-vis outsiders, and negotiations with private investors. Governments and development partners can and should play a role in helping communities confront these challenges. Their facilitation will have to start by recognizing community institutions, governance systems and rules. Facilitation may support documentation of tenure rights, plans for sustainable use, negotiating tools, internal benefit sharing arrangements, and standards and tools for monitoring land and forest health, and use of sanctions (World Bank 2019).

COMMUNITY FORESTRY ENTERPRISES. NEW PLAYERS IN THE RURAL LANDSCAPE?

Transferring forest rights to communities is a very important step towards the sustainable use and conservation of forest resources, but as known, this alone is not enough. Community Forestry Enterprises (CFE) – social enterprises created or licensed to community user groups – create incentives and enabling conditions for sustainable use and conservation of forest resources and have proven to be an important economic sector in rural areas of many countries (FAO 2007, Kozak 2007, Macqueen and Mayers 2019, Mayers 2006, Mayers *et al.* 2016 and World Bank 2008). To succeed and reach their full potential, several key challenges must be overcome. As with any other private enterprise, the inherent commercial value of forest, the capacity of its managers to access markets successfully, the technical capacities of right-holders to manage forests sustainably, and their access to financial services are common constraints that communities confront. Assistance to address these challenges is the most important role that governments and donors can play to improve social, economic and conservation outcomes of communities managing forest landscapes.

As mentioned earlier, the quality of forest assets – or natural capital – and the opportunities to improve their productivity and competitivity are key for the viability of a CFEs. These shape if and how communities will engage in commercial activities, develop product processing and thereby move up the value chain. Wood processing is an especially capital-intensive enterprise. Only some communities find the returns worth the concentrated investment and management requirements. The most successful timber enterprises have evolved in areas where natural capital is high to start with, and where there is enough road infrastructure to reach markets, or local markets with enough demand. Some communities have developed clusters as cooperatives with neighbours to reach economies of scale. Second generation enterprises have developed in communities in Mexico and Central America diversifying incomes with finished wood products, industrial grade resins, bottled spring water, foods or condiments from non-timber forest products, fibre handicrafts, and forest tourism. Diversification of enterprises favours involvement of women in administrative roles and income-generating activities – increasing job opportunities and their presence in decision-making as well (Bray *et al.* 2003).

Even when natural capital has enough commercial value, communities will also be faced with the decision to invest or not in a medium or larger scale operation, either to satisfy local community needs and/or to engage with outside markets. Commercial operations need more specialized technical, administrative and marketing abilities which some communities have addressed by creating CFEs as specialized administrative units, which have a certain degree of governance and financial independence, but which report to the main governing body of the right-holding community. Competing in a crowded marketplace, CFEs are presented with like challenges to those of a private enterprise – production acumen, appropriate market access, and keeping a competitive edge. The high transaction costs associated with the small scale of operations, the limited access to financial capital, and the more complicated administration of common pool resources, where multiple interests must be satisfied and few employees are highly skilled, puts an added burden on many CFEs.

A comparative analysis of 286 Mexican CFEs–those provided with support to strengthen their social capital and other forms of capacity building[3] and those simply provided with enterprise financing or basic forest technical assistance shows a clear difference in community enterprise performance controlling for forest type and quality (Torres Rojo *et al.* 2019). Those benefitting from capacity building have been better able to develop a profitable business accepted by the rest of the community, better able to weather market conditions and develop additional streams of income and incorporate women into the enterprises in a traditional male-controlled sector (Merino and Segura Warnholtz 2005, Segura Warnholtz 2014 and Torres Rojo *et al.* 2019).

An increasingly important form of social capital for small and medium enterprises is that associated with second and third level organizations. In a complex market environment such organizations have adopted a polycentric structure that facilitates benefits at multiple scales and reduces risks (Ostrom 2010). Producer alliances, associations and federations have been one means of mitigating small-scale risk and sharing learning, increasing political and economic influence, and attracting outside finance, market and brand recognition, and, for some, providing shared infrastructure, equipment and business support (MacQueen *et al.* 2018). Smallholder and community forest organizations exist at all levels. The Food and Agriculture Organization of the UN's Farm, Forest Facility works with five global and regional associations: the International Family Forestry alliance (iFFa), the *Alianza Mesoamericana de Pueblos y Bosques*/ Mesoamerican Alliance of People and Forests (ampb), the Asian Farmers'

[3] Capacity building included support to establish and strengthen both **social** (e.g. support to community governance institutions for improving planning, developing community rules, monitoring and evaluation of community plans, development and enforcement of community rules) and **human** capital (e.g. specialized technical assistance and training, including community-to-community exchanges).

Association for Sustainable Rural Development (aFa), the Global alliance for Community Forestry (GacF), and the International Alliance of indigenous and Tribal peoples of the Tropical Forests (iaiTpTF). National and sub-national federations exist in many countries including Canada, Finland, Sweden, Austria, Norway, Nepal, Central America and Mexico. Where governments to play a more active role in promoting and supporting these organizations, small and medium enterprises would gain more competitive advantage particularly where demand for forest products and markets are growing.

Another lesson of Mexico is that it is impossible to predict success of community forestry over the short term. Communities will change and adapt, and those predicted to be the most successful may fail to sustain enterprises, while those facing challenges may find creative solutions to organizational or operational constraints and reach a long-term success (Segura Warnholtz 2014). Developing a mature enterprise model compatible with community governance takes time and trial and error. This lesson is mirrored in the experience of communities in Central America who are members of the Mesoamerican Forest Communities Alliance – another set of communities developing community forestry models over more than 20 years (Stoian *et al.* 2018).

In a significant number of cases, commercial forest and non-timber operations will not be a viable option for local communities, either because the value of their natural capital is too low or because of structural constraints to access markets (e.g. limited access to forests, distance to consumer markets, limited access financial capital). Many forest areas that fall into these categories are precisely those that bear high biodiversity value, and provide important ecosystem services, including water and carbon retention. These values from forest ecosystems are an important positive externality provided, in its majority, by local communities. Community lands with these conditions are the most vulnerable to problems of open access, deforestation and degradation. It is precisely in these areas where government attention and support are most needed, mainly because the opportunity costs for conversion to non-forest uses will tend to be low, and because the communities living there are usually the most marginalized.

Environmental and conservation policies in many of these areas, unfortunately, continue to be heavily influenced by conceptions of the western international conservation community regarding forest ecosystems. A general premise has been that the best way to ensure the preservation of these areas is to exclude people; stopping the harvest of forest products, gazetting more protected areas, and hiring more guards. Forest and environmental agencies need to move away from this paradigm and work directly with communities in high biodiversity areas to support conservation efforts compatible with community values, assets, and livelihoods.

Payment for environmental services (PES) systems, and to a lesser extent, biocarbon financing through REDD+ are beginning to show promising results as alternative incentive-based schemes which address both conservation and poverty reduction goals. Both Costa Rica and Mexico, two of the few countries that have pioneered national PES programs for almost two decades, are showing encouraging results in reducing deforestation, protecting natural habitats, and maintaining carbon sinks. PES, as an instrument for conservation has shown to reduce both forest cover loss and forest fragmentation (Ramirez-Reyes *et al.* 2018). When compared with protected areas, PES schemes show equivalent conservation outcomes but better impacts on livelihoods (Sims and Alix-Garcia 2017). In addition, PES programs have significantly increased the social capital of community governance institutions in their efforts to manage their common pool resources sustainably (Alix-Garcia *et al.* 2018).

CONCLUSIONS

As forest communities benefit from the increasing recognition of the right to own forest lands and their self determination to manage resources, a new paradigm is emerging on how governments and development organizations perceive them and support them in their challenging endeavours, a paradigm that was first envisioned by John Spears in the late 1970s.

The last 40 years have seen an increasing acknowledgement of the potential of locally controlled forestry organizations and a substantial recognition of the forest tenure and rights of millions of IPLC, whether statutory ownership rights, rights of management and use, or recognition of informal customary tenure systems. Although such formal recognition continues to be a small fraction of the extent of forest areas estimated to be under customary tenure systems, regions where formal recognition is greater, such as Latin America, have had an important influence on countries from Africa and Asia, which still lag in recognition.

Recognizing the potential of locally controlled forestry to improve development outcomes has been an important first step. As community outsiders, governments, donors and other practitioners will need to better understand how these emerging players operate and what they must overcome to foster long term prosperity and environmental sustainability. Understanding community-based institutions and their governance of forests as commons are key to help communities tackle obstacles to access and successfully compete in the marketplace. For those communities where commercial activities are not viable, governments can help to develop alternative livelihood options and support schemes that compensate community efforts to maintain environmental and conservation values.

There is also stronger evidence regarding the multiple benefits of community and social forestry, particularly where local autonomy and community ownership link to formal participation in rule-making (Chhatre and Agrawal 2009). Documented benefits include carbon storage, biodiversity conservation, contributions to GDP and local livelihoods, protection of water flow and quality in a world of increasing water scarcity, protection against fire and pests, reduction of social and civil conflict where rights are recognized and secure, opportunities for gender equity and income improvements, and access to forest-derived medicinals, herbaceuticals, seasonings, fuel, fodder, and foodstuffs.

Another positive outcome that was difficult to predict, even as of a few years ago, is the emergence of a rich community of second and third level producer organizations. These forest associations and federations of smallholders and forest communities all operate at different geographical scales, to facilitate benefits and reduce risks throughout the value chain. Their support to CFEs include political cover and advocacy at a scale useful to development partners and governments, particularly to address needs of local communities scattered in remote areas. They can advocate with governments or provide an effective interphase with the private sector, as well as build capacity building and access to finance. As more is learned about the key role that these organizations can play – as legitimate intermediaries and partners – governments should provide more recognition and better support and capacity building.

Governments in their role as owners or regulators of commercial, environmental and conservation activities in forest landscapes have often failed in fulfilling their mandates. This has repeatedly resulted in forest degradation and an increased poverty and marginalization of forest dwellers. Regulatory frameworks in many countries continue to be derived from a model of state forest management and control, rather than applying smart regulations, tailored to varied conditions. This creates unnecessary barriers to the competitiveness of community and small-scale enterprises, where important lessons of smart regulations in higher income countries for private and public forests are already in place.

The role of governments will continue to be highly relevant in forest landscapes. New paradigms are needed by public institutions to recognize and respond to local conditions and development needs (e.g. Kluvánková *et al.* 2018, Macqueen and Mayers 2019 and Macqueen *et al.* 2018) In moving forward, forest and conservation agencies will need to regulate and design support programs that directly address specific challenges of locally controlled forestry organizations and recognize them as true constituents. They will increasingly demand these roles from government and expect them to abide by the principles of a legitimate and inclusive collective action process.

REFERENCES

AGRAWAL, A. 2007. Forests, governance and sustainability: common property theory and its contributions. *International Journal of the Commons* **1**(1): 111–36.

AHUJA, N. 2014. Comeback of community-based forest management: the need to revamp strategies to promote decentralized environmental governance in India and Brazil. Florida A&M *University Law Review* **9**(2): 309–345.

ALCORN, J. 2014. Lessons learned from community forestry in Latin America and their relevance for REDD+. USAID-supported Forest Carbon, Markets and Communities (FCMC) Program. Washington, DC, USA.

ALDEN WILY, L. 2019. Could collective title become a new norm? Land Journal. 15–17. *Royal Institution of Chartered Surveyors.*

ALDEN WILY, L. 2018. Collective land ownership in the 21st century: overview of global trends. *Land* **7**(2): 68.

ALDEN WILY, L., P. VEIT, R. SMITH, F. DUBERTRET, K. REYTAR, and N. TAGLIARINO. 2016. Guidelines for researching, scoring and documenting findings on 'What National Laws Say About Indigenous and Community Land Rights'. Methodology document. from LandMark: *The Global Platform of Indigenous and Community Lands*.

ALIX-GARCIA, J.M, K.R.E. SIMS, V.H. OROZCO-OLVERA, L.E. COSTICA, J.D, FERNÁNDEZ MEDINA, and S.R. MONROY. 2018. Payments for environmental services supported social capital while increasing land management. *Proceedings of the National Academy of Sciences (PNAS)* **115**(27): 7016–7021.

ANAYA, J. 2013. Extractive industries and indigenous peoples. Report of the Special Rapporteur on the Rights of Indigenous Peoples. A/HRC/24/41.

ANSEEUW, W., ALDEN WILY, L., COTULA, L. and M. TAYLOR, 2012. 'Land rights and the rush for land'. Research report. Rome: International Land Coalition.

BAYNES, J., HERBON J., SMITH C., FISHER, B., and BRAY, D. 2015. *Global Environmental Change* **45**: 226–238.

BLOMLEY, T. 2013. Lessons learned from community forestry in Africa and their relevance for REDD+. USAID-supported Forest Carbon, Markets and Communities (FCMC) Program. Washington, DC, USA.

BRAY, D.B., MERINO-PÉREZ, L., NEGREROS-CASTILLO, P., SEGURA WARNHOLTZ, G., TORRES-ROJO, J.M., and VESTER, H.F. 2003. Mexico's community-managed forests as a global model for sustainable landscapes. *Conservation Biology* **17**: 672–677.

BROMLEY, D.W., and CERNEA, M.M. 1989. The Management of common property natural resources: some conceptual and operational fallacies. *World Bank Discussion Papers. No. 57.* The World Bank Group.

BYAMUGISHA, F. 2013. Securing Africa's land for shared prosperity: a program to scale up reforms and investments. Washington, DC. World Bank.

CHHATRE, A. and AGRAWAL, A. 2008. Forest commons and local enforcement. *Proceedings of the National Academy of Sciences (PNAS)* **105**(36): 13286–291.

CLIENT EARTH. 2019. Empowering communities in forestry laws key to stopping global deforestation. February. https://www.clientearth.org/empowering-communities-in-forestry-laws-key-to-stopping-global-deforestation/

COLCHESTER, M. 2003. Salvaging nature: indigenous peoples, protected areas and biodiversity conservation. World Rainforest Movement and Forest Peoples Programme.

COTULA, L., VERMEULEN, S, LEONARD, R. and KEELEY, J. 2009. "Land Grab or Development Opportunity? Agricultural Investment and International Land Deals in Africa." Food and Agriculture Organization of the United Nations (FAO), International Institute for Environment and Development (IIED), and International Fund for Agricultural Development (IFAD). http://pubs.iied.org/12561IIED/.

DEININGER, K., and BYERLEE, D., with LINDSAY, J. NORTON, A, SELOD, H., and STICKLER, H. 2011. Rising global interest in farmland: can it yield sustainable and equitable benefits? Washington, DC: World Bank.

DE JANVRY, A., SADOULET, E. GONZÁLEZ-NAVARRO, M., EMERICK, K., MONTOYA, E., PECENCO, M., and KUTZMAN, D. 2018. Property rights reform in Mexico: Impact on agriculture, rural and structural transformations. Annual World Bank Conference on Land and Poverty.

ELSON, D. 2012. Guide to investing in locally controlled forestry. Growing forest partnerships in association with FAO, IIED, IUCN, The Forests Dialogue, and the World Bank. London: International Institute for Environment and Development (IIED).

FAURE, N., ICHOU, B. and VENISNIK, T. 2019. Communities at the heart of forest management: How can the law make a difference? Sharing lessons from Nepal, the Philippines and Tanzania Client Earth: United Kingdom. February.

FOREST PEOPLES PROGRAMME. 2017. Indigenous Peoples' Rights and Conservation: Recent Developments in Human Rights Jurisprudence UK. Background Report.

FOOD AND AGRICULTURE ORGANIZATION (FAO). 2016a. Forty years of community-based forestry: A review of its extent and effectiveness. FAO Forestry Paper 176.

____. 2016b. Governing tenure rights to commons. Governance of tenure technical guide 8. Rome.

____. 2015. State of the world's forests: enhancing the socioeconomic benefits from forests. Rome.

——. 2012. Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security... Rome: Food and Agriculture Organization of the United Nations.

____. 2011. The State of Food and Agriculture. Women in Agriculture. Closing the gender gap for development.

____. 2007. Community-based forest enterprises. Their status and potential in tropical countries. Rome.

FEIRING, B. 2013. Indigenous peoples' rights to lands, territories, and resources. Rome: International Land Coalition.

FITZPATRICK, D. 2005. Best practice' options for the legal recognition of customary tenure. Development *and Change* **36** (3): 449–75.

FOREST2MARKET. 2016. The economic impact of privately-owned forests in the United States. 42 pp.

FREUDENBERGER, M., with BRUCE, J, MAWALMA B, DE WIT, P and BOUDREAUX, K. 2013. The future of customary tenure: options for policymakers. Washington, DC: U.S. Agency for International Development (USAID).

GARNETT, S.T., N.D. BURGESS, FA, J.E., FERNÁNDEZ-LLAMAZARES, A., MOLNÁR, Z, ROBINSON, C.J. WATSON, J.E.M., ZANDER, KK, AUSTIN, B., BRONDIZIO, E.S., COLLIER, N.F., DUNCAN, T., ELLIS, E., GEYLE, H., JACKSON, M.V., JONAS, H/, MALMER, P., MCGOWAN, B., SIVONGXAY, A. and LEIPER, I. 2018. A spatial overview of the global importance of indigenous lands for conservation. *Nature Sustainability* **1**: 369–74.

GILMOUR, D. 2016. Forty years of community-based Forestry: a review of its extent and effectiveness. FAO Forestry Paper 176. Food and Agriculture Organization of the United Nations (FAO).

GILMOUR, D. AND FISHER, R. 2011. Reforming Forest Tenure: Issues, Principles, Process. FAO Forestry Paper 165. Food and Agriculture Organization of the United Nations (FAO).

GNYCH, S., LAWRY, S., McLAIN, R, MONTERROSO, I, and ADHILKARY, A. 2020. Is community tenure facilitating investment in the commons for inclusive and sustainable development. Forest Policy and Economics. 111 (2020) 102088.

GOVERNMENT OF INDIA. 2010b. Report of the national committee on Forest Rights Act. Ministry of Environment and Forests and Ministry of Tribal Affairs.

HAJJAR R. AND MOLNAR A. 2016. Decentralization and community-based approaches. In: *Forests, Business and Sustainability*. R. Panwar, R. Kozak and E. Hansen, Eds. Routledge.

HAYES, T., and L. PERSHA. 2010. Nesting local forestry initiatives: revisiting community forest management in a REDD+ world. *Forest Policy and Economics* **12**(8): 545–53.

INTERNATIONAL DEVELOPMENT LAW ORGANIZATION (IDLO). 2013. Accessing justice: models, strategies and best practices on women's empowerment. 74 pp.

INGRAM, V; HAVERHALS, H., PETERSEN, S., ELIAS, M. and BASNETT, B. 2015. Gender and forest, tree and agroforestry value chains – Evidence from literature. XIV World Forestry Congress. Durban, South Africa. September 2015.

INDUFOR GROUP. 2017. Future Trends in Smallholder Plantation Forestry. Blog. https://induforgroup.com/future-trends-in-smallholder-plantation-forestry/

JOHNSON, A. 2016. Brief 2. Barriers and Opportunities for MSMEs under Demand-side Legality Policies. Little and Legal: Micro-, Small-, and Medium-Sized Enterprises (MSMEs) within the Emerging Timber Legality Paradigm. Forest Trends. 14p.

GONÇALVES, M.A., and R. TELLES DO VALLE, S. 2014. Advances and setbacks in territorial rights in Brazil. Instituto Socioambiental (ISA) and the Rights and Resources Group (RRI). http://rightsandresources.org/wp-content/uploads/ISAreport_eng_FINAL.pdf.

HAJJAR, R. and MOLNAR, A.A. 2016. Decentralization and community-based approaches. In: PANWAR, R., KOZAK, R. and HANSEN, E. eds., *Forests Business and Sustainability.* Routledge: New York, NY.

HECHT, S., and COCKBURN, A. 1990. *The fate of the forest. developers, destroyers, and defenders of the Amazon.* University of Chicago Press.

KALLUR, M., RAO, J. AND RAVINDRANATH N.H. 2003. Institutional and policy issues of participatory forestry: Indian experience. *Tropical Ecology* **44**(1).

KISHOR, N. and ROSENBAUM, K. 2012. Assessing and Monitoring Forest Governance. A user's guide to a diagnostic tool. Report No. 71436. Program on Forest. The World Bank Group. 116 p.

KLUVÁNKOVÁ, T., BRNKAĽÁKOVA, S., ŠPAČEK, M., SLEE, B., NIJNIK, M., VALERO, D., MILLER, D., BRYCE, R., KOZOVA, M., POLMAN, N., SZABO, T., and GEŽÍK, V., 2018. Understanding social innovation for the well-being of forest-dependent communities: A preliminary theoretical framework. *Forest Policy and Economics* **97**: 163–174.

KOZAK, R. 2007. Small and medium enterprises: instruments of change in a developing world. Rights and Resources Initiative, Washington, D.C.

LARSON, A. and G. DAHAL. 2012. Forest tenure reform: new resource rights for forest-based communities? *Conservation and Society* **10**(2): 77.

LARSON, A.M. and PULHIN, J.M. 2012. Enhancing forest tenure reforms through more responsive regulations. *Conservation and Society* **10**(2): 103–113.

LARSON, A., and SPRINGER, J. 2016. Recognition and respect for tenure rights. Conceptual paper for the Natural Resource Governance Framework (NRGF). IUCN, Commission on Environmental, Economic and Social Policy (CEESP).

LAWRY, S., MCLAIN, R., SWALLOW, B. and BIEDENWEG, K. 2012. Devolution of Forest Rights and Sustainable Forest Management, Vol. 1: A Review of Policies and Programs in 16 Developing Countries and Vol. 2: Case Studies. Washington, DC: United States Agency for International Development (USAID).

MACQUEEN, D., BOLIN, A. GREIJMANS, M, GROUWELS, M.S. and HUMPHRIES, S. 2018. Innovations towards prosperity emerging in locally controlled forest business models and prospects for scaling up. *World Development*. 10.1016/j.worlddev.2018.08.004.

MACQUEEN, D. and MAYERS, J. 2019. Empowerment of Forest-Linked Communities: What Progress and Where Next? Technical Report. International Institute for Environment and Development (IIED).

MAYERS, J. 2006. Small-and medium-sized forestry enterprises. International Tropical Timber Organization (ITTO). *Tropical Forest Update* **6**(2): 10–11.

MAYERS, J., BUCKLEY, L. and MACQUEEN, D. 2016. Small, but many, is big. Challenges in assessing the collective scale of locally controlled forest-linked production and investment. Issue Paper. International Institute for Environment and Development (IIED). 32 pp.

McDERMOTT, M, MAHANTY, S. AND SCHRECKERBERG, K. 2013. Examining equity: a multidimensional framework for assessing equity in payments for ecosystem services. *Environmental Science and Policy* **33**: 416–327.

MEINZEN D., SUSEELA, R, QUISUMBING, A.R., DOSS, C.R., and THEIS, S. 2017. Women's land rights as a pathway to poverty reduction: a framework and review of available evidence. *IFPRI Discussion Paper 1663*. International Food Policy Research Institute (IFPRI), Washington, DC.

MERINO-PÉREZ, L. and SEGURA-WARNHOLTZ, G. 2005. Forest conservation policies and their impact on forest communities in Mexico. In: BRAY, D.B. MERINO-PÉREZ, P, and BARRY, D. (eds.). *The community forests of Mexico. Managing for sustainable landscapes.* University of Texas Press. Pp. 49–69.

MESSERLI, P., GIGER, M., DWYER, M.B., BREU, T AND ECKERT, S. 2014. "The Geography of Large-Scale Land Acquisitions: Analysing Socio-ecological Patterns of Target Contexts in the Global South." *Applied Geography* **53**: 449–59.

MOLNAR, A.K., BARNEY, M., DE VITO, A., KARSENTY, D., ELSON, M., BENAVIDES, P., TIPULA, C., SORIA, P., SHERMAN, P., and FRANCE, M. 2011. 'Large acquisition of rights on forest lands for tropical timber concessions and commercial wood plantations. Rights and Resources Initiative (RRI) contribution to ILC Collaborative Research Project on Commercial Pressures on Land, Rome.

JOHNSON, A. 2016 Barriers and Opportunities for Micro, Small and Medium-Sized Enterprises under Demand-side Legality Policies. Brief 2. Forest Trends: Washington, D.C.

OSTROM, E. 2010. Polycentric systems for coping with collective action and global environmental change. *Global Environmental Change* **20**(4): 550–557.

OSTROM, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press.

OSTROM, E. and E. SCHLAGER. 1992. Property-Rights regimes and natural resources: a conceptual analysis. *Land Economics* **68**(3): 249–262.

PACHECO, P., BARRY, D., CRONKLETON, P., and LARSON, A. 2012. The recognition of forest rights in Latin America: progress and shortcomings of forest tenure reforms. *Society and Natural Resources* **25**(6): 556–571.

PERSHA, L., AGRAWAL, A., and CHHATRE, A. 2011. Social and ecological synergy: local rulemaking, forest livelihoods, and biodiversity conservation. *Science* **331**: 1606–1609.

PETERS, M.C. 2018. *Managing the wild. Stories of people and plants and tropical forests.* Yale University Press. 108 pp.

POFFENBERGER, M. 2001. Communities and forest management in Southeast Asia. Gland. International Union for Conservation of Nature (IUCN). Switzerland.

PORTER-BOLLAND, L., ELLIS, E.A., GUARIGUATA, M.R., RUIZ-MALLÉN, I., NEGRETE-YANKELEVICH, S., and REYES-GARCÍA, V. 2012. Community managed forests and forest protected areas: An assessment of their conservation effectiveness across the tropics. *Forest Ecology and Management* **268**: 6–17.

PROGRAM ON FORESTS (PROFOR). 2008. Poverty and Forest Linkages: A Synthesis and Six Case Studies. Washington, DC: World Bank.

RAMIREZ-REYES, V.C., SIMS, K., P. POTAPOV, and V. RADELOFF. 2018. Payments for ecosystem services in Mexico reduce forest fragmentation. *Ecological Applications* **28**(8): 1–16.

RECOFTC. 2013. People and Forests for a Greener Future. The Center for People and Forests (RECOFTC).

RIGHTS AND RESOURCES INITIATIVE (RRI). 2018. At a crossroads: consequential trends in recognition of community-based forest tenure from 2002–2017. 60 pp.

____. 2017. Power and potential. A comparative analysis of national laws and regulations concerning women's rights to community forests. 94 pp.

____. 2015. Who owns the world's land? A global baseline of formally-recognized indigenous and community land rights. Washington, DC: Rights and Resources Initiative.

____. 2014. What future for reform? progress and slowdown in forest tenure reform since 2002. Rights and Resources Initiative, Washington, DC.

ROBINSON, B.E., MASUDA, Y.J., KELLY, A., HOLLAND, M.B., BEDFORD, C., CHILDRESS, M., FLETSCHNER, D., GAME, E.T, GINSBURG, C. HILHORST, T. LAWRY, S., MITEVA, D.A., MUSENGEZI, J. NAUGHTON-TREVES, L, NOLTE C., SUNDERLIN, W.D., and VEIT, P. 2017b. Incorporating Land Tenure Security into Conservation. *Conservation Letters* **11**(2): 1–12.

ROTH, M. 2013. Land Tenure and Food Security. Washington, DC: U.S. Agency for International Development.

SARIN, M., SINGH, N.H., SUNDAR, N., and BHOGAL, R.K. 2003. Devolution as a threat to democratic decision making in forestry? Findings from three states in India. Working Paper 197. London, UK: Overseas Development Institute.

SAVITRI, M. 2016. Dividing the Land: Legal Gaps in the Recognition of Customary Land in Indonesian Forest Areas. Kasarinlan: *Philippine Journal of Third World Studies* **30**(2), **31**(1): 31–48.

SAYMOUR, F., LA VINA, T. and HITE, K. 2014. Evidence linking Community-level tenure and forest conditions: an annotated bibliography. Climate and Land Use Alliance.

SCHERR, S., WHITE, A. and KAIMOWITZ, D. 2004. A New Agenda for Forest Conservation and Poverty Alleviation: Making Markets Work for Low-Income Producers. Forest Trends: Washington, D.C.

SEGURA WARNHOLTZ, G, with FERNÁNDEZ, M. SMYLE, J. and SPRINGER J. 2017. Securing Forest Tenure Rights for Rural Development: Lessons from Six Countries in Latin America. Washington, DC: Program for Forests (PROFOR).

SEGURA WARNHOLTZ, G. 2014. Quince años de políticas públicas para la acción colectiva en comunidades forestales. *Revista Mexicana de Sociología* **76**: 105–135.

SIKOR, T., GRITTEN, D., ATKINSON, J., BAO-HUY, DAHAL, G.R., DUANGSATHAPORN, K., HURAHURA, F., PHANVILAY, K., MARYUDI, A., PULHIN, J., RAMIREZ, M., WIN, S., TOH, S., VAZ, J., SOKCHEA, T., MARONA, S., and ZHAO, Y. 2013. Community forestry in Asia and the Pacific: Pathway to inclusive development. RECOFTC: The Center for People and Forests. Bangkok, Thailand.

SIMS, K.R.E. and AXIA-GARCIA, J.M. 2017. Parks versus PES: evaluating direct and incentive-based land conservation in Mexico. *Journal of Environmental Economics and Management* **86**: 8–28.

SMYLE, J., COLLINS, S. and BLASON, C. 2016. Rethinking forest regulations. Overcoming the challenges of regulatory reform. Rights and Resources Initiative. 12 pp.

STOIAN, D., RODAS, A. BUTLER, M., MONTERROSO, I. and HOGDON, B. 2018. Forest concessions in Petén, Guatemala. A systematic analysis of the socioeconomic performance of community enterprises in the Maya Biosphere Reserve. Center for International Forestry Research (CIFOR). 8 pp.

SUNDERLIN, W.D., ANGELSEN, A., BELCHER, B., BURGERS, P, NASI, R., SANTOSO, L., and WUNDER, S. 2005. Livelihoods, Forests, and Conservation in Developing Countries: An Overview. *World Development.* **33**(9): 1383–1402.

SUNDERLIN, W.D., DEWI, S. and PUNTODEWO, A. 2007. Poverty and Forests: Multi-Country Analysis of Spatial Association and Proposed Policy Solutions. CIFOR Occasional Paper No. 47. Bogor, Indonesia: Center for International Forestry Research (CIFOR).

THE LAND MATRIX. 2011. Large-scale Land Acquisitions in the World. The Land Matrix Partnership (CDE, CIRAD, GIGA, GIZ, ILC).

TORRES-ROJO, J.M., MORENO-SÁNCHEZ, R. and AMADOR-CALLEJAS, J. 2019. Effect of capacity building in alleviating poverty and improving forest conservation in the communal forests of Mexico. *World Development* **121**: 108–122.

UNITED NATIONS. 2016. Report of the Special Rapporteur of the Human Rights Council on the rights of indigenous peoples. Victoria Tauli-Corpuz. A771/229. Geneva: United Nations, paras. 16–19.

UPADHYAY, S. 2003. Legal concerns with the JFM regime in India, 35 Econ. and Pol. Weekly.

VERDONE, M. 2018. The world's largest private sector? Recognizing the cumulative economic value of small-scale forest and farm producers. IUCN. 24 pp.

WARRINER, D.W. 1969. *Land reform in principle and practice.* Clarendon Press. Oxford.

WHITEMAN, A., WICKAMASINGHE A. and PIÑA, L. 2015. Global trends in forest ownership, public income and expenditure on forestry and forestry employment. *Forest Ecology and Management* **325**: 99–108.

WORLD BANK. 2019. Securing forest tenure rights for rural development. An analytical framework. Program on Forests (PROFOR). Washington, D.C. World Bank Group.

____. 2013. Land governance assessment framework: implementation manual for assessing governance in the land sector. Washington, DC: World Bank.

____. 2008. Unlocking the potential of forest sector small and medium enterprises (SMES). Program on Forests (PROFOR).

____. 1978. Forestry. Sector Policy Paper. Publication 1778. World Bank.

World Commission on Forests and Sustainable Development. 1999. Our Forests. Our Future. Summary Report.

YASHAR, D. 1998. Contesting citizenship: indigenous movements and democracy in Latin America. *Comparative Politics* **31**(1): 23–42.

XIE, L., P. BERCK, J. XU. 2016. The effect on forestation of the collective forest tenure reform in China. *China Economic Review* **38**: 116–129.

Forests and poverty: how has our understanding of the relationship been changed by experience?

G. SHEPHERD[a], K. WARNER[b] and N. HOGARTH[c]

[a]*Anthropology Department, London School of Economics, Houghton Street, London WC1 1AA, UK*
[b]*Sustainability Research Centre, University of the Sunshine Coast, Queensland, Australia*
[c]*Helsinki Institute of Sustainability Science (HELSUS). Department of Forest Sciences, University of Helsinki, Finland*

Email: gillshepherd@compuserve.com, gill@gillshepherd.com

SUMMARY

Understanding of the relationship between forests and the poor has grown enormously, especially in the last twenty years. Aid donors worked on poverty reduction in the forest sector in the 1990s and into the early 2000s, but thereafter broadened their attention to address climate change mitigation, better forest governance and timber legality, and payments for environmental services. There has so far been an incomplete integration of new insights into the nature of poor people's reliance on forests, of their own efforts to use that reliance to escape from poverty, and of current forestry aid concerns. Future projects need to choose interventions which make better use of the results now available about forest-poverty relationships, both for the better conservation of forests, and for better focus on the livelihoods of the forest-reliant poor as they continue to try to move out of poverty.

Keywords: forests, poverty, forest reliance, non-cash income, livelihood resilience

Forêts et pauvreté: comment notre compréhension de cette relation a-t-elle été changée par l'expérience?

G. SHEPHERD, K. WARNER et N. HOGARTH

La compréhension de la relation entre les forêts et les personnes démunies s'est énormément accrue, particulièrement au cours des vingt dernières années. Les donateurs d'aide se sont occupés de la réduction de la pauvreté dans le secteur forestier dans les années 90 et ce, jusqu'au début des années 2000, mais ils ont par la suite élargi leur attention à l'atténuation du changement climatique, à une gestion forestière et une légalité du bois meilleures et au paiement des services environnementaux. Jusqu'à présent, il n'y a eu qu'une intégration incomplète des nouvelles découvertes quant à la nature de la dépendance des démunis sur les forêts, leurs efforts personnels pour utiliser cette dépendance comme une échappatoire à la pauvreté et les soucis actuels de la foresterie. Les projets futurs doivent choisir des interventions faisant un meilleur usage des résultats actuellement disponibles sur les relations de pauvres avec la forêt, pour assurer non seulement une meilleure conservation de cette dernière mais aussi pouvoir se concentrer plus finement sur les revenus des pauvres dépendant de la forêt, alors qu'eux-mêmes continuent de s'efforcer de pouvoir échapper à l'indigence.

Los bosques y la pobreza: ¿cómo ha cambiado la experiencia nuestra comprensión de la relación entre ambos?

G. SHEPHERD, K. WARNER y N. HOGARTH

La comprensión de la relación entre los bosques y la pobreza ha aumentado enormemente, especialmente en los últimos veinte años. Los donantes de ayuda humanitaria se han esforzado por reducir la pobreza en el sector forestal en la década de 1990 y a principios de la década de 2000, pero posteriormente ampliaron sus objetivos para abordar la mitigación del cambio climático, la mejora de la gobernanza forestal y la legalidad de la madera, así como los pagos por servicios ambientales. Hasta ahora se ha producido una integración incompleta de las nuevas percepciones sobre la naturaleza de la dependencia de los bosques que tienen las personas que se encuentran en situaciones de pobreza, de sus propios esfuerzos por utilizar esa dependencia para escapar de la pobreza y de las actuales preocupaciones sobre la ayuda al sector forestal. Los proyectos futuros deberían preferir las intervenciones que puedan aprovechar mejor los conocimientos disponibles en este momento sobre las relaciones entre bosques y pobreza, tanto para una mejor conservación de los bosques como para centrarse mejor en los medios de subsistencia de las personas en situaciones de pobreza que dependen de los bosques mientras siguen tratando de salir de esa situación.

INTRODUCTION

The last 40 years has seen a slow evolution in understanding of the relationship between forests and the poor. Looking back at the 1978 Forest Sector paper (World Bank 1978) – one of whose lead authors was John Spears – it can be seen that though there was an ambition to address people's needs, poverty itself was not mentioned. The issues it focused on were fuelwood and timber production, shelterbelts, fodder, and the planting of fruit trees. Tenure and market access were mentioned as barriers to on-farm or small-scale forest production.

The paper was framed by two prior trends. Until then, forestry's most recent developing country investments had been in plantations. At the same time, the oil price rises of the early 1970s suggested that people in developing countries might be relying on woodfuel for their energy needs for some time to come. The obvious answer seemed to be programmes in which rural people grew fuelwood plantations to meet their needs, and thereby plugged a rapidly widening 'fuelwood gap' (Shepherd 1990).

FAO first addressed 'community forestry' in 1978 at which point it meant community woodlots for fuel and small timber (Arnold and Persson 2009). Early efforts in South Korea, Thailand and India quickly showed that farmers preferred on-farm trees to woodlots, however, and sought a much wider range of products than fuelwood and poles (Arnold 2001a). In 1985 the first Common Property Resource Management conference was held (NAS 1985), gathering together examples of the communal management of natural forests in Nepal, South India, Niger and Thailand among others. Donor support began to be sought also for the involvement of rural people in the management of existing forests (Hobley 1991).

The application of rural development participatory methods to forest management and tree-planting was new to foresters, and the first steps taken were towards people-focussed rather than poverty-focussed forestry. CIFOR (the Center for International Forestry Research) was established in 1993, following the Rio Earth Summit, to take an approach to forests that combined social, economic and environmental concerns and recognised that forests should be managed for broader societal values than timber alone.

In its opening section, the paper sets out what has been learned about the forest reliant poor over the last decade or more. Thereafter it examines a range of donor interventions which have attempted to address the relationships between forests and the poor, followed by a section on actions the forest-reliant poor themselves have undertaken to move out of poverty. It concludes with recommendations for the future.

FOCUSSING ON THE POOR

During the 1990s, many multilateral and bilateral donors adopted poverty reduction as their primary overall aid objective, and sought to apply it, and better governance, to the forest sector among others (Brown *et al*. 1999, Arnold 2001a).

From around 2000 there began an outpouring of research into the poor and their use of forests (Wunder 2001, Angelsen and Wunder 2003, Vedeld *et al*. 2004, for instance) which led to the work of the CIFOR Poverty Environment Network (PEN). Substantial comparative research on commercial non-timber forest products (NTFPs) was also undertaken which explored, and was forced to reject, the hypothesis that the poor might be able to use them as a way out of poverty (Kusters and Belcher 2004, Sunderland and Ndoye 2004, Arnold 2004, Belcher *et al.* 2005). A further important cluster of papers on forests and poverty appeared in 2020 in a special issue of World Development (Miller and Hajjar 2020).

Around 1.6 billion people depend in part on forests for their livelihoods, including 70 million indigenous people (SDG website), forest dependency being defined as the share of absolute household income (including cash and subsistence), or the "relative income", that is derived from forest resources (Mamo *et al*. 2007, Kamanga *et al*. 2009). Forest-based contribution to livelihoods are defined as any product collected from a forest, or from trees. These include timber and non-timber forest products, whether tree, plant or animal-based.

Where are the forest dependent poor?

The relationship between chronic poverty (where an individual or group is in a state of poverty – lacking sufficient material possessions or income – over an extended period of time) and remoteness was first researched by the Chronic Poverty Research Centre (Bird *et al*. 2002, CPRC 2004). Since then papers by Sunderlin *et al.* (2005, 2007, 2008) have examined spatial aspects of the forests-poverty link at a district to national-level scale in several countries. Other research has investigated poverty increases in 23 landscapes at a much more local intra-landscape level over just a few kilometres (Shepherd 2012).

Sunderlin *et al*. explained (2008) that the highest incidence of poverty (the proportion of poor people in an area) was to be found in the most remote and forested areas, a pattern repeated again and again wherever there is the data to show the relationship between poverty and forests (Hulme and Shepherd 2003, Kanbur and Venables 2005, Müller and Senf 2010). High poverty rates are found not only in remote high forest cover areas, but also in remote areas where forest is present but at much lower crown cover levels (Shepherd *et al*. 2012).

Those in remote areas are more likely to be chronically poor, while those closer to markets and roads are more likely to be the transient poor (who dip in and out of poverty) and the non-poor. As Chomitz remarks (2007, p71) travelling away from towns into rural areas is like travelling back in time: the further you go, the poorer people are, and the conditions you see today in remote rural areas are those of yesterday in now market-accessible areas.

Unpacking forest reliance

CIFOR's Poverty Environment Network (PEN) study used standardized definitions and methods to quantify the contribution of forest and environmental income (including

the cash-equivalent value of subsistence extraction and production) in rural livelihoods across 24 developing countries. Detailed socioeconomic data was collected from nearly 8,000 households in 333 villages, making it the largest quantitative, global-comparative research project on the topic (Angelsen *et al*. 2014).

One of the key results from the analyses is the now much-cited average figure of around 22% for the average household forest income share, most of which comes from natural forests (Angelsen *et al*. 2014). There are however, large variations within this aggregate figure, both across and within regions. Hogarth *et al.* (2013) cite a figure of 31% for an area of Southern China. IUCN data (Table 2 below) shows a range from 9th to 59%. Wood fuels – predominantly firewood but also charcoal – are the most important products, accounting for about 35% of forest income and representing about 7.8% of total household income. The second-most important product category is food (around 30%), which includes wild fish and bush meat, as well as wild fruits, vegetables, and mushrooms. The third most important category is timber, poles and fibre products for house construction and domestic equipment, which make up about 25% of forest income. The fourth category (around 5%) is made up of forest medicines, resins and dyes.

Forest and environmental income proportions are higher for low-income households, but differences across wealth classes proved less-pronounced than previously assumed. Forest income is approximately five times higher in the higher income households compared to the lowest income households. Low-income households tend to rely more heavily on subsistence forest products such as wood fuels and wild foods by contrast with higher income households (Sunderland *et al*. 2014).

Previous assumptions about men, women and product use were challenged by some of the results from the PEN study. Men generated at least as much forest income as women, though Sunderland *et al*. (2014) found significant gender differentiation in the products collected. However, men do play a much more important and diverse role in the contribution of forest products to rural livelihoods than previously reported. Researchers did not find that environmental income is more important to households that are female headed (Angelsen *et al*. 2014).

The role of forest income within overall livelihood incomes

Certain broad patterns about the relationship between cash and non-cash income also emerged from the 23 landscapes in which IUCN's 'Livelihoods and Landscapes' programme worked from 2006–2010. Firstly, non-cash income continues to be drawn from forests even where there are no cash sales of forest products at all. Secondly, forest non-cash values make a larger contribution to overall household income than do forest cash values in almost every case. Where cash values are high, because there are high-value forest products to sell, the ratio of cash to non-cash forest income is about 1:2. Where – the more usual case – these cash values are lower, the ratio rises to 1:3, 1:4 or more (Shepherd 2012).

IUCN and CIFOR results showed that men tended to sell a third or more of what they collected with the remainder going to the household, while women sold no more than 20 to 25% of what they collect. Forest products are often collected as a side-line while other more mainstream economic activities are underway. So, men may collect food or medicinal products from remote areas as part of a hunting expedition, while women collect fuelwood and wild foods while working on agricultural plots. Fuelwood, building materials, and forest foods were the most important contributors to both cash and non-cash income; but for consumption only, other items such as fibre and herbal medicine also scored high (Shepherd 2012, Sunderland *et al.* 2014).

The importance of recognising non-cash reliance on forests

The fundamental importance of forests for the poor was sometimes underplayed in earlier work (Angelsen and Wunder 2003, Cavendish 2003) precisely because the contribution of cash from forest products to overall cash income is often very small. Where villagers are living on a total cash equivalent of under $2.00 a day, the small fraction of that drawn from forest is nugatory and will certainly not make much contribution to an exit from poverty. There was also an assumption, (before the CIFOR PEN study results came in) that the non-cash component of forest income played no more than a safety net or gap-filler role (Wunder 2001, Wunder *et al.* 2014).

Cash income from forest sales was recorded in household budget surveys, living standards surveys and the like. But, until recently, forest non-cash income was not being systematically recorded anywhere. As a result, the constant and profound reliance on forests of local people was under-observed by both Bureaux of Statistics and Forestry Departments in government, and in consequence greatly undervalued (Agrawal *et al*. 2013). Attempts are now being made to rectify this (Bakkegaard *et al*. 2016, Bakkegaard *et al*. 2017), but a recent systematic map on the subject shows that assessments of poverty in forests are still very over-reliant on assumptions about the cash value of forests (Cheng *et al*. 2019).

MAJOR FOREST POLICY AND PROJECT INTERVENTIONS THAT IMPACT UPON THE POOR

When forest management interventions involving local people were first devised, there was no doubt that forests were being prioritized over people. The focus was on lowering deforestation and degradation. Forest-based benefits for the poor and poverty reduction took second place. Indeed, early assumptions about local people who lived near forests showed a lack of trust. It was assumed that they were responsible for much deforestation, and that granting them greater rights or greater benefits might increase the deforestation rate (Arnold 2001a, 2001b, Arnold and Persson 2009). In-depth research on the main drivers of deforestation (Curtis *et al*. 2018) in due course suggested otherwise.

Others hypothesized that it was the lack of recognized rights of access and use by rural communities that led to local deforestation. So, logically, if rights to manage or protect a forest area were granted and communities could retain a portion of the forest products from their forest, deforestation and degradation would be reduced, along with poverty (Jagger *et al*. 2014).

Community-based forestry (CFM) and, community forest enterprises (CFEs)

Community forestry (CFM) worked from the outset on the assumption that, handed some forest rights and some access to forest products, communities would be willing to invest their labour, and forego or postpone harvesting to encourage forest restoration.

While community forestry appealed to donors, it was less popular with forestry departments, which often employed various tactics to retain control. Officials were sceptical of the ability of communities to manage forests, and found the change in roles from policing to local support challenging. More broadly, the higher the potential marketed benefits from community forestry, the greater the hostility of the policy environment towards community management. Such issues were reported regularly in research undertaken in Nepal, East Africa and Cameroon (Brown *et al*. 2002, Pokorny and Johnson 2008, McDermott and Schreckenberg 2009).

In Nepal, rural communities are granted access to a forest area and must agree an Operational Plan stipulating what can be harvested and how the products/benefits are to be shared within the village (including percentages for the poor), and with the forestry department (Hobley 1996). While community forestry has improved the livelihoods of rural people (Hobley *et al*. 2012), commitment to special help for the poor has often been lacking. (Thoms 2006, Parajuli *et al*. 2015). Nevertheless, Oldekop *et al.* (2019) conclude, using high-resolution forest cover change data and near complete information on Nepal's 18,000 community forests, that community forest management (CFM) has contributed to significant net reductions in both poverty and deforestation. Reduced deforestation is lower where poverty levels are high, and higher where community forests are larger and have existed for longer, suggesting that additional support will be needed in poorer areas to minimise trade-offs between socio-economic and environmental outcomes.

A comparative review of cases from Asia, Latin America and Africa conducted by Baynes *et al*. (2015) confirms that the success of community forestry turns on good governance within the community forestry group, relatively secure tenure rights, genuine government support and a reliable stream of shorter and longer term benefits for members, findings also noted by others (Warner 2006, Anderson *et al*. 2015, Shyamsundar *et al*. 2018). None of these factors necessarily reduce poverty.

But McDermott and Schreckenberg (2009) contend that the poor do, nevertheless, benefit from community forestry. It both expands decision-making spaces for the community, and enlarges benefits at the supra-community level (through national policy reform) providing opportunities to challenge factors perpetuating poverty.

Community forest enterprises (CFEs) face challenges similar to those encountered in CFM. A summary of the main findings from six key sources – largely concurring about CFE issues and challenges – is instructive. (Arnold 2001b, Stoian *et al*. 2009, Macqueen 2013, Foundjem-Tita *et al*. 2018, Hajjar and Oldekop 2018, Adhikary *et al*. 2019).

- The resource upon which the enterprise is based has to be adequate to generate sufficient benefit flows for enterprise participants to feel its management is worthwhile (Dolsak and Ostrom eds 2003). Reliable tenure rights are important.
- Long-term donor or NGO support is critical: CFEs may take years to mature and almost all begin with low levels of productivity and product quality, because they lack processing, management, and business administration skills. Occasionally private sector partnerships (e.g. Foundjem-Tita *et al*. 2018) provide this support.
- Government legal and regulatory frameworks hinder CFE development. Regulations developed for larger formal organisations, need recasting for small-scale operations, but this is slow to happen. The time and costs involved in negotiating regulatory bureaucracy are beyond the capacities of most CFEs, and as a result many choose instead to operate in an informal unregulated manner.
- Government service delivery is often weak, and unable to offer help with market development or even effective forest management.
- Many country governments try to control forest product trade in ways that hamper small producers. Forest departments often look for a share of product value.
- CFEs themselves are torn between the desire to distribute profits to members and the need to reinvest in the enterprise. It is often expected that CFE cash will provide social welfare benefits such as schools and health centres, and members may expect employment as well.
- The participation of women in CFEs is often low, and there is a risk that wealthier CFE members capture a disproportionate percentage of benefits.

Experience suggests, then, that while community forest enterprises have generated some benefits, poverty reduction has been modest.

FLEGT AND VPAS

There is a commitment to poverty reduction in the FLEGT (Forest Law Enforcement, Governance and Trade) action plan and VPAs (Voluntary Partnership Agreements) which accompany it (European Commission 2003). The VPA has social safeguard instruments inbuilt to understand, prevent, and mitigate adverse effects of VPAs on livelihoods and one early proposal was to conduct a Poverty Impact Assessment before

VPA negotiations begin and to use the PIA to track effects on the poor. (Hobley and Buchy 2013).

But the realities of forest use and competing forest conceptions are perhaps too complex for a PIA. Owusu *et al.* (2010) in Ghana, (cited by Buchy and Hobley 2018) noted that while a VPA could in theory improve forest conditions, legalise small-scale forest activities and enhance local rights, more realistically the effects would likely be negative. They would include less employment in and income from 'illegal' logging; the denial of customary forest use-rights; a ban on small-scale technologies such as chainsaws; the enforcement of anti-poor aspects of forest laws; a focus on the technical at the expense of benefit sharing, and the empowerment of government bureaucracy at the expense of wider concepts of justice.

Originally VPAs were concerned only with the export of timber to European markets, but as regional and domestic markets grew these were included under the VPA, and the same legality framework was enforced for both export and domestic timber. This has imposed crushing regulatory barriers on small forest enterprises (Buchy and Hobley 2018)

Derous and Verhaeghe (2019) argue that the impact of formalising access to resources for vast numbers of actors in the grey zone between legality and illegality, and who depend on the forest for their livelihoods, has not been taken sufficiently seriously. They point out that forests are governed by a wide range of types of governance including customary systems, but that if there has been no reference to these traditional systems, VPAs turn local actors into criminals. Other writers concur that indigenous peoples have found it difficult to engage in these processes everywhere (Lesniewska and McDermott 2014, Setyowatia and McDermott 2017).

In their analysis of the Indonesian VPA, van Heeswijk and Turnhout, (2013), set out two interpretations of 'legality', with one more narrowly focused on law enforcement and a strong role for the state, and the other having a broader focus on issues of participation and sustainability. Both EU and Indonesian officials chose the narrower focus. If this is how debates in other VPA countries have gone, ambitions for poverty reduction through FLEGT and VPAS look unlikely to be realised.

Protected areas

Around 1.6 billion people rely on forests, and of these an estimated 40 percent of the extreme rural poor – around 250 million people – live in relatively remote forest and open woodland savannah areas (FAO 2018). It is also the more forested of these same remote areas that are of interest to conservation and forest carbon initiatives. For households here to move out of poverty to relative prosperity 'is likely to be a slow, even inter-generational, process' (Shyamsundar *et al*. 2018). And for people who have very little, even minor setbacks or mistakes can undermine a slow improvement in livelihoods (Banerjee and Duflo 2011). Protected areas (PAs) create major additional hurdles for chronically poor households in remote areas, if they remove access to assets without providing compensating benefits.

After World War 2 there was an expansion of conservation initiatives by international organizations and donors into developing countries which chose a form of conservation premised on the ideal of people-free landscapes (Dressler *et al*. 2010). At a time when professionals in the forest sector were encouraging communities to play an active role in forest restoration through community forestry and forest co-management, conservation bodies were still locking them out of forests and criminalizing customary use (Neumann 2002).

Some protected area (PA) managers began to try to integrate conservation and development from the 1980s and 1990s onwards (Dressler *et al*. 2010) by managing both the PA and its buffer zone as one, combining strict protection within the PA with modest development opportunities in the buffer zone. The premise of these integrated conservation and development (ICDP) projects, as they were initially known, was that by providing communities living in biodiversity-rich areas with income-generating opportunities, compensation would be provided for loss of access to natural resources and these would become easier to protect (McShane and Wells 2004, Weber *et al*. 2011).

The term ICDP is now less often heard, superseded by what are nowadays referred to as Alternative Livelihoods projects (Roe *et al*. 2015). But earlier weaknesses tended to flow on into them. There was poor understanding that in the remote areas where most PAs were located, market opportunities were scant and forest reliance profound. The assumption that cash from income generation could almost entirely replace resources foregone was naïve in many ways. For instance, Table 1, drawing on results from a study in Uganda, shows that here, as elsewhere, many natural resources cannot be substituted for. Cash sales from natural resource products – which might hypothetically be replaced by other income sources – are insignificant beside the volumes of products used for home consumption, for which there is no alternative. The remoter the area, the truer this is (Shepherd 2012).

There was also failure to accept that local resource users might have only minor impacts on local biodiversity compared with those of commercial or government initiatives (Garcia-Amado *et al*. 2013). Above all, the benefit – if any – of alternative livelihood interventions to conservation outcomes was profoundly unclear (Sayer *et al*. 2007, Weber *et al*. 2011). A Systematic Review of alternative livelihood projects was undertaken by Roe *et al*. in 2015 to try to illuminate this issue with better evidence. Hundreds of such projects were screened and about 100 of them were reviewed in more detail, only 21 containing sufficient data to say whether positive, neutral, or negative outcomes were obtained. Projects had usually failed to put in place measures to monitor progress towards improved conservation status, for instance. The influence of the external economic environment was barely taken into account in assessing results, even where it was considerable – such as road construction or commodity price changes. In short it was impossible to identify potential success factors from the data. The Review's recommendations included developing a solid Theory of Change, and monitoring against its assumptions, and also recommended much more consultation with local stakeholders about potentially attractive interventions (Roe *et al*. in 2015).

TABLE 1 *Cash and non-cash income in percentage terms from eight villages in Uganda*

Forest Products	Cash %	Non-cash %	How much more important are products for non-cash use than for cash use?
Fuel	10.1	29.5	3 times as important
Building materials	8.6	16.3	Twice as important
Forest foods	6.0	12.7	Twice as important
Fibre (for ropes, mats, baskets etc)	1.7	6.4	4 times as important
Herbal medicine	1.1	3.6	Over 3 times as important
Timber	0.8	3.2	4 times as important
Percentage split between cash and non-cash	28.3	71.7	100%

Source: Shepherd, Kazoora and Muller, 2012, Table 9 p. 55

Some Systematic Review authors pushed analysis further in a separate article (Wright *et al*. 2015). Firstly, they recommended more nuanced analysis of which activities within livelihood strategies might be environmentally damaging and which not. Secondly, and very long overdue, they recommended abandoning the assumption of a homogeneous community, to investigate which households in the community caused the greatest negative environmental impact, and which were rendered especially vulnerable by resource access restrictions. Finally, they suggested abandoning the phrase 'Alternative Livelihoods' altogether and replacing it with 'Livelihood Focused Interventions' to avoid the assumption that alternatives actually exist. (Wright *et al*. 2015).

Far too few initiatives have attempted to work closely with local people from the start, however. Research undertaken by Sheil *et al*. (2006) suggested a very different approach. Working in East Kalimantan, the team partnered with local people to document locally valued habitats, species and sites, and their significance; to clarify threats and suggest management options, and to list issues requiring further investigation. Community meetings and joint mapping exercises elicited local landscape classification and terminology, provided a basis for biodiversity field surveys, and were iteratively revised and clarified. The exercise demonstrated a conservation approach that might build on the needs and priorities of local communities (Sheil *et al*. 2006).

Research efforts of this kind have been slow to influence conservation organisations, and approaches making the knowledge and capacities of local people a starting point are still controversial. This is because they involve building first on local conservation values, which translate into poverty-relevant issues such food security, and only then exploring ways to synthesise these with global values (Baldauf 2020). Rights-based approaches to conservation are also just beginning to gain traction (Blomley and Walters 2019).

REDD+ and PES initiatives

REDD+

Results-based finance is the current cornerstone in the approach to REDD+, with a special focus on intermediate outputs to reduce deforestation and forest degradation. Understanding better who is bearing the costs of REDD+ projects is critical in incentivizing outcomes which are both carbon effective and equitable (Wong *et al*. 2016).

A review of forty-five articles from recent scientific literature on REDD+ outcomes was conducted by Duchelle *et al*. (2018). (In that year, REDD+ projects were mostly to be found in Brazil, Colombia, Peru, Indonesia and Kenya.) In the articles reviewed, most REDD+ projects focus on local people – indeed, many bear a close resemblance to integrated conservation and development projects. There is a strong emphasis in several studies on the importance of a pro-poor approach to REDD+, to enhance effectiveness and to promote equity and social co-benefits. Recommendations include recognising community rights, land tenure clarification, promoting equity through small cash transfers to the poor, and the better combining of climate change mitigation and adaptation goals. There has also been a focus on creating or strengthening local governance institutions (Duchelle *et al*. 2018).

Articles focussing on the measurement of livelihood outcomes are much more numerous than those of carbon outcomes (though those that exist paint a moderately encouraging picture). REDD+ projects are extremely heterogeneous and there is as yet no adequate evaluation of REDD+ performance overall (Duchelle *et al*. 2018).

REDD+ has catalysed national dialogues highlighting the inequitable outcomes of business-as-usual forest management. In several countries, including Indonesia, such dialogues have strengthened the position of indigenous peoples and given them a voice in national policy arenas which they did not previously have (Seymour 2019). In the same way, IUCN's multicountry project 'Towards Pro-Poor REDD+' moved debate decisively forward, both for the organisation itself, and for REDD+ dialogue in the countries concerned (Blomley and Walters 2019). Using rights-based approaches (RBAs), teams worked with the premise that a decent livelihood was such a right. In Uganda, Cameroon, Guatemala, and Ghana, women argued for better recognition of their investments in local-level forest activities which led in due course to the development of a national gender policy within government REDD+ programmes.

PES

In 2014, Samii *et al*. undertook a detailed Systematic Review of the effects of PES on deforestation and poverty in low and middle-income countries. The database search returned 1382 articles, but only 20 met the review's criteria, cases being located in Costa Rica, China, Mexico and Mozambique. While the PES programmes reviewed did show reductions in deforestation rates, evidence on welfare outcomes was very limited. Qualitative data in the 20 studies suggested that forest conservation effects were worse in poorer areas, and that lack of institutional capacity to carry out PES was a limiting factor in many places. The review was unable to demonstrate any beneficial effects on poverty reduction (Samii *et al*. 2014),

Alix-Garcia *et al*. 2013 found that environmental impact was highest where poverty was low and poverty alleviation highest where risk of deforestation was low. Programs in Latin America where payments for hydrological services were involved were moderately effective at reducing deforestation but not particularly effective at alleviating poverty (Alix-Garcia and Wolff 2014).

China's huge sloping land PES scheme seems to show that though the scheme targeted the poorest areas, it did not successfully involve the poorest people within those areas (Ren *et al*. 2018). Finally, it is not clear how PES programs function in week institutional settings, in particular in places where land tenure is ambiguous (Wunder 2008).

So PES programmes have not so far succeeded in simultaneously supporting environmental protection and in alleviating poverty. The best that can be said is that to the extent that PES programmes increase the hunt for off farm labour opportunities, it may be that they have an indirect antipoverty impact (Alix-Garcia and Wolff 2014). A recent Systematic Review of large numbers of PES programmes (Snilstveit *et al*. 2019) concludes that, though they are now also considered as potential engines for climate change mitigation, the effectiveness of both environmental and socio-economic outcomes continue to be questioned.

Policy and Project interventions – summary

To summarise, the policy and project interventions examined in this entire section of the paper, which taken together cover hundreds of initiatives over at least a 40-year period, show at best only modest successes in livelihood improvement, and barely touch poverty reduction.

A recent survey, focussing on the evaluation of a wide range of donor forest interventions in low and middle-income countries, provides an invaluable Evidence Gap Map based on two decades of literature (Pirard *et al*. 2019). Protected areas are by far the most commonly reported on, followed by community-based management, PES and tenure reform. The review's main findings are as follows.

- Forest cover is much the most evaluated outcome of intervention success. Measuring forest cover is straightforward using remote sensing, and avoids the time-consuming collection of primary data. By contrast, evaluations of biodiversity and socio-economic impacts require longer-term on-the-ground commitment and a broader combination of skills. Protected areas of course do have positive forest conservation impacts, though research is lacking so far on the efficiency of different subtypes – for instance strict protected areas versus those that tolerate some human activity.
- The three most evaluated intervention/outcome combinations, are protected areas, conservation based on local community practice (of growing interest in the conservation community), and PES managed by public authorities.
- Livelihoods have received more focus, since socio-economic aspects of conservation are increasingly seen by donors and practitioners as important for ethical reasons as well as success. But evidence for poverty reduction outcomes is scanty.
- Both the carbon and the forest cover outcomes of REDD+ interventions have, surprisingly, been less well studied than human well-being outcomes, where a strong interest in REDD+ social safeguards has been shown. It is not yet clear how far REDD+ interventions achieve climate change mitigation.
- Environmental and social trade-offs have rarely been monitored side by side from the start in any project, with the exception of investigations in a small number of PES interventions (Samii *et al*. 2014, Alix-Garcia *et al*. 2013).
- Though it is generally recognised that conservation in one place may lead to deforestation in another, conservation 'leakage' remains under-studied with only seven examples identified. The broader impacts of protected areas within larger landscapes are an essential future research topic.
- Methods for simplifying results and presenting them vividly for decision makers are urgent if received wisdom is to change. Evaluations need the quality that research centres and universities provide, but donors and governments need that information in a format for them to make better policy choices.

THE TACTICS OF THE POOR – PATHWAYS OUT OF POVERTY?

There are no simple answers to questions about the conditions under which forests might help people to move out of poverty (Shyamsunder, *et al*. 2020). We now turn instead to the efforts people themselves have made to make an escape from poverty, using forests as one of a portfolio of livelihood resources.

1. Using forests as one part of a livelihood portfolio, and building on choices available

Sunderlin's work at CIFOR (Sunderlin *et al*. 2005, 2007, 2008) has shown how those in remote areas are unlikely to get out of poverty in one bound. Rather we need to understand how forests (among other resources) can help to move the

TABLE 2 *Relative remoteness and reliance on forest*

Location	Cash income %	Non-cash income %	%	Comments
Very remote: Baka pygmies, Mambele and Salapoumbe, Cameroon				
Cash: non-cash income split	30	70	100	Very high forest reliance for protein, vegetables, fruits, eaten at home and traded. Carbohydrates mainly obtained through trade.
Of which forest contribution	17	42	59	
About 10 km from a market town: Pensanom village, S W Ghana. Original forest owners in the cocoa belt				
Cash: non-cash income split	47	53	100	Forests important for fuelwood, protein, wide range of NTFPs.
Of which forest contribution	10	27	37	
Huayuan village, Miyun water catchment, about 80 km from Beijing, China				
Cash: non-cash income split	82	18	100	Most cash comes from household members working as labour migrants in Beijing, but a little from forest NTFPs provided for tourists. Fuelwood vital for home heating in winter.
Of which forest contribution	6	3	9	

Shepherd, 2012

chronically poor to the transient poor, and the transient poor to the non-poor. Rural incomes are generally made up of cash and consumption forest income, cash and consumption farm income, and off-farm income, and the balance of income derived from these sources usually has to change before poverty reduction can take place. The ingenuity of rural producers in adapting livelihood strategies to new opportunities over long periods of time is well documented by Tiffen (1976, 1994) and this is no less true in a forest context. Changes such as gradually improving market access or employment availability slowly reduce forest reliance. Using relative landscape remoteness as a proxy for change over time (Chomitz 2007) it is possible to see a very clear pattern, in which rural people gradually reduce their forest reliance as agriculture and off-farm income sources become more profitable or more available.

Most farming systems were originally built upon synergy with forests, and forest income continues to work with agricultural income in various ways: making up shortfalls, releasing a greater proportion of agricultural produce for sale or enabling the keeping of more animals for capital investment through fodder provision. Indeed, the catalytic value of forests in supporting an increase in the accumulation of other sources of income is still an under-researched area. Gradually, as new non-forest pathways out of poverty present themselves, cash income from forests may disappear entirely, though non-cash reliance on forests continues for much longer (Shepherd 2012).

2. The complex role played by NTFPs in livelihood advancement

NTFPS fulfil multiple functions in the lives of the poor (Shackleton and Pandey 2014). Direct household consumption is by far the most important of these for both the poor and the less poor. (Kaimowitz 2003, Babulo *et al*. 2009, Belcher *et al*. 2005). Without them, many more people would fall into further poverty and become food insecure. NTFPs thus play a vital livelihood resilience role.

Secondly NTFPs are used to create capital assets for the household: housing, house furnishings, and productive farming and hunting equipment. Thirdly they supply needs which would otherwise have to be paid for, such as energy and medicinals, sparing precious cash resources for the things that only money can buy such as children's education, agricultural inputs and so on. NTFPs thus make important contributions to income indirectly, as well as directly (Rasul *et al*. 2008, Shackleton *et al*. 2007, 2008, Shackleton and Pandey 2014).

Finally, of course, NTFPs offer income generation, usually as supplementary income but sometimes as a primary, though usually modest, source of income (Babulo *et al*. 2009, Mahapatra *et al*. 2005, Shackleton *et al*. 2008). Each NTFP may be of fairly low value, but a wide range may be sold over the year. Some products such as fuelwood, chew-stick toothbrushes or wrapping leaves for use in markets, may have low unit value, but are sold in such vast quantities (Schure, Levang and Wiersum 2014, Falconer 1990), that small but steady contributions to overall income can be earned – and by both sexes.

3. The longer-term – investment in the future

Women in particular go to great trouble to increase the chances of their children eventually escaping from poverty, by investing in education (school fees and school uniforms) using forest sales. (Shackleton *et al*. 2007, 2008). In southern Cameroon, an increase in NTFP sales by women was noted before the start of each school term (Schreckenberg *et al*. 2002).

Wherever cattle can be raised, cash from the sale of forest products such as fuelwood or timber is invested by men

in livestock. Cattle and smaller livestock such as goats can rapidly help to multiply cash income and build capital assets in remote savanna forest areas, if droughts and wars do not intervene (Hesse and MacGregor 2006). Livestock live on forest savannah tree browse for most of the year (e.g. Barrow 1990, Mortimore and Adams 1999).

4. The role of forest in re-establishing livelihoods after major shocks

In the Northern and Eastern Regions of Uganda, when eventually populations were free to leave IDP (internally displaced person) camps, the forest played a major role in livelihood reconstruction as households settled back into private life and begin to look for ways to invest for the future. Over and above 'normal' support provided by forest households in these regions were able to draw down substantial extra resources, to see them through the early resettlement period. Non-cash support was used to rebuild and restock homesteads, while fuelwood and building materials were sold to raise cash for livestock, seed, and tools (Shepherd, Kazoora and Müller 2012).

5. Adding value to forest through enrichment and diversification

In tropical moist forests where forest fallows are important in the agricultural cycle, a field about to be fallowed is often enriched by being planted up with economic fruit trees. Over time, villagers' fallowing farm plots turned into high value orchards under which some crops can still be grown. This has been a common pattern throughout South-East Asia, as multi-storey forest gardens testify. (Ziegler *et al*. 2011). Manipulation of forest composition to increase value is also well attested for the Amazon rainforest (Barlow *et al*. 2012). Around Mount Cameroon, forest is modified as part of the shifting cultivation cycle so that in some plots highly valued forest trees such as Irvingia gabonensis are moved as wildings and gradually clustered in accessible orchards. In other plots fallows alternate between agriculture and the forest regrowth which restores fertility, while in still others cultivation is almost continuous (Brocklesby and Ambrose-Oji 1997).

On the volcanic island of Anjouan in the Comoro Islands near Madagascar, efforts at poverty reduction have resulted in the conversion of the lower reaches of mountain forests almost entirely into agroforestry areas combining high value tree-crops – cloves and ylangylang – with domestic fruit trees such as mango and breadfruit, only the most highly valued indigenous timber species being retained (Shepherd *et al*. 2019). Such manipulation of the composition of forests greatly raises its value to owners. Ideally upper mountain slopes remain well-clothed in natural forest, and forest functions (such as protection of water sources) are thus also maintained.

6. Migration

The tactics listed so far are all concerned with making the best use of forest resources, among others, first to build livelihood resilience and then to seek ways of reducing poverty in the household. A more radical but increasingly common solution is for one or more members of the household to migrate, seasonally or for the longer term, to raise cash for the household left behind. In this case the forest may play a role in helping part-families survive tough times at home while key household members seek livelihood diversification elsewhere (de Sherbinin *et al*. 2008, Cohen, J.H. 2011). Hecht *et al.* (2015) note the importance of migration not only for the households concerned, but also for its impact on forest. Depending on household strategies as a whole, forest may begin to disappear if migration stokes agricultural expansion, or may regenerate if labour-short households abandon remoter fields.

In the Middle Hills of Nepal, labour migrants to the Middle East and Malaysia leave in their thousands. A recent study (Adhikari and Hobley 2015) investigated the impact of migration on two villages where 51–71% of households had a migrant member. Remittances in the district totalled $26 million in 2010–2011. Initially, remittances are used to repay airfare loans. Subsequently, money is invested in children's education, house improvements and land purchase. Hitherto landless wage laborers buy land as wealthier families migrate from the Middle Hills to the Terai. Forests are managed less intensively and agriculture practised less intensively but more trees are planted on private land.

7. Small forest enterprises (SFEs)

Finally, in somewhat less remote areas, where there is still plenty of forest but where also markets can be accessed, small forest enterprises (SFEs) are flourishing. SFEs typically contain only 2 – 6 employees, often recruited from among family members or co-villagers. Macqueen (2008) and Kozak (2007) argue that SFEs offer better prospects for poverty reduction than medium-sized enterprises or Community Forest Enterprises, and observe that the growth of small SFEs is outpacing that of larger enterprises everywhere, avoiding many of their management complexities, and staying 'below the radar' as far as business registration is concerned (Saigal and Bose 2003). SFEs may work in chainsaw timber felling and milling, or small-scale carpentry, and in northern Ghana at least over 600,000 women were working in SFEs collecting and processing shea butter (Osei-Tutu 2010). Indeed 77% of SFE proprietors in northern Ghana were women.

SFEs have the potential to enhance rural livelihoods since they may require little initial investment yet greatly diversify economic opportunities. Macqueen *et al.* (2020) suggest that such small forest businesses will play a key role in shaping the future of forest landscapes.

It is very difficult to estimate the total number of people working in SFEs worldwide, but it is large. Macqueen (2008) and Shackleton *et al*. (2011) suggest the figure is over 45 million. The World Bank (2016) estimates that there are 13.2 formal sector workers and up to 41 million informal sector workers. Kozak (2007) thinks SFEs may actually employ as many as 140 million people, if all informal forest sector enterprises are included.

CONCLUSIONS: PRIORITIES FOR THE FUTURE

Much of the world about which John Spears and his colleagues were writing in the 1980s has changed almost beyond recognition. It has changed especially for the urban poor and for the non-remote rural poor (the transient poor). But it has changed much less for the chronic poor, living in relatively remote forested areas in parts of Africa and South and Southeast Asia.

As the first section of this paper shows, we now have a much greater understanding of the lives of poor people in forests. CIFOR's PEN results in particular, have enormously illuminated this relationship. It has become clear that reliance on forests – for cash income but above all for subsistence income – is far more profound than was originally realised, especially in the remoter areas where extensive forests are found.

Many aid interventions in the 1990s, and for while thereafter, focused on poverty reduction, and thus in the forest sector on the relationship between forests and poverty, at a time when CIFOR's data was not yet available. As a result, there was a primary focus on helping local people to generate cash incomes from forest, and a serious under-recognition of the role of forests as a steady supplier of the subsistence income which builds livelihood resilience for poor people.

But then for much of the next 18 years to the present, forestry donors have focused, rather, on forest interventions which are concerned with climate change mitigation, payments for environmental services and better forest sector governance. Pirard (2019) shows that the most evaluated aspect of all these projects is forest cover, though Oldekop *et al.* (2019)'s review does also go wider to consider poverty reduction as well.

Paradoxically livelihoods have received more focus in protected area projects over the last decade or more than ever before, partly because donors and practitioners are more concerned than they were with local people for ethical reasons, and partly because it is increasingly clear that conservation cannot work without their goodwill. The near universal commitment to the SDGs, which intertwine goals for poverty reduction, environmental protection and justice (Katila *et al*. 2019) are also important in this context. Nevertheless, there is a long way to go before poverty reduction is likely to occur in protected areas.

The forest-reliant poor themselves find their own means to escape, little by little, from poverty.

From those insights, two other themes emerge. Firstly, the assurance of livelihood security and resilience is the primary function of forests as far as poor people in forested areas are concerned. Out of that reliance, in certain circumstances, poverty reduction may be constructed. That this absolutely vital forest function was under-observed and under-recognised for so long was the result of the failure to measure the consumption values of forest as well as its cash values.

Secondly, the corollary to this is that great damage can be done to people living in remote forested rural areas if the protective underpinning to livelihoods provided by forests is removed. If that reliance on forest cannot be guaranteed, then rural people can rapidly fall into much greater poverty (Shackleton and Pandey 2014). Poverty may similarly be increased in forests where land conversion removes resources from poor people. In Chile, for instance, large-scale private plantations drove people out from rural areas (Andersson *et al*. 2016).

Government allocation of forest to protected areas or logging concessions may have the same effect for those who abruptly lose access to resources they previously relied on. This has been widely reported from Cameroon and the Congo basin, for instance, where pygmies have been driven out of the forests they had lived in for centuries (e.g. Lewis 2005) by conservation organisations.

Future projects and programmes will need to make intervention choices which keep all that is now known about the role of forests in the lives of the poor, more clearly in view. And much more attention to baselines, monitoring, and targeted intervention will be required.

Climate change could actually give forests renewed importance for the poor. Recent research (Wunder *et al*. 2018) shows that climate-change related fluctuations in crop production and income may be tipping livelihood strategies back towards forests in many lower- and middle-income countries.

In terms of research there is still a need to understand longer-term strategies better, and the differing pathways out of poverty that men and women may take. (Women start from a position of greater forest reliance and fewer rights, for instance. Colfer *et al*. 2016). Panel data offers one solution (Miller and Hajjar 2020). Or a simpler research method may be to apply the predictive proxy indicators promoted by Miller *et al*. (2017). As these authors point out, much more is currently known about spatial aspects of poverty than about temporal aspects.

But above all, as Pirard *et al*. (2019) make clear, donors and governments need information presented to them in a format which is simple, compelling, and which leads to action. They need to understand that reliance on forests – for cash income but above all for subsistence income – is far more profound for many people than was originally realised, especially in the remoter areas where extensive forests are found Without making changes to accommodate that reality, forestry interventions are likely to fail and the poor will grow poorer.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the very helpful suggestions of two peer reviewers, who challenged the paper's arguments in productive ways and provided useful additional references. The authors are grateful for their generous assistance.

REFERENCES

ADHIKARI, A., JHAVERI, N., KARKI, N., and PAUDEL, N.S. 2019. *Analysing the investment effects of forest rights devolution in Nepal's community-managed forest enterprises*. Working paper **254**, CIFOR, Bogor, Indonesia.

ADHIKARI, J. and HOBLEY, M. 2015. Everyone is leaving. Who will sow our fields? *Himalaya, the Journal of the Association for Nepal and Himalayan Studies*. Volume **35**, no.1, Article 7.

AGRAWAL, A., CASHORE, B., HARDIN, R., SHEPHERD, G., BENSON, C., and MILLER, D. 2013. Economic contributions of forests. Commissioned Background Paper, *United Nations Forum on Forests*, **10**th session.

ALIX-GARCIA, J.M., MCINTOSH, C., SIMS, K.R.E., and WELCH, J.R. 2013. *Review of Economics and Statistics* **95**(2): 417–4, answer 35.

ALIX-GARCIA, J.M., and WOLFF, H. 2014. Payment for ecosystems services from forests. *Annual review of Resource Economics* **6**: 361–380.

ANDERSON, J., MEHTA, S., EPELU, E., and COHEN, B. 2015. Managing leftovers: does community forestry increase secure and equitable access to valuable resources for the rural poor? *Forest Policy and Economics* vol **58**, September 2015.

ANDERSSON, K., LAWRENCE, D., ZAVALETA, J., and GUARIGUATA, M.R. 2016. More trees, more poverty? The socio-economic effects of tree plantations in Chile, 2001–2011. *Environmental Management* **57**(1): 123–136.

ANGELSEN, A., and WUNDER, S. 2003. Exploring the Forest-Poverty-Link: key concepts, issues and research implications. *CIFOR Occasional Paper* No.**40**.

ANGELSEN, A., JAGGER, P., BABIGUMIRA, R., BELCHER, B., HOGARTH, N.J., BAUCH, S., BORNER, J., SMITH-HALL, C., and WUNDER, S. 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. *World Development* **64**: S12–S28.

ARNOLD, J.E.M. 2001a. Forestry, Poverty and Aid. *CIFOR Occasional paper* No. **33**. CIFOR, Bogor, Indonesia.

Customers ARNOLD, J.E.M. 2001b. *25 years of Community Forestry.* FAO, Rome, Italy.

ARNOLD, J.E.M. 2004. Forward to *Forest products, livelihoods and conservation. Case studies of non-timber forest products systems.* CIFOR, Bogor Indonesia.

ARNOLD, J.E.M., and PERSSON, R. 2009. Reorienting forestry development strategies in the 1970s towards 'Forests for People'. *International Forestry Review* **11**(1).

BABULO, B., MUYS, B., Tricked out NEGA, F.,TOLLENS, E., NYSSON, J., DECKERS, J., MATHIJS, E. 2009. The economic contribution of forest resource use to rural livelihoods in Tigray Northern Ethiopia. *Forest Policy and Economics* **11**: 109–117.

BAKKEGAARD, R.K., AGRAWAL, A., ANIMON, I., HOGARTH, N.J., MILLER, D., PERSHA, L., RAMET-STEINER, E., WUNDER, S. and ZEZZA, A. 2016. National socioeconomic surveys in forestry: Guidance and survey modules for measuring the multiple roles of forests in household welfare and livelihoods. *FAO Forestry Paper* No. **179**. FAO, CIFOR, IFRI, and World Bank.

BAKKEGAARD, R.K., HOGARTH, N.J., BONG, I.W., BOSSELMANN, A.S. and WUNDER, S. 2017. Measuring forest and wild product contributions to household welfare: Testing a scalable household survey instrument in Indonesia. In Forest, Food, and Livelihoods. Special edition. *Forest Policy and Economics* **84**: 1–8.

BALDAUF, C. (ed). 2020. *Participatory biodiversity conservation. Concepts, experiences, and perspectives*. Springer Nature Switzerland A.G.

BANERJEE, A. and DUFLO, E. 2011. *Poor Economics: A radical rethinking of the way to fight global poverty.* Public Affairs: New York.

BARLOW, J., GARDNER, T., LEES, A., PARRY, L. and PERES, C. 2012. How pristine are tropical forests? An ecological perspective on the pre-Columbian human footprint in Amazonia and implications for contemporary conservation. *Biological Conservation* **151**: 45–49.

BARROW, E. 1990. Usufruct rights to trees: the role of Ekwar in dryland central Turkana, Kenya. *Human Ecology* **18**(2).

BAYNES, J., HERBOHN, J., SMITH, C., FISHER, R., and BRAY, D. 2015. Key factors which influence the success of community forestry in developing countries. *Global Environmental Change* **35**: 226–238.

BELCHER, B., RUIZ-PEREZ, M., and ACHDIAWAN, R. 2005. Global patterns and trends in the use and management of commercial NTFPs: implications for livelihoods and conservation. *World Development* **33**(9).

BIRD, K. HULME, D. MOORE, K. and SHEPHERD, A. 2002. Chronic poverty and Remote Rural Areas. *Chronic Poverty Research Centre*, Working Paper Number **13**.

BLOMLEY, T., and WALTERS, G. (eds) 2019. *A landscape for everyone: integrating rights-based and landscape governance approaches.* IUCN, Gland, Switzerland.

BROCKLSBY, M., and AMBROSE-OJI, B. 1997. Neither the forest nor the farm. Livelihoods in the forest zone – the role of shifting agriculture on Mount Cameroon. *Rural Development Forestry Network.* Paper **21d**, ODI, London.

BROWN, D., RICHARDS, M., SCHRECKENBERG, K., and SHEPHERD, G. 1999. Getting aid delivery right: host country, donor and international complementarity for greater aid effectiveness in the forest sector. *European Union Tropical Forestry Paper 4*. Overseas Development Institute, London and European Commission, Brussels.

BUCHY, M., and HOBLEY, M. 2018 FLEGT and livelihoods. *CAB Reviews.* **13** No. 057

CAVENDISH, W. 2003. How do forests support, insure and improve the livelihoods of the rural poor: a research note. *Center for International Forestry Research*, Bogor, Indonesia.

CHENG, S.H., MACLEOD, K., AHLROTH, S., ONDER, S., PERGE, E., SHYAMSUNDAR, P., RANA, P., GARSIDE, R., KRISTJANSON, P., MCKINNON, M., and MILLER, D.C. 2019. A systematic map of evidence on the contribution of forests to poverty alleviation. *Environmental Evidence* **8**(3).

CHOMITZ, K.M. 2007. At loggerheads? Agricultural expansion, poverty reduction, and environment in the tropical forests. *World Bank Group Policy Research Report*, Washington DC: World Bank.

COLFER, C.J.P., BASNETT, B.S., and ELIAS, M. 2016. *Gender and forests: climate change, tenure value chains and emerging issues.* London: Earthscan, Routledge.

COHEN, J.H. 2011. Migration, remittances and household strategies. *Annual Review of Anthropology* **40**.

CPRC (CHRONIC POVERTY RESEARCH CENTRE) 2004. *The Chronic Poverty Report 2004–2005*. Institute for Development Policy and Management, University of Manchester, Manchester, UK.

CURTIS, P., SLAY, C., HARRIS, N., TYUKAVINA, A., HANSEN, M. 2018. Classifying drivers of global forest loss. *Science* **361**(6407). September 2018.

DEROUS, M., and VERHAEGHE, E. 2019. When the P stands for politics. The role of the EU in the VPAs: a research agenda. *Forest Policy and Economics* **101**: 81–87.

DE SHERBANIN, A., VANWEY, L.,MCSWEENEY, K., AGGARWAL, R.,BARBIERI, A., HENRY, S., HUNTER, L., TWINE, W., and WALKER, R. 2008. Rural Household Demographics, livelihoods and the environment. *Global Environmental Change* **18**.

DOLSAK, N., and OSTROM, E. (eds). 2003. *The Commons in the New Millennium: Challenges and Adaptations*. Cambridge, MA: MIT Press.

DUCHELLE, A., SIMONET, G., SUNDERLIN, W., and WUNDER, S. 2018. What is REDD+ achieving on the ground? *Current Opinion in Environmental Sustainability* **32**: 134–140.

DRESSLER, W., BUSCHER, B., SCHOON, M, BROCKINGTON, D., HAYES, T. KULL, C., MCCARTHY, J. and STRESTHA, K. 2010. From Hope to Crisis and Back Again? A Critical History of the Global CBNRM Narrative. *Environmental Conservation* **37**(1): 5–15.

EUROPEAN COMMISSION. 2003. Forest Law Enforcement, Governance and Trade (FLEGT). *Proposal for an EU action plan* (COM/2003/0251 final).

FALCONER, J. 1990. The major significance of 'minor' forest products. The local use and value of forests in the West African humid forest zone. *Community Forestry Note* No 6. FAO, Rome, Italy.

FAO (FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS), 2018. *State of the World's Forests 2018: Forest pathways to sustainable development.* Rome, Italy.

FOUNDJEM-TITA, D., DUGUMA, L.A., SPEELMAN, S., and PIABUO, S.M. 2018. Viability of community forests as social enterprises: A Cameroon case study. *Ecology and Society* **23**(4): 50.

GARCIA-AMADO, L.R., PEREZ, M.R. and GARCIA, S.B., 2013. Motivation for conservation: Assessing integrated conservation and development projects and payments for environmental services in La Sepultura Biosphere Reserve, Chiapas, Mexico. *Ecological Economics* **89**: 92–100.

HAJJAR, R. and OLDEKOP, J.A. 2018. Research frontiers in community forest management. *Current Opinion in Environment Sustainability* **32**: 119–125.

HECHT, S., TANG, A., BASNETT, B., PADOCH, C, PELUSO, N. 2015. People in motion, forests in transition: trends in migration, urbanisation, and remittances and their effects on tropical forests. *CIFOR Occasional Paper* **142**. CIFOR, Bogor, Indonesia.

HESSE, C., and MACGREGOR, J. 2006. *Pastoralism: drylands' invisible asset?* Issue paper no.**142**. International Institute for Environment and Development, London.

HOBLEY, M. 1991. From passive to active participatory forestry: Nepal. In *Projects with People: The Practice of Participation in Rural Development.* P. Oakley, World Employment Programme, ILO Geneva.

HOBLEY, M. 1996. Participatory forestry: the process of change in India and Nepal. *Rural Development Forestry Study Guide.* Overseas Development Institute, London.

HOBLEY, M., and BUCHY, M. 2013. How can a VPA contribute to poverty reduction? *FLEGT in Action* No. **3**, EU FLEGT Facility, European Forest Institute, Joensuu, Finland.

HOBLEY, M., JHA, C. and POUDEL, K. 2012. *Persistence and Change: review of 30 years of community forestry in Nepal.* Multi Stakeholder Forestry Programme (MSFP). Lalitpur, Nepal. https://www.researchgate.net/publication/282287096_Persistence_and_change_review_of_30_years_of_community_forestry_in_Nepal/link/560a7b9a08ae1396914bd62d/download

HOGARTH, N., BELCHER, B., CAMPBELL, B., and STACEY, N. 2013. The role of forest -related income in household economies and rural livelihoods in the border region of Southern China. *World Development* Vol. **43**.

HULME, D. and SHEPHERD, A. (eds) 2003. Special issue on Chronic Poverty and Development Policy. *World Development* **31**(3), Washington USA.

JAGGER, P., LUCKERT, M., DUCHELLE, A., LUND, J., and SUNDERLIN, W. 2014 Tenure and forest income: observations from a global study on forests and poverty. *World Development* **64**: S43–S55.

KAIMOWITZ, D. 2003. Not by bread alone. Forests and rural livelihoods in sub-Saharan Africa in Oksanen, T., Pajari, B., Tuomasjukka, (eds). Forestry in poverty reduction strategies: capturing the potential. EFI Proceedings, No **47**. European Forest Institute, Joensuu.

KAMANGA, P., VEDELD, P., and SJAASTAD, E. 2009. Forest incomes and rural livelihoods in Chiradzulu District, Malawi. *Ecological Economics* **68**(3): 613–624.

KANBUR, R., and VENABLES, A.J. (eds) 2005. *Spatial Inequality and Development* Oxford University Press, Oxford, UK.

KATILA, P., COLFER, C., DE JONG, W., GALLOWAY, G., PACHECO, P., and WINKEL, G. 2019. *Sustainable development goals: their impacts on forests and people*. Cambridge University Press, Cambridge, UK.

KOZAK, R. 2007. *Small and Medium Forest Enterprises: Instruments of Change in the Developing World.* Rights and Resources Initiative, Washington, USA.

KUSTERS, K., and BELCHER, B. Eds. 2004. *Forest products, livelihoods and conservation. Case studies of non-timber forest products systems.* Volume **1** – Asia. CIFOR, Bogor Indonesia.

LESNIEWSKA, F., and MCDERMOTT, C. 2014. FLEGT VPAs: laying a pathway to sustainability via legality. Lessons from Ghana and Indonesia. *Forest policy and economics* **48**: 16–23.

LEWIS, J. 2005. Whose forest is it anyway? Mbendjele Yaka pygmies, the Ndoki forest and the wider world. In *Encapsulation, Commercialisation, Discrimination. Property and Equality vol 2*. Widlok, T., and Tadesse, W., G. Berghahn Books: New York and Oxford.

MACQUEEN, D. 2008. Forest Connect: reducing poverty and deforestation through support to community forest enterprises. *International Forest Review* **10**: 670–675.

MACQUEEN, D. 2013. Enabling conditions for successful community forest enterprises. *Small-scale Forestry* **12**(1): 145–163.

MACQUEEN, D., BOLIN, A., GREIJMANS, M., GROUWELS, S., HUMPHRIES, S. 2020. Innovations towards prosperity emerging in locally controlled forest business models and prospects for scaling up. *World Development* **125**.

MAHAPATRA, A., SHACKLETON, C. 2011. Has deregulation of nontimber forest products controls and marketing in India affected local livelihoods? *Forest Policy and Economics* **13**: 622–629.

MAMO, G., SJAASTAD, E., and VEDELD, P. 2007. Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics* **9**: 916–927.

MCDERMOTT, M.H., and SCHRECKENBERG, K. 2009. Equity in community forestry: insights from North and South. *International Forestry Review* **11**(2).

MCSHANE, T. and Wells, M. 2004. *Getting biodiversity projects to work: towards more effective conservation and development.* Biology and Resource Management Series. Columbia University Press.

MILLER, D.C., RANA, P., and WAHLÉN, C.B. 2017. A crystal ball for forests? Analyzing the social-ecological impacts of forest conservation and management over the long term. *Environment and Society: Advances in Research* **8**: 40–62 Berghahn Books.

MILLER, D.C., and HAJJAR, R. 2020. Forests as pathways to prosperity: empirical insights and conceptual advances. *World Development* **125**.

MORTIMORE, M., and ADAM, W. 1999. Working the Sahel. *Global Environmental Change Programme.* Routledge, London and New York.

MÜLLER, D. and SENF, C. 2010. *Global spatial associations of forests and poverty: analysis of 27 country cases*. Background document prepared for FAO-FRA 2010 Thematic study Forests, poverty and livelihoods. Humboldt University, Berlin and the Liebniz Institute of Agricultural Development. Halle Germany.

NATIONAL ACADEMY OF SCIENCES. 1986. Proceedings of the conference on common property resource management. Office of International affairs, National Research Council. *National Academy press.* Washington DC.

NEUMANN, R.P. 2002. *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa.* University of California Press.

NIELSEN, M.R., POULIOT, M., and BAKKEGAARD, R.K. 2012. Combining income and assets measures to include the transitory nature of poverty in assessments of forest dependence: evidence from the Democratic Republic of Congo *Ecological Economics* **78**: 37–46.

OLDEKOP, J., SIMS, K., KARNA, B. WHITTINGHAM, M., and AGRAWAL, A. 2019. Reductions in deforestation and poverty from decentralised forest management in Nepal. *Nature sustainability* **2**: 421–428.

OSEI-TUTU, P., NKETIAH, K., KYEREH, B., OWUSU-ANSAH, M., FANIYAN, J. 2010. Hidden forestry revealed: Characteristics, constraints and opportunities for small and medium forest enterprises in Ghana. *IIED Small and Medium Forest Enterprise Series* No **27**. Tropenbos International and International Institute for Environment and Development, London, UK.

OWUSU, B., NKETIAH, K.S., AGGREY, J., and WIERSUM, F. 2010. Timber legality, local livelihoods and social safeguards: implications of FLEGT/VPA in Ghana. Proceedings of a workshop in Kumasi. *Tropenbos International* Ghana.

PARAJULI, R., LAMICHHANE, D. and JOSHI, O. 2015. Does Nepal's community forestry program improve the rural household economy? A cost-benefit analysis of community forestry user groups in Kaski and Syangja districts of Nepal. *Journal of Forest Research* **20**(6): 475–483.

PIRARD, R., WUNDER, S., DUCHELLE, A., PURI, J., ASFAW, S., BULUSU, M., PETIT, H., and VEDOVETO, M. 2019. Effectiveness of forest conservation interventions: an evidence gap map. *Independent Evaluation Unit Learning Paper* No **2** Green Climate Fund, Incheon, Republic of Korea.

POKORNY, B. and JOHNSON, J. 2008. Community Forestry in the Amazon: the unsolved challenge of forests and the poor. *Natural Resources Perspectives* **112**. ODI London.

RASUL, G., KARKI, M., and SAH, R. 2008. The role of nontimber forest products in poverty reduction in India: prospects and problems. *Development in practice* **18**: 779–788.

REN, L., LI, J., LI, C., LI, S. and DAILY, G.C. 2018. Does Poverty Matter in Payment for Ecosystem Services Programs? Participation in the New Stage Sloping Land Conversion Program. *Sustainability* **10**: 1888.

ROE, D., BOOKER, F., DAY, M., ZHOU, W., ALLEBONE-WEBB, S., HILL, N., KUMPEL, N., PETROKOFSKY, G., REDFORD, K., RUSSELL, D., SHEPHERD, G., WRIGHT, J., and SUNDERLAND, T. 2015. Are alternative livelihood projects effective at reducing local threats to specified elements of biodiversity and/or improving or maintaining the conservation status of those elements? *Environmental Evidence* **4**: 22.

SAIGAL, S., and BOSE, S. 2003. Small-scale Forestry Enterprise in India. *Small and Medium Forest Enterprises Series*, No. **6**, Winrock International India (WII) and International Institute for Environment and Development (IIED), London, UK.

SAMII, C., LISIECKI, M., KULKARNI, P., PALER, L., and CHAVIS, L. 2014. Effects of payment for environmental services (PES) on deforestation and poverty in low and middle income countries: a Systematic Review. *Campbell Systematic Reviews* **10**(1): 11.

SAYER, J., CAMPBELL, B., PETHERAM, E., ALDRICH, M., PEREZ, M.R., ENDAMANA, D., DONGMO, Z.I.N., DEFO, L., MARIKI, S., DOGGART, N. and BURGESS, N. 2007. Assessing environment and development outcomes in conservation landscapes. *Biodiversity and Conservation* **16**(9): 2677–2694.

SCHRECKENBERG, K., DEGRANDE, A., MBOSSO, C., EOLI BABOULE, Z., BOYD, C.,ENYONG, J., KANMEGNE, J., and NGONG, C. 2002. The social and economic importance of Dacryodes edulis in southern Cameroon. *Journal of Forests, Trees and Livelihoods* **12**(2): 15–40.

SCHURE, J., LEVANG, P., and WIERSUM, F. 2014. Producing woodfuel for urban centres in the Democratic Republic of Congo: a path out of poverty for rural households? *World Development* **64S**.

SETYOWATIA, A., and MCDERMOTT, C. 2017. Commodifying legality? Who and what counts as legal in the Indonesian wood trade. *Society and natural resources* **34**(6).

SEYMOUR, F. 2019. Looking back, looking forward: REDD+. https://nature4climate.org/news/frances-seymour-looking-back-at-redd-and-looking-forward-on-the-finance-gap/

SHACKLETON, C., SHACKLETON, S., BUITEN, E., and BIRD, N. 2007. The importance of dry forests and woodlands in rural livelihoods and poverty alleviation in South Africa. *Forest policy and Economics* **9**: 558–577.

SHACKLETON, C., SHACKLETON S., and SHANLEY, P. 2011. *Non Timber Forest Products in the Global Context.* Tropical Forestry. Berlin, Springer-Verlag.

SHACKLETON, C., and PANDEY, A. 2014. Positioning nontimber forest products on the development agenda. *Forest Policy and Economics* **38**.

SHACKLETON, S., CAMPBELL, B., LOTZ-SISITKA, H., and SHACKLETON, C. 2008. Links between the local trading natural products, livelihoods and poverty alleviation in a semiarid region of South Africa. *World Development* **36**.

SHEIL, G., PURI, R., WAN, M., BASUKI, I., VAN HEIST, M., LISWANTI, N., RUKMIYATI, RACHMATIKA, I., and SAMSOEDIN, I. 2006. Recognizing local people's priorities for tropical forest biodiversity. *Ambio* **35**(1).

SHEPHERD, G. 1990. Forestry, Social Forestry, Fuelwood and the Environment: a tour of the horizon. *Social Forestry Network*, Paper **11**a. Overseas Development Institute, London.

SHEPHERD, G. 2012. Rethinking forest reliance: findings about poverty, livelihood resilience and forests from IUCN's Livelihoods and Landscapes strategy. *Landscape Papers* **1**. IUCN, Gland Switzerland.

SHEPHERD, G., KAZOORA, C., and MÜLLER, D. 2012. *Forests, Livelihoods and Poverty Alleviation: the case of Uganda.* FAO, Rome.

SHEPHERD, G., MOHAMED, M., MOHAMADI, N. and DOULTON, H. 2019. Wood utilization in the Moya region of Anjouan, Comoro Islands: volume, value and implications for biodiversity. *Critical Ecosystems Partnership Fund*, Arlington Virginia USA.

SHYAMSUNDAR, P, AHLROTH, S.E., KRISTJANSON, P.M., and ONDER, S. 2018. Understanding forests' contribution to poverty alleviation: a framework for interventions in forested areas (English). *Policy Research Working Paper*; no. WPS 8462. Washington, D.C.: World Bank Group.

SHYAMSUNDER, P., AHLROTH, S.,KRISTJANSON, P., and ONDER, S. 2020. Supporting pathways to prosperity in forest landscapes – a PRIME framework. *World Development* **125**.

SNILSVEIT, B., STEVENSON, J., LANGER, L., DA SILVA, N., RABAT, Z., NDUKU, P., POLANIN, J., SHEMITT, I., EYERS, J., and FERRARO, P. 2019. Incentives for climate mitigation in the land use sector – the effects of payment for environmental services (PES) on environmental and socio-economic outcomes in low- and middle-income countries: a mixed method systematic review. *3ie Systematic Review* **44**. London: International Initiative for Impact Evaluation.

STOIAN, D., DONOVAN, J., and POOLE, N. 2009. Unlocking the development potential of community forest enterprises: findings from a comparative study in Asia, Africa, Latin America, and the United States. *XIII World Forestry Congress, 18–23 October 2009*, Buenos Aires, Argentina.

SUNDERLAND, T., and NDOYE, O. (eds). 2004. *Forest products, livelihoods and conservation. Case studies of non-timber forest products systems.* Volume **2** – Africa. CIFOR, Bogor Indonesia.

SUNDERLAND, T., ACHDIAWAN, R., ANGELSEN, A., BABIGUMIRA, R., ICKOWITZ, A., PAUMGARTEN, F., REYES-GARCÍA, V. and SHIVELY, G. 2014. Challenging perceptions about men, women, and forest product use: a global comparative study. *World Development* **64**: S56–66.

SUNDERLIN, W.D., ANGELSEN, A., BELCHER, B., NASI, R., SANTOSO, L. and WUNDER, S. 2005. Livelihoods, Forests and Conservation in Developing Countries: an Overview. *World Development* **33**(9), Washington, USA.

SUNDERLIN, W.D., DEWI, S., and PUNTODEWO, A. 2007 Poverty and Forests: Multicountry Analysis of Spatial Association and Proposed Policy Solutions. *CIFOR Occasional paper* no **47**. Center for International Forestry Research, Bogor Indonesia.

SUNDERLIN, W.D., DEWI, S., PUNTODEWO, A., MÜLLER, D., ANGELSEN, A., and EPPRECHT, M. 2008. Why forests are important for global poverty alleviation: a spatial explanation. *Ecology and Society* **13**(2): 24. [online] URL:

SUSTAINABLE DEVELOPMENT GOALS (SDG) website https://sustainabledevelopment.un.org/

THOMS, C. 2006. Conservation success, livelihoods failure? Community forestry in Nepal. *Policy matters* **14**: 169–179.

TIFFEN, M. 1976. *The enterprising peasant: a study of economic development in Gombe Emirate, north-eastern state 1900–1968, Nigeria*. Her Majesty's Stationery office, London.

TIFFEN, M., MORTIMORE, M., and GICHUKI, F. 1994. *More people, less erosion: environmental recovery in Kenya*. Wiley, UK and USA.

VAN HEESWIJK, L., and TURNHOUT, E. 2013. The discursive structure of FLEGT (Forest Law Enforcement, Governance and Trade): the negotiation and interpretation of legality in the EU and Indonesia. *Forest policy and economics* **32**: 6–13.

VEDELD, P., ANGELSEN, A., SJAASTAD, E., and BERG, G.K. 2004. Counting on the environment: Forest income and the rural poor. *Environmental Economics Series* No. **98**. The World Bank: Washington, D.C.

WARNER, K. 2006. Big Trees for Little People: Managing forests for poverty reduction. In *A Cut for the Poor. Proceedings of the International Conference on Managing Forests for Poverty Reduction: Capturing Opportunities in Forest Harvesting and Wood Processing for the Benefit of the Poor.* (eds) Oberndorf, R., Durst, P., Mahanty, S., Burslem, K. and Suzuki, R. Ho Chi Minh City, Vietnam, 306 October 2006.

WEBER, J., SILLS.E.O., BAUCH, S. and PATTAN, S.K. 2011. Do ICDPs Work? An Empirical Evaluation of Forest-Based Microenterprises in the Brazilian Amazon. *Land Economics* **87**(4).

WONG, G.,ANGELSEN, A., BROCKHAUS, M., CARMENTA, R., DUCHELLE, A., LEONARD, S., LUTTRELL, C., MARTIUS, C., and WUNDER, S. 2016. Results-based payments for REDD+: lessons on finance, performance and non-carbon benefits. *CIFOR Infobrief,* No **138**, May 2016.

WORLD BANK. 1978. *Forestry Sector Policy paper*. February 1978. Washington DC, USA.

WORLD BANK. 2016. Forests generate jobs and incomes. http://www.worldbank.org/en/topic/forests/brief/forests-generate-jobs-and-incomes

WRIGHT, J.H., HILL, N., ROSE, D., ROWCLIFFE, M., KŰMPEL, N., DAY, M., BOOKER, F., and MILNER-GULLAND, E.J. 2015. Reframing the concept of alternative livelihoods. *Conservation Biology* **30**(1): 7–13.

WUNDER, S. 2001. Poverty alleviation and tropical forests – what scope for synergies? *World Development* **29**(11).

WUNDER, S. 2008. Payments for environmental services and the poor: concepts and preliminary evidence. *Environment and Development Economics* **13**: 279–297.

WUNDER, S., BÖRNER, J., SHIVELY, G. and WYMAN, M. 2014. Safety nets, gap filling and forests: a global-comparative perspective. *World Development* **64**: S29–S42.

WUNDER, S., NOACK, F., and ANGELSEN, A. 2018. Climate, crops and forests: a pan tropical analysis of household income generation. *Environment and Development Economics* **23**: 279–297.

ZIEGLER, A., FOX, J., WEBB, E., PADOCH, C., LEISZ, S., CRAMB, R., MERTZ, O., BRUUN, T., and VIEN, T. 2011. Recognizing contemporary roles of swidden agriculture in transforming landscapes of Southeast Asia. *Conservation Biology* **25**(4).

Closing gender gaps in forest landscape initiatives

P. KRISTJANSON

World Bank, 1818 H St. NW, Washington, DC 20043

Email: pkristjanson@worldbank.org

SUMMARY

Recent research evidence shows that women and men often have different knowledge, capabilities, interests and roles in the management of forest landscapes and use of forest resources. The importance of examining the intersection of gender issues in forest landscapes with other socially differentiating factors such as ethnicity, age, poverty, and vulnerability has also been emphasized. This paper reviews how gender issues are being incorporated in forest-based investment projects, programmes and policies by various international organizations and governments in many countries, with a focus on activities and actions. It finds there is a wide range of gender-responsive forest landscape investments that can be considered by those wishing to contribute to and catalyse results on multiple sustainable development goals. By synthesizing and categorizing these actions, this paper offers inspiration and practical, concrete ideas on how to link knowledge with action in the context of this complex challenge.

Keywords: gender, forests, landscapes, investments, sustainable development

Rétrécir les écarts entre les sexes dans les initiatives de paysages

P. KRISTJANSON

Les preuves glanées dans la recherche récente mettent en lumière le fait que hommes et femmes ont souvent des connaissances, des capabilités, des intérêts et des rôles bien différents dans la gestion du paysage forestier et dans l'utilisation des ressources forestières. L'importance d'examiner l'intersection des questions des sexes dans les paysages forestiers avec d'autres facteurs sociaux différentiels tels que l'ethnicité, l'âge, la pauvreté et la vulnérabilité doivent également être soulignée. Ce papier examine comment les questions des sexes sont incorporées dans des projets d'investissement et des politiques basés sur la forêt lancés par des organisations internationales variées et par les gouvernements de plusieurs pays, en se concentrant sur les activités et les actions. Il y trouve un large éventail d'investissements de paysage forestier sensibles au rôle des sexes, pouvant être considérés par les personnes désireuses de contribuer et de catalyser les résultats dans de multiples buts de développement durable. En synthétisant et en catégorisant ces actions, ce papier offre une inspiration et des idées concrètes et pratiques sur la manière de tisser des liens entre la connaissance et les actions dans le contexte de ce défi complexe.

Como cerrar las brechas de género en las iniciativas de paisajes forestales

P. KRISTJANSON

La evidencia procedente de investigaciones recientes demuestra que las mujeres y los hombres tienen a menudo conocimientos, capacidades, intereses y roles diferentes en la gestión de los paisajes forestales y el uso de los recursos del bosque. También ha subrayado la importancia de examinar la interacción entre las cuestiones de género en los paisajes forestales con otros factores de diferenciación social como la etnia, la edad, y el nivel de pobreza o de vulnerabilidad. Este artículo examina como se están incorporando las cuestiones de género en los proyectos, programas y políticas de inversión en el ámbito forestal por parte de diversas organizaciones internacionales y gobiernos de muchos países, centrándose en las actividades y las acciones. Uno de los hallazgos es que existe una amplia gama de inversiones en el paisaje forestal que tienen en cuenta las cuestiones de género y que pueden ser consideradas por quienes desean contribuir a los resultados y catalizarlos, en relación con los múltiples objetivos de desarrollo sostenible. Por medio de la síntesis y la categorización de estas acciones, este artículo ofrece inspiración e ideas prácticas y concretas sobre cómo aunar el conocimiento a la acción en el contexto de este complejo desafío.

INTRODUCTION

International forest development efforts, outside of those focussed on logging (primarily to earn hard currency through export), began many decades ago with forest professionals that focused on the biophysical, technical and environmental aspects of tree planting, harvesting, seedling production, etc. In the late 1970's and 1980's, forestry development policies started to shift from a production and industrial sector focus towards a broader rural development approach[1]. This shift led to an increasing recognition that the people and communities living in and around forests are central to the success of such efforts, thus a better understanding of the relationship between people and forests in very different social and physical environments was needed. During the same period, government ownership of forests with top-down management and policing approaches began to shift to community-led forest management (and community, social/participatory forestry efforts) in many countries (Agarwal 2001, FAO 1986, Ginsburg and Keene 2018, Leach *et al*. 1999).

As the focus shifted to better understanding the links between people and forests, more attention began to be paid to better understanding women's roles in particular (e.g. Coleman and Mwangi 2013, Colfer and Minarchek 2012, Mwangi *et al.* 2011, Pottinger and Mwangi 2011, Townsend *et al*. 1995). The intersection of gender issues in forest landscapes with other social stratifiers also began to receive attention (Schroeder 1999). On the global policy side, the shift towards human rights-based approaches, free and prior informed consent (which establishes bottom-up participation and consent of Indigenous Peoples or local communities prior to any intervention involving their land, forests or natural resources), and increased calls to strengthen the rights of indigenous communities was also occurring (Colchester 2010). Many international environmental agreements over the years have explicitly acknowledged the need to address gender issues more directly. The Convention on Biological Diversity (CBD) and the CBD's 'Gender Plan of Action', for example, argues for a central role of women in CBD efforts (Mata and Sasvari 2009). More recently, the UN's New York Declaration on Forests initiative assessed global progress regarding strengthening women's roles in forest management and the empowerment of forest-linked communities (UN 2019). They concluded that actions demonstrating success towards these aims include support to collective women's action and mentoring by women entrepreneurial champions; efforts towards seeing increased women's leadership in business such as leadership training, peer-to-peer women's exchanges, and market analysis and development training; and gender-based investment funds for local forest organizations (e.g. a women's entrepreneur development fund) (UN 2019).

On the research side, as community-led forests in tropical regions proliferated, researchers began producing evidence of just how diverse forest communities are (Agarwal 2001, Arora-Jonsson 2009, Colfer *et al.* 2001, McDougall 2001, Townsend *et al.* 1995). This implied that while a community focus was necessary, it would seldom be sufficient if more equitable outcomes were being sought through forest landscape projects and programs. It was time to begin seriously taking into account the importance of understanding and addressing the differing roles, resources, opportunities and constraints facing women and men, and more or less vulnerable individuals (Rocheleau 1991, Agarwal 2009, 2010, Colfer 2005).

Many early gender-forests studies were based on geographically-focused case studies that showed the diversity between locations and complexity of the issues at each site. One of the first broad studies to use a gender-disaggregated global database (covering a large number of sites, countries, and regions) to examine the robustness of these previous case study findings on gender and forests was the highly collaborative Poverty Environment Network (PEN) study led by the Centre for International Forestry (CIFOR) (Angelsen *et al.* 2014). This work was undertaken at sites in 24 countries, including the major tropical forested regions in Africa, Asia, and Latin America. It investigated gender differences in forest product collection and sale, access to forest product, and community forest management. They found that there are indeed distinctive "male" and "female" roles associated with the collection of forest products, but that the relative contribution of forest products by men and women to incomes and rural livelihoods differs across regions (Sunderland *et al.* 2014).

Elias *et al.* (2017) clearly lay out the gender biases that continue to persist in forestry research and practice across the globe, and how they lead to inequitable, ineffective, and less efficient policies, programs, and interventions. They describe five key areas of concern, relating to gendered governance, tree tenure, forest spaces, division of labour, and ecological knowledge. They discuss why widespread inequities in women's and men's ability to make decisions about and benefit from trees, forests, and their products require more attention. Kristjanson *et al.* (2019) bring together a body of evidence on the wide range of gender gaps that persist in forest landscapes in many countries, presenting both challenges and opportunities for forest landscape project and policy developers and investors (from public, private or civil society). These gaps include the typically lower women's participation, and ability to participate, in community-based forest governance than men's; their more limited access to, ownership and control over trees and forest products; women's limitations with respect to forest use and forest product processing due to limited access to information, credit and transportation, high personal security risks, and local gender norms and traditions limiting women's (and men's) flexibility and options in relation to forestry and

[1] A reviewer also pointed out that in some countries with widespread forests, government ownership claims were not in line with their Constitutions or Forest laws, and political reforms doing away with military-based regimes were first needed. They also note that the eighth World Forestry Congress in Jakarta in 1978 is widely recognized as putting a spotlight on forests for people (Gilmour 2016, Arnold 2001).

agroforestry-related activities (Arora-Jonsson 2011, Colfer *et al.* 2015, Elias *et al*. 2017, Kristjanson *et al*. 2019, Mai *et al*. 2011). Given the overlap between community forestry efforts and farmer/community-managed agroforests, it is not surprising that a growing body of agroforestry research with a gender focus finds similar gender gaps and constraints (Bourne *et al*. 2105, Catacutan and Naz 2015, Catacutan and Villamor 2016, Kiptot and Franzel 2012, 2014, Kiptot 2015, Meijer *et al.* 2015, Mulyoutami *et al*. 2012, Schroeder 1999, Schroeder and Suryanata 2002, Villamor *et al*. 2014, Villamor *et al*. 2015, Villamor *et al*. 2017).

This body of research inspired and has contributed to a growing recognition of the importance of gender in forestry development, leading to more actors involved in the forest sector asking just what this means in practice (Colfer *et al.* 2016, Marin and Kuriakose 2017). FAO developed one of the first training guides on gender analysis focused specifically on forests in the mid 1990's (Wilde and Vainio-Mattila 1995). This 'Gender Analysis and Forestry Framework' provided forest sector actors guidance on interviewing, analysing, and developing strategies to increase women's and men's participation in and benefits from forestry programs. It acknowledges the important, pro-active role that several (male) forestry professionals in Nepal and Indonesia, among others, took at this time. Increasingly, we are seeing more efforts to apply and act upon gender analyses in the forest sector, for example in Mexico (World Bank 2018) and Vietnam (Pham *et al.* 2016), among others.

The discussion on gender in the context of forest landscapes (and indeed the shift towards talking about landscapes and not forests per se) has come a long way. Hopefully it has moved past a primary focus on the 'why' question, towards addressing the challenging 'how and what' questions. Towards this aim, this paper examines how gender considerations and responses are being incorporated in forest landscape initiatives through a review of recent projects and forest-sector investments supported by the World Bank Group (WBG) and partners in many countries, including the experience with Reducing Emissions from Deforestation and Forest Degradation (REDD+)-related efforts in many countries. Here, how the most recent thinking on equity and participation is being translated into gender-REDD+ action plans, with gender-responsive forest landscape project activities and actions, is synthesized with the aim of illuminating practical, concrete ideas that forest project and program designers, policymakers and practitioners can consider in their quest for more effective, efficient and equitable impacts.

METHODOLOGY

A review of recent forest landscape (including agroforestry) and gender-related literature was undertaken, focusing on identifying key gender gaps described in the context of forest-related initiatives and interventions (projects, programs, policies, etc.). The review concentrated on relatively recent evidence being generated in tropical and subtropical regions (the Global South). The kinds of gender-focused activities and actions being taken to address these gaps in many countries was then explored by reviewing projects and forest-sector investments supported by the WBG and partners that are now incorporating such actions. The selection of such projects was part of a project portfolio review undertaken by the WBG's Environment group that aimed at identifying if and how well gender aspects were being covered in recent forest landscape investments (i.e., global and country-specific grants and loans that had forestry, forest landscape, or agroforestry components) undertaken towards implementation of their Forest Action Plan (FAP). It included 14 FY18 projects from the environment and agriculture sectors with significant forestry or agroforestry components that were also 'gender tagged', i.e. in their design documents, they had identified gender analyses, actions and indicators for the project.

In a similar fashion, a collaborative review of REDD+ gender action plans in seven countries[2] was undertaken by the WBG's Program on Forests (PROFOR), with the goal of understanding the specific gender-related needs and gaps expressed in these gender-REDD+ 'roadmaps', and the corresponding investment/activity/actions included in them to address these gender-related challenges (these seven gender action plans are described in more detail in Kristjanson *et al.* 2019). Table 1 summarizes the countries, names and broad aims of the WBG and REDD+ projects reviewed and indicates which types of gender-responsive actions are included in the project documents or gender action plans.

GENDER ACTIONS BEING INCORPORATED IN FOREST INTERVENTIONS

REDD+ and gender

Various global climate change-related funds began supporting programs focused on Reducing Emissions from Deforestation and Forest Degradation (REDD+) in many countries since 2007 when REDD countries were stimulated to experiment with REDD and increase REDDINESS in the Bali Action Plan. In 2011, FAO, UNEP and UNDP put forward a business case for mainstreaming gender in REDD+ (UN-REDD 2011). At COP20 in 2014, the Lima work program on gender advocated for gender-responsive climate policies and activities (UNFCCC 2016). Gender-responsive forest-related activities are considered those that promote 'gender equality, women's empowerment, inclusion and equal opportunities for men and women' (Aguilar *et al*. 2011).

Several studies looking at how well national REDD+ policies have incorporated gender concerns found that women have not been participating equally in climate change and REDD+ dialogues, and when they are, they are not in decision-making or leadership positions (Khadka *et al.* 2014,

[2] Mexico, Ghana, Uganda, Cameroon, Vietnam, Nepal, and Guatemala.

TABLE 1 Summary of projects reviewed and areas of planned gender-responsive actions

Country	Name of Project	Broad Aim of Project	Women's participation in forest decision-making bodies	FTA tenure rights	Equitable benefit sharing mechanisms	Collective action, groups, institutions	Women's access to FTA credit, grants, value chains	Women's FTA knowledge, skills, leadership
WBG FY18 Projects with Forest and/or Agroforestry-related Components								
Côte d'Ivoire	Forest Investment	Restoration of degraded forests through AF	X	X	X	X	X	X
Burundi	Landscape restoration	Restoration of degraded landscapes; SFM of forest PAs	X	X				X
CAR	Natural resources governance	Governance institutional support to reduce illegal logging & SFM	X			X	X	X
Peru	Integrated forest landscape mgment	Institutional strengthening for forest landscape management and conservation	X			X	X	
West Africa	Coastal Areas Resilience Investment	Integrated regional & national policies, institutions, investments in coastal zone management	X			X		
Mexico	Sustainable Productive Landscapes	Government FTA institutions, producer groups, associations	X			X	X	X
Haiti	Resilient Productive Landscapes	Improving adoption of resilience-enhancing ag & landscape mgment practices	X				X	
Mexico	Dedicated grant for IPLCs	Strengthening capacity, participation and benefits of IPLCs in REDD+ processes	X			X	X	X
India	Community-led landscapes mgment	Community-led management of natural resources	X				X	X
Colombia	Sustainable low-carbon develop	Sustainable and Low-carbon landscape planning and management		X			X	X
Mali	Economic & Environmental Rehabilitation of Niger River	Environmental restoration and livelihood improvement in the Niger Inner Delta				X	X	X
Chad	Climate resilient agriculture productivity enhancement	Technologies to enhance climate resilience of agricultural systems					X	X
Malawi	Second Ag sector wide approach support	Productivity and market access for smallholders				X		X
Mali	Drylands development	Productivity and resilience of smallholders				X	X	X

TABLE 1 (*Continued*)

Country	Name of Project	Broad Aim of Project	Women's participation in forest decision-making bodies	FTA tenure rights	Equitable benefit sharing mechanisms	Collective action, groups, institutions	Women's access to FTA credit, grants, value chains	Women's FTA knowledge, skills, leadership
Gender-REDD+ Action Plans								
Mexico	Gender – REDD+ Action Plan	Empowering women in productive NRM	X	X			X	X
Ghana	Cocoa-forest Gender – REDD+ Action Plan	Gender actions in cocoa-forest REDD+, ERP, forestry commission	X			X	X	X
Uganda	Gender REDD+ Roadmap	Gender mainstreaming in REDD+ and forest interventions	X			X		X
Cameroon	Gender-REDD+ Roadmap	Nat'l strategy on involvement of IPs and gender in all REDD+ interventions	X					X
Nepal	Gender integration in REDD+ and ERP	Gender components in all intervention areas of the ERP	X		X	X	X	X
Vietnam	Gender Action Plan for the ERP	Empowering ethnic minority women for REDD+, climate change and development	X	X	X	X		X
Guatemala	Gender-REDD+ Roadmap	Actions id'd by IPs, women for gender actions throughout REDD+ process	X	X	X	X	X	X
Total			16 (76%)	6 (29%)	4 (19%)	14 (67%)	15 (71%)	18 (86%)

Where:
FTA – forest, tree and agroforestry
SFM – sustainable forest management
IPs – indigenous peoples
IPLCs – indigenous peoples and local communities
NRM – natural resource management
ERP – Emission Reduction Program

Larson *et al.* 2015, Peach Brown 2011, Pham *et al.* 2016, Stiem and Krause 2016, Westholm and Arora-Jonsson 2015). The evidence to date suggests that there remain many challenges to successful implementation of gender-responsive REDD+ actions, including a lack of capacity to implement gender strategies within government agencies and local organizations working on REDD+, structural power imbalances and inequalities, a systematic devaluation of women's work and their knowledge about the forest, women's preferences regarding benefits not being considered, an increase in women's workload in the actions being supported, and leaving women out of REDD+ benefits (Chomba *et al.* 2017, Gurung *et al.* 2011, Larson *et al.* 2018).

One study analysed subnational REDD+ initiatives in six countries to see how well they actually achieved desired gender outcomes (Larson *et al.* 2018). The results showed that perceived well-being decreased in REDD+ villages relative to control villages for both men and women, but the decrease was much worse for women. The authors suggest that these declines may be partly due to unrealized expectations for REDD+, but clearly point to the need for more attention to gender in REDD+ initiatives.

In response to these concerns, developing 'gender roadmaps' and gender action plans has become a desirable step in the process for a country to receive results-based payments for progress towards multiple REDD+ goals. The seven country-specific Gender-REDD+ action plans that were reviewed (summarized in the last seven rows of Table 1) all used highly collaborative, participatory processes that include many diverse individuals and groups – men and women – in their

development. Beyond supporting inclusive processes, however, similar actions can be seen across these seven Gender-REDD+ plans (Kristjanson *et al.* 2019). These include:

- Trainings/capacity strengthening targeted to the needs of women (including weather forecasts, climate change info, greenhouse gases (GHG), REDD+, related policy frameworks, gender considerations, safeguards in national REDD+ strategy, forest governance, forest management, and agroforestry techniques) (100%, Table 1)
- Collective action – support to existing and new inclusive forest user groups (71%)
- New credit and financing mechanisms targeting women's forest and agroforestry-related enterprises and groups (57%)
- Rules, targets, quotas – aimed at equitable participation and benefits from forest-related programs and committees, including women in leadership positions (43%)
- Joint signatures (both spouses, or women only where appropriate) on contracts or certificates (such as land/tree/forest rights certificates) (14%)
- Earmarked budgets for project activities that explicitly target and help close gender gaps (14%)

These results are indicative only, as these gender action plans continue to evolve and add activities, but they are helpful for learning purposes – particularly for countries that are just starting with such initiatives. Ensuring that national and sub-national level REDD+ policy and project planning processes are more inclusive has been the first step of many of these plans, and a necessary one. As the research evidence shows, women and marginalized peoples have been historically left out of processes such as REDD+, climate change and forest landscape management planning and related policy and decision-making (IUCN 2009). But additional strategies and tactics are needed. Bringing gender champions that are in powerful positions into these processes, with incentives for actively engaging, is one key strategy for seeing successful gender-responsive actions implements (Kristjanson *et al.* 2019). While it is too early to evaluate impacts of these nascent gender action plans, it will be important to start seeing and monitoring a shift in the focus from merely having women on committees and in community forest user groups, toward actions that ensure their participation is meaningful and their needs are met, and benefits from forest initiatives are actually reaching them. The jury is still out on whether these gender action plans will be supported by dedicated budgets (early indications are this is a constraining factor for some) and be implemented successfully (Kristjanson *et al.* 2019, Mwangi *et al*. 2011).

Gender actions in World Bank Group forest landscape projects

The WBG is the leading public funder of forestry and conservation in developing countries. During the period 2002–2015, the WBG invested $6.5 billion in forestry activities and was actively working on around 106 projects related to forests in 2015 (Shyamsundar *et al.* 2019, World Bank 2016).

The WBG's Forest Action Plan (FAP, FY16-20, WB 2016*)* aspires to see that all forest-related operations are 'gender tagged' – i.e. they should include information from a gender analysis that identifies key gender gaps relevant to the project (and/or a budgeted activity that undertakes such an analysis), activities aimed at addressing gender gaps, and gender-disaggregated indicators to be monitored. An assessment undertaken by the author after the first two years of implementation examined how well this target is being addressed in recent investments. It found that 14 out of 18 FY18 forest landscape projects (summarized in Table 1) attempted to include gender considerations as integral components, indicating up front in their project design/appraisal documents (PADs) that they are 'gender tagged'. The gender tag section was recently added to PADs when the new WBG gender strategy was launched in FY16, so a similar comparison to forestry projects in earlier years is not possible, but it does indicate that forest landscape project design teams are increasingly taking gender issues into consideration. The assessment focused on the elements of the gender tag included – the gender analysis and identification of gender gaps related to the project; specific gender-focused activities included; and the indicators for monitoring progress towards gender outcomes found in the PADs. This information aimed to inspire ideas of the kinds of actions those developing future forest landscape projects may want to consider as well as an indication of what efforts are still needed to reach the FAP's gender target.

In looking across the fourteen projects (Table 1), some patterns and lessons regarding gender-tagging efforts emerged. These include:

1. Gender analysis and gaps. One-half of the projects undertook some kind of gender analysis, or used a recent relevant one, as part of the project design stage to inform the choice of gender activities targeted at issues (gender gaps) identified in these analyses. These ranged from hiring a gender expert to review documents and interview field partners, to undertaking social assessments as part of the safeguard process, to reviewing gender-related lessons from the literature and previous projects. The challenge of identifying specific gender gaps relevant to each project is not a small one, and evident in the relative lack of gender-disaggregated data and specificity on gender gaps in the forest landscapes in question reflected in these PADs[3].

[3] A reviewer pointed out that gaps are also influenced by the content and goal of the project as well as the context of implementation – especially in terms of how intersecting dimensions of gender with other forms of social differentiation influence gender relations and roles.

2. Gender actions/activities included in recent forest landscape projects

Gender expertise. In terms of gender expertise, almost all of these projects relied on social development and safeguards specialists for advice during the design stage. One project included a senior gender-forests specialist on the design team and earmarked and budgeted activities aimed at addressing specific gender gaps identified during the design stage. Six projects specified the project implementation team must include a gender/social development specialist.

Women's participation and representation. Sixty-four percent of the projects identified, although often very vaguely, actions aimed at ensuring women's representation in relevant decision-making bodies (Table 1). For example, activities "encouraging participation of women and youth on project decision-making platforms", or "establishing Local Development Committees with women representatives" were included. Several of the reviewed forest landscape projects specified targets for women's representation in leadership positions in forest groups/initiatives.

Capacity strengthening targeted at women and youths. Enhanced access by women to training/capacity building activities was included in 79% of these projects. The type of training was often not specified, although some projects included trainings, community visits, or other activities that address specific gender gaps identified. One project in Latin America, for example, included an activity for designing training modules in sustainable and low-carbon practices that consider gender-differentiated roles, with at least one module specifically geared toward women. Another in West Africa included targeted trainings for youth and women in agricultural practices such as market-oriented vegetable gardens and fruit trees using small-scale irrigation, fishponds, reforestation efforts in village forests, and treatment and conservation of agricultural products.

Strategic gender implementing partners. Two projects explicitly included women's groups/associations as key project *implementing* partners, although most mention including women's groups or associations only in consultations.

Joint signatures. A strategy for ensuring women benefit equally in several projects was the specification that land certificates/contracts can be signed by women alone, or jointly by a husband and wife. One project explicitly 'de-linked' project benefits from a requirement of land ownership.

Targeted grants. Earmarked grants targeted to women, youths, women's groups, female-owned/headed enterprises, or gender activities, were included in eight projects (57%).

Targeted information and services. Over half of reviewed WBG projects included actions aimed at enhancing women's access to project-relevant information and/or services. Support towards innovative extension/rural advisory activities targeting women's needs are included in many of these, including women-specific Farmer Field Schools. Another specified that innovative strategies will be pursued to enhance reaching women, including finding alternative meeting places close to households and time schedules; dissemination of materials specifically targeting women; and pursuing role model strategies. Several projects included exchange visits targeting women's needs.

Livelihood diversification for women and youths. Almost half of these projects had activities aimed at livelihood diversification for women. These included support to productive activities in forest-landscapes such as ecotourism, commercialization of non-timber products (honey, mushrooms, etc.) and arts and crafts. One project provided grants towards further value-added activities, specifying that half of these grants must go to women. Another project established a target of 20% women beneficiaries in a small-scale grant sub-component that will provide financing for community-level investments in agroforestry, ecotourism and timber and non-timber products.

Support to women's collective action/groups. Nine projects (64%) specifically include support targeted at women's groups or associations. These incorporated organizational, technical and financial support to women's groups in processing and marketing agricultural (including agroforestry) and forest products, and designated funds for water catchment investments for a women's association involved in reforestation activities.

3. Gender indicators

The majority of the FY18 forest projects reviewed included several sex-disaggregated indicators at different levels. These varied considerably, including indicators related to adoption of sustainable land management practices, or improved agricultural technologies, assets or services (number adopting, with % female). Others included: the percentage of women participating in local platforms created or strengthened by the project; number of female community leaders with enhanced capacity; number of indigenous peoples, women, men with increased monetary and non-monetary benefits from forests; number of registered artisanal and small mining entities accessing small grants (of which 30% must be female); number of female grant recipients; number of female household heads as direct project beneficiaries; number of farmers/land users trained and % female in agroforestry, sustainable land management, low carbon practices, women's farmer field schools; number of contracts/land certificates signed by women or jointly signed; number and share of women in leadership positions, or forest-related committees; and number of municipal land tenure plans using gender criteria.

It is only when these types of specific indicators for tracking progress towards gender outcomes are measured that we will begin to have more evidence as to the actual outcomes of gender-responsive actions. Since much of the monitoring needs to be done in a participatory manner, by the project participants or local implementing agency, capacity strengthening on gender monitoring and evaluation clearly will be a valuable addition to projects that want to be able to demonstrate gender-relevant results.

In terms of getting past a focus on more equitable participation towards better understanding just who is benefitting and empowered by project actions, sex-disaggregated indicators on the number of grant recipients, direct project beneficiaries, jointly or female-signed contracts, women in leadership positions of forest-related decision making bodies are much more valuable indicators, and it is encouraging to see them beginning to be included in project plans.

CONCLUSIONS AND RECOMMENDATIONS

Many countries and institutions have been making progress towards incorporating gender-responsive approaches in forest landscape projects. With ongoing social and cultural shifts, the opportunities that more inclusive forest-related projects, programs and policies present are becoming increasingly more apparent. The heightened awareness of the need to strengthen land, tree and forest tenure security of indigenous peoples as well as women is an encouraging example of this trend (RRI 2017, UN 2019, World Bank 2019).

However, while we've come a long way towards including gender considerations in the dialogue around scaling up sustainable forest landscape management-related efforts, many challenges remain. Comprehensive gender analysis, sharing of sex-disaggregated data/evidence, and identification of specific gender gaps in the forest landscape realm that could fairly easily be addressed by targeted project activities is still largely lacking. Many such projects rely on social assessments that aim to highlight and address gender constraints in general, but do not necessarily lead to specific gender-targeted actions that can increase the effectiveness of the project or program. It is time to start moving beyond 'do no harm' principles to more pro-active 'do some good' ones. Opportunities to include gender-responsive activities that make these projects more inclusive and share benefits more equally are simply being missed. This review has attempted to highlight specific examples of such activities.

Gender analysis approaches based on participatory, largely qualitative methods are widely and freely available. They can greatly aid in identifying ideas and potential project activities that directly address and help close existing forest-landscape gender gaps (e.g. see Colfer and Minarchek 2012, Kristjanson *et al.* 2019). To be truly effective, they must be undertaken at the earliest stages of project conceptualization. This review of forest projects suggests that most include activities that focus solely on women's participation. While necessary, this is clearly insufficient and leads to missed opportunities to also include strategies and actions aimed at ensuring equality in benefit-sharing. Participatory, inclusive processes can also empower women and other marginalized people, but the evidence to date suggests they are still not being emphasized very strongly in most forest landscape investments.

Strategic gender partners are lacking in many of the forest projects reviewed. Few include Ministries, Agencies or NGOs/CSOs that have a track record in working on the ground on gender issues as full partners, and not just part of consultations. In terms of achieving gender-related outcomes, initiatives that have built such strategic gender partnerships appear to be much more likely to achieve them.

It would be nice if this review was able to discuss in more detail, for the projects that did attempt such actions, exactly when and how strategic gender partners were identified, how joint signatures were specified, more specificity on types of targeted gender grants, and how livelihood diversification activities were chosen (and do they take into consideration existing women/gender-related groups?). Further research into these issues is needed.

A relatively new global initiative focusing on gender and forest landscapes and forest restoration efforts has come together within the CIFOR-led global landscapes forum initiative. This is a network reaching hundreds of thousands of people globally. Several recent gender-focused forest landscape events in global and regional GLF events have suggested the following potential new directions and ideas for gender-conscious forest landscape project, program and policy designers and investors and agencies to consider including (Kristjanson *et al.* 2018):

- Labour-saving technologies for women, including biogas, energy efficient stoves and briquettes, solar energy, and non-timber forest product processing-related investments (e.g. nuts, fruits, oils).
- Innovative rural advisory services (with private sector) related to forest landscapes that train women as well as men to provide targeted services to women and others that have been underserved in the past (e.g. providing market-related information on forest products, technical guidance on agroforestry, etc.).
- ICT-based approaches to reach and inform rural women (e.g. a REDD+ Togo group is using WhatsApp to link the national REDD+ group with rural women's implementing groups).
- Seriously budgeting for targeted gender activities outlined in gender action plans (not expecting extra funds to materialize for them).
- Using innovative tools and approaches to reach women and youths, including participatory resource mapping, citizen science, and crowd sourcing.
- Using technologies that enable direct (performance-based) payments to women for tree and forest management-related activities (e.g. M-Pesa in Kenya).
- Supporting innovative communication and knowledge-sharing efforts targeting diverse rural audiences, such as 'edutainment' shows highlighting female farmers/foresters (e.g. Shamba Shape-Up in East Africa).

Initiatives aiming to incorporate gender-responsive actions are increasingly developing gender-focused theories of change that identify critical gender gaps, actions to address each gap, and indicators to monitor progress towards gender-related outcomes. This will allow further analyses of actual gender outcomes (i.e. what the pathways to gender outcomes were in comparison to their starting points and hypothesized routes) in the future, so increased investment in such efforts are needed.

It is also time to revisit concerns over social stratifiers in community forestry first identified 40 years ago (Schroeder 1999), to look beyond sex and consider gender roles and how they intersect with other factors of social differentiation (e.g. with age, socio-economic status, ethnicity) more generally (Colfer *et al.* 2018). Failing to do so represents another lost opportunity. Thus, policymakers need to take this on more fully, shifting from a focus on 'women's roles in forests' to 'gender roles in forests'.

ACKNOWLEDGEMENTS

Financial support for this work was provided by PROFOR, a multi-donor partnership housed at the World Bank (www.profor.info). This article is based largely on an earlier PROFOR working paper (Kristjanson et al. 2019), with thanks to the authors of that paper for their contributions. I also thank five reviewers for their valuable comments that improved the paper.

REFERENCES

AGARWAL, B. 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Development* **29**: 1623–1648.

AGARWAL, B. 2009. Gender and forest conservation: The impact of women's participation in community forest governance. *Ecological Economics* **68**: 2785–2799.

AGARWAL, B. 2010. *Gender and green governance: the political economy of women's presence within and beyond community forestry*. Oxford University Press, Oxford, UK.

ANGELSON, A., JAGGER, P., BABIGUMIRA, R., BELCHER, B., HOGARTH, N., BAUCH, S., BORNER, J., SMITH-HALL, C., and WUNDER, S. 2014. Environmental income and rural livelihoods: A global comparative analysis. *World Development* **64**: S12–S28.

AGUILAR, L., QUESADA-AGUILAR, A. and SHAW, D.M.P. (eds). 2011. *Forests and Gender*. Gland, Switzerland: IUCN and New York, NY: WEDO.

ARNOLD, J.E.M. *"Forests and People: 25 years of Community Forestry"*. FAO. Rome, 2001.

ARORA-JONSSON, S. 2009. Discordant connections: discourses on gender and grassroots activism in two forest communities in India and Sweden. *Signs* **35**: 213–240.

ARORA-JONSSON, S. 2011. Virtue and vulnerability: Discourses on women, gender and climate change. *Global Environmental Change* **21**(2): 744–51.

BOURNE, M., KIMAIYO, J., TANUI, J., CATACUTAN, D. and OTIENDE, V. 2015. Can gender appreciation of trees enhance landscape multifunctionality? A case of smallholder farming systems on Mount Elgon. *International Forestry Review* **17**(4): 33–45.

CATACUTAN, D. and NAZ, F. 2015. Gender roles, decision-making and challenges to agroforestry adoption in Northwest Vietnam. *International Forestry Review* **17**(4): 22–32.

Catacutan, D.C. and Villamor, G.B. 2016. Gender roles and land use preferences – Implications to landscape restoration in Southeast Asia. In: Chabay, I., Frick, M., Helgeson J. (Eds.), Land Restoration: Reclaiming Landscapes for a Sustainable Future. Academic Press: Boston: pp. 431–440.

CHOMBA, S., KARIUKI, J., LUND, J.F. and SINCLAIR, F. 2017. Roots of Inequity: How the Implementation of REDD+ Reinforces Past Injustices. *Land Use Policy* **50**: 202–213.

COLCHESTER, M. 2010. Free, prior and informed consent: Making FPIC work for forests and peoples. The Forests Dialogue. Yale University. TFD Research Paper No. 11. https://theforestsdialogue.org/sites/default/files/tfd_fpic_researchpaper_colchester_lo-res.pdf

COLFER, C.J.P. (ed.) 2005. *The Equitable Forest: Diversity, Community and Natural Resources*. Washington, D.C.: RFF/CIFOR.

COLFER, C.P. and MINARCHEK, R.D. 2012. *Women, men and forest research: A review of approaches, resources and methods for addressing gender*. Occasional Paper 80. CIFOR, Bogor, Indonesia.

COLFER, C.J.P., WOELFEL, J., WADLEY, R.L. and HARWELL, E. 2001. Assessing people's perceptions of forests: research in West Kalimantan, Indonesia. In: COLFER, C.J.P. and BYRON, Y. (eds.) *People managing forests: the links between human well-being and sustainability*, 135–154. Resources for the Future, Washington DC, US.

COLFER, C.J.P., ELIAS, M., and JAMNADASS, R. 2015. Women and men in tropical dry forests: A preliminary review. *International Forestry Review* **17**(2): 70–90.

COLFER, C.J.P., SIJAPATI BASNETT, B., and ELIAS, M. 2016. *Gender and forests: Climate change, tenure, value chains and emerging issues*. London and New York: Earthscan from Routledge.

COLFER, C.J.P., SIJAPATI BASNETT, B., and IHALANIEN, M. 2018. *Making sense of 'intersectionality': A manual for lovers of people and forests*. CIFOR Occasional Paper no. 184. CIFOR, Bogor, Indonesia.

COLEMAN, E., and MWANGI, E. 2013. Women's Participation in Forest Management: A Cross-Country Analysis. *Global Environmental Change* **23**(1): 193–205.

ELIAS, M., STEVENS HUMMEL, S., BASNETT, B.S., and COLFER, C.J.P. 2017. Gender bias affects forests worldwide. *Ethnobiology letters*. DOI 10.14237/ebl.8.1.2017.834

FAO. 1986. *Monitoring and evaluation of social forestry in India*. FAO Forestry Paper 75. http://www.fao.org/3/an799e/an799e00.pdf

GILMOUR, D. 2016. *FAO Forestry Paper 176: Forty years of community-based forestry: A review of its extent and effectiveness.* FAO, Rome.

GINSBURG, C., and KEENE, S. 2018. *At a crossroads: Consequential trends in recognition of community-based forest tenure from 2002–2017*. Washington, DC: Rights and NYDF Briefing Series Goal 10: A Closer Look Resources Initiative. https://rightsandresources.org/wp-content/uploads/2018/11/At-A-Crossroads_RRI_Nov-2018.pdf.

GURUNG, J., GIRI, K., SETYOWATI, A., and LEBOW, E. 2011. *Getting REDD+ right for women: Analysis of the barriers and opportunities for women's participation in the REDD+sector in Asia*. Washington, DC: USAID. Available at: http://gender-climate.org/wp-content/uploads/docs/publications/Gender_REDD_Asia_Regional_Analysis.pdf.

INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN). 2009. *REDD-plus and Benefit Sharing: Experiences in Forest Conservation and Other Resource Management Sectors*. Washington DC: IUCN.

KHADKA, M., KARKI, S., KARKY, B.S., KOTRU, R. and DARJEE, K.B. 2014. Gender Equality Challenges to the REDD+ Initiative. *Nepal Mountain Research and Development* **34**(3): 197–207. http://dx.doi.org/10.1659/MRD-JOURNAL-D-13-00081.1

KIPTOT, E., FRANZEL, S., and DEGRANDE, A. 2014. Gender, agroforestry and food security in Africa. *Current Opinion in Environmental Sustainability* **6**: 104–109.

KIPTOT, E. 2015. Gender roles, responsibilities, and spaces: Implications for agroforestry research and development in Africa. *International Forestry Review* **17**(4): 11–21.

KIPTOT, E. and FRANZEL, S. 2012. Gender and agroforestry in Africa: a review of women's participation. *Agroforestry Systems* **84**(1): 35–58.

KRISTJANSON, P., BAH, T., KURIAKOSE, A., SHAKIROVA, M., SEGURA, G., SIEGMANN, K., and GRANAT, M. 2019. *Taking action on gender gaps in forest landscapes*. Program on Forests (PROFOR). Washington, DC: World Bank.

KRISTJANSON, P., SIEGMANN, K., AFIF, Z., MANCHESTER, K., and GURUNG, J. 2018. *Enhancing effectiveness of forest landscape programs through gender-responsive actions.* Global Landscapes Forum, GLF Brief No. 1. Center for International Forestry Research (CIFOR), Bogor, Indonesia. https://www.cifor.org/library/7003

LARSON, A.M., DOKKEN, T., DUCHELLE, A.E., ATMADJA, S., RESOSUDARMO, I.A.P., CRONKLETON, P., CROMBERG, M., SUNDERLIN, W., AWONO, A. and SELAYA, G. 2015. The Role of Women in Early REDD+ Implementation: Lessons for Future Engagement. *International Forestry Review* **17**(1): 43–65.

LARSON, A.M., SOLIS, D., DUCHELLE, A.E., ATMADJA, S., RESOSUDARMO, I.A.P., DOKKEN, T. and KOMALASARI, M. 2018. Gender lessons for climate initiatives: A comparative study of REDD+ impacts on subjective wellbeing. *World Development* **108**: 86–102.

LEACH, M., MEARNS, R., and SCOONES, I. 1999. Environmental entitlements: Dynamics and institutions in community-based natural resource management. *World Development* **27**(2): 225–247.

MAI, Y.H., MWANGI, E., and WAN, M. 2011. Gender analysis in forestry research: Looking back and thinking ahead. *International Forestry Review* **13**(2): 245–258.

MARIN, A.B., and A. KURIAKOSE. 2017. Gender and Sustainable Forest Management: Entry Points for Design and Implementation. Climate Investment Fund (CIF), World Bank Group. https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/gender_and_sustainable_forest_management.pdf.

MATA, G. and SASVÁRI, A.A. 2009. Integrating gender equality and equity in access and benefit-sharing governance through a rights-based approach. In: CAMPESE, J., SUNDERLand, T., GREIBER, T. and OVIEDO, G. (eds.) *Rights based approaches: exploring issues and opportunities for conservation*, 250–268. CIFOR, Bogor, Indonesia.

McDOUGALL, C. 2001. Gender and diversity in assessing sustainable forest management and human well-being. In: COLFER, C.J.P. and BYRON, Y. (eds.) *People managing forests: the links between human well-being and sustainability*, 50–72. Resources for the Future/CIFOR, Washington DC, US.

MEIJER, S.S., SILESHI, G.W., KUNDHLandE, G., CATACUTAN, D. and NIEUWENHUIS, M. 2015. The role of gender and kinship structure in household decision-making for agriculture and tree planting in Malawi. *Journal of Gender, Agriculture and Food Security* (Agri-Gender), 1(302-2016-4750): 54–76.

MULYOUTAMI, E., MARTINI, E. and KHUSUSIYAH, N. 2012. Agroforestry and Forestry in Sulawesi Series: Gender, Livelihood and Land in South and Southeast Sulawesi. ICRAF Working Paper No. 158: World Agroforestry Centre, Nairobi, Kenya.

MWANGI, E., MEINZEN-DICK, R., and SUN, Y. 2011. Gender and sustainable forest management in East Africa and Latin America. *Ecology and Society* **16**(1): 17.

PEACH BROWN, H.C. 2011. Gender, Climate Change and REDD+ in the Congo Basin Forests of Central Africa. *International Forestry Review* **13**(2): 163–176.

PHAM, T.T., MAI, Y.H., MOELIONO, M., and BROCKHAUS, M. 2016. Women's Participation in REDD+ National Decision-Making in Vietnam. *International Forestry Review* **18**(3): 334–344. DOI: 10.1505/146554816819501691

POTTINGER, A.J. and MWANGI, E. 2011. Special Issue: Forests and Gender. *The International Forestry Review* **13**: 1–258.

RIGHTS AND RESOURCES INSTITUTE (RRI). 2017. *Power and Potential. A comparative analysis of national laws and regulations concerning women's rights to community forests*. RRI: Washington, DC.

ROCHELEAU, D.E. 1991. Gender, ecology, and the science of survival: Stories and lessons from Kenya. *Agriculture and human values* **8**(1–2): 156–165.

SCHROEDER, R.A. 1999. Shady practices: Agroforestry and Gender Politics in the Gambia (Vol. 5). University of California Press.

SCHROEDER, R.A. and SURYANATA, K. 2002. Gender and class power in agroforestry systems: case studies from Indonesia and West Africa. In: Liberation Ecologies. Routledge Press. pp. 200–216.

SHYAMSUNDAR, P., AHLROTH, S., KRISTJANSON, P., and ONDER, S. 2019. Supporting pathways to prosperity in forest landscapes – A PRIME framework. *World Development*. https://doi.org/10.1016/j.worlddev.2019.104622

STIEM, L., and KRAUSE, T. 2016. Exploring the Impact of Social Norms and Perceptions on Women's Participation in Customary Forest and Land Governance in the Democratic Republic of Congo – Implications for REDD+." *International Forestry Review* **18**(1): 110–122. https://doi.org/10.1505/146554816818206113.

SUNDERLAND, T., ACHDIAWAN, R., ANGELSEN, A., BABIGUMIRA, R., ICKOWITZ, A., PAUMGARTEN, F., and SHIVELY, G. 2014. Challenging perceptions about men, women, and forest product use: A global comparative study. *World Development* **64**(S1): S56–S66.

TOWNSEND, J.G., WITH ARREVILLAGA, U., BAIN, J., CANCINO, S., FRENK, S., PACHECO, S. and PEREZ, E. (eds.) 1995. *Women's voices from the rainforest*. Routledge, London, UK.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC). 2016. Gender and climate change. Decision 21/DP22. FCCC/CP/2016/10/Add.2. http://unfccc.int/files/gender_and_climate_change/application/pdf/pages_17-20_from_10a02.pdf.

UN NY DECLARATION ON FORESTS. 2019. 'Empowerment of Forest-Linked Communities: What Progress and Where Next? NY Declaration on Forests Progress Assessment Briefing Series. Available at: www.Forest declaration.org

UN-REDD. 2011. The business case for mainstreaming gender in REDD+. United Nations Development Programme, Food and Agricultural Organization of the United Nations, United Nations Environment Programme, Geneva, Switzerland. org/vol16/iss1/art17/.

VILLAMOR, G.B., VAN NOORDWIJK, M., DJANIBEKOV, U., CHIONG-JAVIER, M.E. and CATACUTAN, D. 2014. Gender differences in land-use decisions: shaping multifunctional landscapes? *Current Opinion in Environmental Sustainability* **6**: 128–133.

VILLAMOR, G.B., AKIEFNAWATI, R., VAN NOORDWIJK, M., DESRIANTI, F. and PRADHAN, U. 2015. Land use change and shifts in gender roles in central Sumatra, Indonesia. *International Forestry Review* **17**(4): 61–75.

VILLAMOR, G.B., CATACUTAN, D.C., VAN ANH, T.T. and THI, L.D. 2017. Tree-cover transition in Northern Vietnam from a gender-specific land-use preferences perspective. *Land Use Policy* **61**: 53–62.

WESTHOLM, L., and ARORA-JONSSON, S. 2015. Defining Solutions, Finding Problems: Deforestation, Gender, and REDD+ in Burkina Faso. *Conservation and Society* **13**(2): 189.

WILDE, V.L. and VAINIO-MATTILA, A. 1995. Gender analysis and forestry. Food and Agriculture Organization of the United Nations, Rome, Italy.

WORLD BANK. 2016. Forest action plan FY16-20 (No. 106467). Washington, DC: World Bank Group. Retrieved from http://documents.worldbank.org/curated/en/240231467291388831/Forest-action-plan-FY16-20.

WORLD BANK. 2019. *Securing Forest Tenure Rights for Rural Development. An Analytical Framework.* Program on Forests (PROFOR). Washington, DC. World Bank. https://www.profor.info/sites/profor.info/files/PROFOR_SecuringForestTenureRights_0.pdf

WORLD BANK. 2018. *Closing the Gender Gap in Natural Resource Programs in Mexico*. World Bank, Washington, DC. http://pubdocs.worldbank.org/en/243311534947810543/Mexico-Forestry-Report-V14-DIGITAL.pdf.

Whose problem is it anyway? Narratives and counternarratives and their impact on woodfuel policy formulation

P.A. DEWEES

Independent researcher, Juntulantie 80, Taipalsaari 54920, Finland

Email: pdewees@gmail.com

SUMMARY

The perception that there were rapidly growing demands for woodfuel in developing countries was an early driver of policies and measures which had the objectives of increasing wood energy supplies or of attenuating demand. A series of compelling narratives developed around the "woodfuel crisis," in support of technocratic responses. Their shortcomings became evident with experience gained in implementation, and new narratives and counternarratives emerged, building on a growing body of research about the dynamics of woodfuel supply and demand.

This paper examines the role of woodfuel narratives and counternarratives, and how they continue to inform policy. Evidence suggests that after nearly 40 years of focusing narrowly on woodfuel, policy makers remain poorly equipped to respond to the problem. Effective solutions to the problem of woodfuel must be rooted in a broader reframing of the role of trees, woodlands and forests in the rural economy, and how rights of use and access to these important resources can be mediated by policy and legislation, and supported by development investment.

Keywords: woodfuel, energy, policy, narrative

«A qui la faute, en fait?» Narrations, narrations antithétiques, et leur impact sur la formulation de la politique en bois de chauffage

P. DEWEES

La perception que la demande en bois de chauffage était en rapide croissance dans les pays en voie de développement a été l'un des moteurs initiaux de politiques et de mesures ayant pour objectif d'accroître la production de bois à usage énergétique ou d'en atténuer la demande. Une série de narrations convaincantes se développa autour de la «crise du bois de chauffage», pour soutenir les réponses technocrates. Leurs limites devinrent évidentes au cours de l'expérience glanée durant la mise en application, et de nouvelles narrations, ainsi que des narrations antithétiques émergèrent, basées sur un corps grandissant de recherche sur la dynamique de l'offre et de la demande en bois de chauffage.

Ce papier examine le rôle des narrations et de leurs narrations antithétiques sur le bois de chauffage, et de la manière dont celles-ci continuent d'informer la politique. Les preuves suggèrent qu'après s'être concentrées étroitement presque 40 ans sur le bois de chauffage, les créateurs de politiques demeurent pauvrement équipés pour répondre à cette question problématique. Des solutions efficaces au problème posé par la question du bois de chauffage doivent prendre racine dans une évaluation plus large du rôle des arbres, des terres boisées et des forêts dans l'économie rurale, et comment les droits d'accès à et d'utilisation de ces ressources importantes peuvent avoir pour médiateur la politique et la législation, et être soutenues par des investissements dans le développement.

¿De quién es el problema? Narrativas y contra narrativas y su impacto en la formulación de políticas sobre la leña

P. DEWEES

La percepción de una creciente demanda de leña acelerándose en los países en desarrollo fue uno de los primeros impulsores de las políticas y medidas cuyo objeto era aumentar el suministro de leña o atenuar la demanda. Se elaboraron una serie de narrativas convincentes en torno a la "crisis de la leña", que apoyaban las respuestas tecnocráticas. Sus deficiencias se hicieron evidentes con la experiencia adquirida en la implementación, y surgieron nuevas narrativas y contra narrativas a partir de un conjunto creciente de investigaciones sobre la dinámica de la oferta y la demanda de leña. Este artículo examina el papel de las narrativas y contra narrativas sobre la leña, y cómo continúan influyendo en la formulación de políticas. La evidencia sugiere que después de casi 40 años de centrarse estrechamente en el tema de la leña, los responsables de las políticas siguen estando mal equipados para responder al problema. Las soluciones eficaces al problema del combustible de madera deben basarse en un replanteamiento más amplio del papel de los árboles, los bosques y las tierras forestales en la economía rural, y en la forma en que los derechos de uso y acceso a estos importantes recursos pueden ser controlados mediante las políticas y la legislación, y apoyados por la inversión en el desarrollo.

INTRODUCTION

The woodfuel 'crisis' was first articulated in the mid-1970s as a way of raising awareness about the growing energy needs of people in developing countries. As a rhetorical construct, it was articulated as a crisis to mirror the transient energy shortages and petroleum product price increases affecting developed economies, precipitated in part by conflict in the Middle East and the rise of OPEC in 1973. Its framing as a crisis spurred development agencies and governments to give increased attention to addressing problems of forests, trees, and woodfuel consumption.

But this "other energy crisis" (Eckholm 1975) was neither transient, nor did it meet the usual definition of a crisis as a critical juncture or turning point in the way woodfuels were being used and produced in developing economies.[1] Since publication of Eckholm's seminal and highly influential piece, there have been no radical changes in the ways and rates that households in most countries use wood energy. Woodfuel and its biomass variants remain the dominant form of household energy used in developing countries.[2] With the exception of modest downward shifts in woodfuel consumption in East Asia and Latin America, significant or profound energy transitions to conventional sources have not transpired at the national or regional scale. People in Africa, South Asia, and Southeast Asia are continuing to use vast quantities of fuelwood for domestic cooking and heating (Fernandes *et al.* 2007) and all indications are that they will continue to do so into the near future.

The woodfuel 'crisis' was articulated through a particular set of narratives – arguably, narratives which were intended to provoke a response on the part of donors, development agencies, and governments because of dire outcomes thought to be likely or inevitable if immediate actions were not taken. The research base supporting these early narratives around woodfuel scarcity was, for the most part, absent. Early narratives were not derived from a substantive body of work. Instead, they relied heavily on 'back-of the envelope' calculations, anecdotal information and observations, and a weak understanding of the role of trees in rural economies as sources of goods and services.[3] That, of course, has changed – there is now a large and growing body of research about woodfuel use and its impacts.[4]

The objective of this paper is to describe how and why narratives about woodfuel use and its impacts have persisted, the counternarratives that have emerged in response, framed by a growing body of research, and how both narratives and counternarratives inform and continue to guide the development and implementation of wood energy policy.

It is neither a systematic review of the literature, nor is it an exhaustive effort to summarize current thinking about woodfuel use and its impacts, though it draws on the literature extensively to make its points. There have been a number of extensive and comprehensive reviews of knowledge about woodfuel use and its impacts, such as Arnold *et al.* (2003), which reached thoughtful conclusions about the dynamic interplay of woodfuel demand and supply and the scope for government and donor response. The objective is also not to critically assess the *quality* of the research to-date, though some studies are, of course, more robust than others are. Recent assessments such as Sola *et al*. (2016) for example, draw valuable conclusions about the limitations of published research about woodfuel value chains in Africa.

Narratives can be objectively "right" or "wrong."[5] To criticize a narrative is not to necessarily say it is wrong. Conversely, to acknowledge the power of a narrative and its impact on policy formulation is not to necessarily say it is correct. In examining the issue of narrative and counternarrative in the discourse about woodfuel, and its relationship to policy formulation, central is the question of the nature of the understanding of the problem, and who 'owns' the problem in the first place: Whose problem is it anyway?

THE POWER OF NARRATIVE

The simplification of complex issues into compelling and uncomplicated narratives has long been a feature of international development dialogue, guiding development policies, materializing in project interventions, and engendering a

---

[1] Erik Eckholm's 1975 paper is usually credited with being among the earliest to describe how people in developing countries are dependent on woodfuels, and the potential impacts of this dependency. An earlier assessment was Keith Openshaw's January 1974 article in New Scientist, which noted that "the energy crisis in 'Third World' countries is at least as serious as the much publicized problems of the developed nations." (Openshaw 1974: 271). Eckholm echoed this theme of woodfuel as 'the other energy crisis' in his 1975 paper, which created the framework for many of the narratives which emerged.

[2] Despite this widely shared understanding, and a desire to cite a definitive consumption estimate here, there is surprisingly little analysis of current global rates of woodfuel use viz. total energy use and projections of future energy use. The best work to-date on modelling regional and global woodfuel demand comes from statistical revisions carried out by FAO in 2001 (see Broadhead *et al*, 2003) which projected woodfuel consumption until 2030. Most recently published estimates appear to be derivatives of these.

[3] There were of course exceptions. FAO, for example, had undertaken woodfuel consumption surveys in Tanzania, Gambia and Thailand. Openshaw (1974) thought these were representative enough to extrapolate findings from these surveys to the rest of the developing world.

[4] Arguably, much of this present body of knowledge built on or emerged out of development interventions designed to address the so-called woodfuel crisis. Thus, early and subsequent research agenda were framed by these early narratives and the associated theoretical constructs that emerged.

[5] Arguably, it is the role of peer reviewed research to assess whether particular narratives are objectively credible. Two points are worth repeating: first, narratives themselves have a powerful role in creating a research agenda which is reinforcing, and second, solid research findings may contradict particular narratives, but often do not succeed in undermining them. Narratives persist.

body of literature. Not unlike how politicians appeal to the electorate through populist messaging, narratives reduce an issue to its barest outline. They are a way of leading audiences toward conclusions that justify a proposed response, which appears both logical and imperative. Albert O. Hirschmann, in his early pioneering study, *Development Projects Observed*, (Hirschmann 1967) spoke of the power of narrative and its consequences. He suggested that development planners, in the process of developing simplified narratives, tended to be unrealistically optimistic about the likelihood that a proposed intervention would achieve its expected impact. Nonetheless, he argued that there was power in creating simple narratives, because when the true nature of the difficulty and complexity of the task became apparent, planners would be challenged to come up with creative and more effective solutions than the ones originally envisaged. This was his so-called "Hiding Hand," which was aimed at problem solving in the face of possible failure.

Hirschmann's view of the prevalence of straightforward narratives as a stimulant to creative problem solving provided a useful perspective of how early development initiatives moved forward. Despite the short sightedness of committing large sums of development assistance to support untested measures, based on hypothetical assertions, wider trends in the 1970s and 1980s mostly took this approach. By confidently asserting action A will lead to outcome B, development planners and policy makers claimed with technocratic certainty that a power plant, or roads project, or school program which they had successfully implemented in one country could be used wholesale as a model for the same kind of investment in any another country. Nevertheless, experience increasingly showed that the likelihood that action A would consistently lead to outcome B was less likely the more complex the setting.

As the scale and nature of development project interventions expanded in scope, the gap between narrative and reality became increasingly difficult to bridge by introducing reactive (though admittedly creative) solutions. As small, one-off initiatives evolved into complex national programs, government and donor bureaucracies charged with implementing development interventions had less flexibility in adapting to changed circumstances. Narrative simplification, instead of providing opportunities for creative problem solving, entrenched damaging and poorly justified interventions. In Ethiopia, for example, Alan Hoben noted the shortcomings of narrative simplification as a tool for environmental policy implementation. Policy implementation,

> "...was based on inadequate scientific and technical knowledge. It was implemented with a standardized approach and with little regard to regional or local agro-ecological conditions. The views and interests of the rural men and women it was intended to benefit were not solicited or heeded. Instead, implementation was top-down, authoritarian and politicized. Peasant interest in investing in long-term environmental management, to the extent that it had existed, had been undermined by the government's land reform program." (Hoben 1995:1007)

His target was Hirschmann's Hiding Hand: simple narratives and solutions, Hoben argued, are simply not up to the task of dealing with scale and complexity. Particularly, neo-Malthusian environmental policy narratives, used to justify the rapid, massive and widespread use of narrowly conceived technological interventions, are often wrong, "...misrepresenting environmental conditions and trends, the role of human agency in causing the trends, or both." (Hoben 1995:1008)

The simplification of narratives rests largely on a reliance on iconic 'facts.' Iconic facts, in turn, generate prescriptive solutions, rooted – or not – in reality, but more often than not derived from anecdotes and the sometimes-elaborate stories that follow. Reiterated stories of cause-and-effect enter their way into policy making, as they meet the demand for clarity and easy marketing. (Keeley and Schoones 2003).

Critics of this approach argued that the alternative was to design interventions with strong learning elements, which embraced failure as a means for clarifying the way forward (cf. Chambers 1983). This approach requires flexibility in design, an inherent openness and willingness to move away from the original plan, and clarity that planned outcomes would really be moving targets. Log frames and expected input/output/outcome/impact pathways were only relevant if they could incorporate strong learning elements to them. Even the World Bank embraced the idea of these types of interventions in the 1990s. It launched a series of Learning and Innovation Loans (LILs), meant to make funds available quickly and simply to tackle new and untested areas and to provide scope for flexible outcomes. However, LILs relied on conventional and unchanged evaluation criteria: a failed LIL was one that did not meet its original objectives, largely defined by the achievement of clearly defined physical or thematic outcomes.

Given the pervasiveness of narrative and rather than suggesting narratives should be abandoned entirely, Roe (1991) made the case that the greater challenge is to consider ways in which narratives can be improved, deepened or superseded by counternarratives. It is not enough just to displace a discredited narrative. This only increases uncertainty for development planners, and leaves decision makers without the means to make a transition to something else. What effectively displaces a narrative are not just the facts which refute it, but a counternarrative which tells a better story and which offers viable alternative approaches and solutions, even expanding and building on elements of the original narrative.

Narrative simplification was a key characteristic of much of the initial discourse about woodfuel supply and demand, and the impacts of woodfuel consumption, which emerged in the 1970s. As experience accumulated with implementing woodfuel policies and projects, and as a body of research began to improve an understanding of the dynamics of woodfuel supply and demand, counternarratives emerged as well. One of the objectives of this paper is to ask the question of whether or not counternarratives have effectively displaced the original narratives by going beyond simply refuting the original narrative, and do so by 'telling a better story.' In doing so, good counternarratives should also provide greater scope for action to deal with the original problem by supporting actions which are more effective.

WOODFUEL AND THE PERSISTENCE OF NARRATIVE

Woodfuel narratives especially feature strongly in narratives about environmental degradation and deforestation. Deforestation and land degradation narratives in turn, typically have three common and persistent themes: rapidly growing populations pose Malthusian pressures on the environment; the poor do not have adequate technical knowledge about their impact on the environment; and the poor's livelihood practices are not sustainable (cf. Rai 2019). These narratives are consistent with the widespread view of the poor, and especially women, as "victims, villains, and fixers."[6] These problems, however incompletely identified, differ from many narratives because they are intractable and not easily addressed through narrow, technocratic or prescriptive mechanisms. Rather, their solution depends on reducing poverty, improving the environment, and addressing social inequity – the three pillars of 'sustainable development.'

Woodfuel orthodoxies are like other development narratives that try to build on iconic facts in support of global truths. Moreover, as with other narratives, the reality is highly dependent on local specificities and complexities around the dynamics of woodfuel supply and demand. In some respects, woodfuel narratives are confounded because of the significant difference between physical and economic scarcities. Even when woodfuels become physically scarce, households have a huge range of options for maintaining consumption patterns, and the economic costs of doing so may be nil (Dewees 1989).

As earlier noted, many narratives about woodfuel derived heavily from Erik Eckholm's writing in the 1970s about 'the other energy crisis.' These narratives fit neatly with neo-Malthusian concerns about the impacts of a growing population on resource scarcity, modelled, for example, by Meadows *et al.* (1972) in *The Limits to Growth.* Development agencies, similarly, embraced the idea that there were growing woodfuel scarcities, driven by population growth.

The World Bank, for example, posited that in India alone, the 'supply gap' would increase to between 100 and 200 million m³ per year by 2025, requiring a minimum of 10 million ha of highly productive plantations to meet demand (Draper 1975). Other impacts of these neo-Malthusian demands for woodfuel were expected to result in ". . . .long distances over which fuel is carted, consuming a significant proportion of labour availability; high level consumption of cattle manure and farm residues which are then lost for agricultural production; denudation of large areas of vegetative cover; incipient erosion occurring around homesteads and villages; large scale erosion . . . ." (Draper 1975: 9).

Sweeping conclusions notwithstanding, at the time, these themes had not been subject to much empirical work.[7] They seemed like reasonable assumptions regardless. Even in the absence of robust supporting research, all of these themes became core elements of the dominant narratives about woodfuel supply and demand. In brief, the expected results of growing woodfuel demands were:

- an increase in deforestation, because more trees had to be felled to meet greater woodfuel demands; forest degradation, increased erosion and the loss of biodiversity were expected to be the outcome;
- an increase in the use of agricultural residues and animal dung; land degradation and the loss of soil productivity was expected to be the outcome;
- increased labour time for woodfuel collection; this was expected to impose constraints on household labour supply, limiting increases in household production needed to move people out of poverty;
- changes in cooking and heating habits because of a deterioration in the quality and type of household fuel used, resulting in poorer nutritional outcomes and increased incidence of disease during cold and rainy seasons;
- the emergence of woodfuel markets, and where these markets already exist, an increase in woodfuel prices, pushing the already poor who depend on woodfuel deeper into poverty (Dewees 1989).

Early woodfuel narratives were strongly oriented toward supporting forest-based investments as the solution to the perceived problem. Many donors and governments followed the lead of the World Bank, which proposed and strongly promoted investment in four specific areas: farmer-managed woodlots; community managed woodlots; local authority plantations; and state-managed plantations (Draper 1975). Woodfuel narratives followed a familiar pattern: a clearly defined and Malthusian-driven problem with potentially devastating environmental, social, and economic impacts could be addressed only by a series of technocratic solutions for which there was an assumed demand.

As the theory of the Hiding Hand might have suggested, it did not take long for the head scratching to begin. Early donor-supported woodfuel interventions stumbled, and it was not exactly clear why. A social scientist brought on board by the Bank in part to look at the problem, Raymond Noronha, concluded that the reasons for the failure of woodlot projects were not technological. Rather, they were more likely to be social and political, rooted in inequities in access to land (and the related right to plant, use, and access trees), competing demands for household labour (given the long time it takes for trees to produce any useful firewood), and the fact that rural people did not seem to share the view that woodfuel supplies of the type proposed should be a priority (Noronha 1981). In Noronha's work, various counternarratives began to emerge.

---

[6] Dianne Rocheleau coined this particular phrase, in discussing how women's relationship to the environment is often described. (Rocheleau 1990).

[7] As noted earlier, FAO carried out a very limited number of woodfuel consumption studies, and these were widely cited as representative.

Central to these counternarratives was the fact that the reality was just much more complex than originally envisaged. While none of the first order impacts were necessarily or always untrue, the failure to observe the emergence of expected outcomes on a significant scale led to the development of a series of further counternarratives that challenged woodfuel orthodoxy (cf. Leach and Mearns 1988, Dewees 1989.) The counternarratives were not intended to 'debunk' the original narrative as much as they were meant to expand on it. Indeed, counternarratives became strongly rooted in broader questions related to energy access, agriculture, and rural development more generally. Nonetheless, despite the effort to develop viable counternarratives, the original narratives have, in many cases, persisted.

Why has this been so? As Rai (2019:2) points out, in his assessment of environmental narratives, it is straightforward: ". . .Narratives are pervasive because they simplify complexities, are easy to communicate and have popular appeal. They are persistent because they are a useful political and policymaking tool." Roe (1991) similarly argues that simple narratives often retain both descriptive and explanatory power, even after the conventional wisdoms from which they are derived are weakened by evidence.

Since the early 1980s, there has been a vast expansion in the published literature about woodfuel supply and demand, sometimes challenging original narratives, but also establishing new narratives strongly rooted in a body of research. Have the counternarratives which have emerged been effective in displacing the original narrative, by "telling a better story?" Have they offered viable solutions with demonstrable impacts in alleviating the problems associated with woodfuel supply and demand? Indeed, are policy makers and development planners any better enabled to tackle the problem of woodfuel? And whose problem is it anyway?

WOODFUEL AND THE SUSTAINABLE DEVELOPMENT PARADIGM

By drawing on the sustainable development framework, rooted in its three dimensions of economic, environmental, and social sustainability, the evolution of various woodfuel narratives is described, including how they have been complemented – or even replaced – by counternarratives. Many woodfuel narratives and counternarratives have emerged since the early 1970s. This discussion is by no means exhaustive and is intended to be demonstrative rather than conclusive.

Woodfuel and environmental sustainability

The original 'woodfuel crisis' narrative posited that rapidly growing demands for woodfuel were expected to cause deforestation and land degradation. At the farm level, households, in the face of growing scarcities, would have to rely on crop residues for household fuel. As residues and manure were no longer available for maintaining soil fertility, crop yields were expected to decline, and soil erosion and land degradation would be expected to increase.

The dominant counternarrative has been that environmental impacts resulting from rural woodfuel demands are actually relatively modest, or are at best highly variable, as supplies are extracted from a wide range of sources and alternatives, including farm-grown trees. Environmental impacts are still thought to be most severe near urban areas, where growing demands for charcoal create ever-expanding von Thünen circles of degraded forest cover. Other counternarratives suggest that charcoal production is a result of agricultural land clearance, and that a far greater threat to forests results from land conversion. In still other cases, charcoal production is thought to be driven by the lack of alternative income possibilities in dryland regions far from urban centres. With respect to the narrative about land degradation resulting from a reliance on crop residues and the use of animal dung for household cooking, this appears less commonly in contemporary discussions about woodfuel use, and has, to some extent, been abandoned.

Are the dominant narratives and counternarratives about the environmental impact of woodfuel demand supported by research findings? Sola *et al.* (2017) noted, in their review of research on woodfuel value chains in Africa, that the empirical basis for establishing that forest degradation could be attributed to woodfuel demands was weak. Inadequate baseline information and a failure to explore other causes of land use change and drivers of degradation obscure the relationship between cause and effect. This, of course, is not to suggest that the narrative is wrong, rather, that research related to the issue has been methodologically weak. Recent innovations in how remote sensing data is used have suggested important mechanisms for addressing methodological weaknesses (Sedano *et al.* 2019).

In addition to these weaknesses, a normative definition of what constitutes environmental degradation is also generally absent. Dry woodlands can be enormously productive in response to different usage regimes (Syampungani *et al.* 2016). Nonetheless, woodfuel harvesting may result in a transition in tree cover from closed woodland to more open savannah (cf. Treddenick and Hanan 2015), supporting different populations of flora and fauna. In so doing, they may lose both diversity and structure (cf. Mograbi *et al.* 2018). At the same time, they can continue to provide other, albeit diminished or different, environmental services such as water regulation, and, depending on the intensity with which they are used, can continue producing woodfuel supplies (Chidumayo and Gumbo 2013). These types of trade-offs are seldom addressed in woodfuel narratives. They are difficult to incorporate into most narratives because of their complexity and because responses are often non-linear. Forest or woodland degradation which results in a change in vegetation structure and biodiversity, may simply be the price to pay for sustaining woodfuel consumption. This is an arguably less serious environmental outcome compared with outright forest loss due to agricultural expansion (or mining, or urban expansion, etc.).

Some of the more significant counternarratives that have emerged put land degradation and its restoration into a broader economic and demographic context, rather than

singularly focusing on woodfuel. For example, Tiffen *et al.* (1994), in their pioneering study of land-use change in Machakos District of Kenya, suggested that, contrary to most Malthusian projections, environmental recovery has featured more prominently than has degradation, because of specialisation, economic diversification, improved living standards, and technological change. Similar longer-term trends rooted in tenure change, land use dynamics, and economic growth have been noted by others in Kenya, particularly by Rochelieu *et al.* (1995) in Ukambani, Castro (1995) in the Mt. Kenya region, and Dewees (1995) in Murang'a District. Far from being an isolated phenomenon, the planting and management of trees on farms is becoming increasingly common globally, with significant impacts, for example, in sequestering carbon, as well as contributing to other positive environmental impacts (Zomer *et al.* 2010).

While counternarratives more or less reduce the burden on rural woodfuel consuming households for environmental degradation (and sometimes give credit for environmental recovery), urban demands remain at the centre of much of the discussion about woodfuel's potential negative environmental impacts. What is frustrating about this view is that, few solutions, mediated by policy or by project interventions, have been systemically implemented in a manner that demonstrably reduce environmental degradation resulting from urban demands. For example, the published literature is bereft of cases where the regulation of woodfuel markets has had anything other than extremely modest impacts on urban demand – and no measured impacts on deforestation or forest degradation. Efforts to formalize woodfuel markets *de jure* have been ineffective in displacing the extensive *de facto* informal networks and the rent seeking which dominate the market (cf. Schure *et al*. 2013 for the experience from West and Central Africa.) Despite this, and the fact that this counternarrative is increasingly supported by supply chain studies, woodfuel market regulation remains a dominant policy choice in many energy economies (cf. Government of Kenya 2018). The widespread protection of forests from woodfuel exploitation, either by establishing reserves or by otherwise assigning property rights in a manner which might improve their management specifically to meet urban woodfuel demand is an occasional recommendation for policy (as in Zulu 2010) but is seldom implemented in practice.[8]

The transition to sustainable, dedicated woodfuel supplies – one of the original technocratic approaches proposed in the mid-1970s to deal with woodfuel shortages – is sometimes an outcome in the face of significant physical scarcities. It is not clear that these approaches are relevant, however, for mitigating environmental damage. In Ethiopia, the bulk of Addis Ababa's woodfuel is provided by managed eucalyptus stocks surrounding the city, in an area remote from natural forests and virtually devoid of other tree resources (Fekerte 1989, Asfaw and Demissie 2012). In Haiti, where narratives of deforestation and forest degradation due to woodfuel use have a long history, a great deal of charcoal is now produced by small, intensively managed woodlots that are found throughout the country (Ghilardi *et al.* 2018). These solutions, however, only emerged in the face of overwhelming physical scarcities of woodfuel, and long after proximate forest resources had disappeared – a situation that is not typical in many economies. Rather than averting deforestation and forest degradation, the development of sustainable woodfuel supplies for urban markets can be an outcome of it.

A range of other possible approaches toward dealing with woodfuel demand, and its potential environmental impacts, focus on using economic instruments. These include policy and pricing measures to encourage fuel substitution, and rely to some extent on the idea that the move out of woodfuels to conventional sources is a natural progression. We turn to this question in the next section.

Woodfuel and questions of economic sustainability

The original woodfuel crisis narrative posited quite narrowly that growing woodfuel demands would result in the emergence of woodfuel markets, and that increased woodfuel prices would pose onerous burdens on the poor, who would be pushed even deeper into poverty. There was also a view that, for households which are able to escape the poverty trap, as income increased they would shift to the use of other fuels. While these narratives certainly helped inform policy, they were less successful in generating solutions to these perceived problems. A growth agenda which 'lifts all boats' is certainly appealing for a range of reasons, but it was never driven, expect on the periphery, by concerns about the impacts of woodfuel scarcity on the poor. The focus here is on two key elements of this particular narrative: fuel switching and fuel stacking.

The "energy ladder" is the term, used to characterize fuel switching – the expected shift out of woodfuels in response to higher incomes, or to lower alternative energy prices. As one of the original narratives rooted in the growth agenda, households were expected to move to using higher quality fuels, such as kerosene and bottled gas, and eventually to using electricity as incomes increased.[9] Muller and Yan (2018) provide an exhaustive review of the literature regarding fuel switching, noting that the evidence is sometimes confounded by the fact that woodfuels are not always considered inferior goods.

The complexities of household fuel choice gave rise to a further counternarrative, that the use of multiple fuels and fuel switching between preferred fuels was mediated as much by price and income, as by the need to mitigate the risk of being

[8] There are exceptions. In Senegal, for example, an effort to improve community-based tenure over woodland resources, coupled with measures to improve the charcoal supply chain and marketing system, has, in limited areas established a more sustainable system of supply (World Bank 2011). Others argue that vested interests in Senegal have successfully undermined the original objective of decentralizing woodfuel production (Poteete and Ribot 2011).

[9] The first use of the term 'energy ladder' to describe how fuel use changes with rising income appears to have been by Hosier and Dowd (1987).

without household fuel. The use of multiple fuels in parallel, to meet preferred demands for particular types of energy is referred to as "fuel stacking." While stacking was observed by early researchers (cf. O'Keefe and Munslow 1989), it was only relatively recently articulated in a way which expands substantively on the energy ladder hypothesis, to a great extent replacing it. Woodfuel use is seldom fully eclipsed by the use of other fuels, but retains an important role in the mix of household energies used, even as incomes increase. Even when other energy sources may be supported and subsidized, woodfuel may still feature in the household energy mix (cf. Madubansi and Shackleton 2007). Van der Kroon *et al.* (2013) posit that energy stacking should be seen as a reflection of complex decision making processes which enable households to cope with irregular income flows, unstable markets and uncertain supplies. It also is a reflection of cultural practices on the one hand rooted in the use of traditional fuels, while providing benefits from the use of modern fuels on the other.

In terms of providing scope for policy makers to have an impact on how households use woodfuel, and irrespective of the broader growth question, the propensity for fuel switching or fuel stacking poses two particular challenges. Firstly, policy measures explicitly in support of fuel switching generally require that alternative fuels and cooking devices should be subsidized, that these subsidies should be maintained, or that the price of woodfuel should be increased through taxation or regulation. Second, even if subsidies were thought to be fiscally sustainable (they seldom are. . .) and if regulation of woodfuel markets could be effective in limiting supplies and in increasing prices (they seldom can . . .), the much more substantive question is with respect to energy access. Noting the alarmingly low rate of rural electrification in Sub Saharan Africa, Sokona *et al.* (2012) point out that achieving an energy transition depends fundamentally on improving access to modern sources of energy.[10] Woodfuel will remain the fuel of choice unless the overwhelmingly meagre investment in electricity production or other forms of energy, which has characterized energy development, particularly in Sub Saharan Africa over the past 50 years, can be overcome.

Woodfuel and social sustainability

The original woodfuel narratives focused narrowly on the likely increased labour time required for woodfuel collection which was expected to impose constraints on household labour, limiting increases in household production needed to move people out of poverty. In addition, there were expected to be changes in cooking and heating habits because of a deterioration in the quality and type of household fuel used, resulting in poorer nutritional outcomes and increased incidence of disease during cold and rainy seasons. Later narratives began to focus on gender roles related to woodfuel collection, that woodfuel collection was often primarily a woman's task. There were also concerns about the breakdown of tenure relations over the use of trees and forests which had been reserved for other uses, and that the emergence of greater demand for woodfuel would lead to a decline in collective forest management in favour of private ownership of trees.

These narratives gave rise to a range of interventions such as improved cookstove programs geared to reducing woodfuel consumption, gender-specific woodfuel production and management projects (Bradley 1991), and a range of initiatives aimed at improving tenure, initially over the rights to use and access trees for woodfuel.

The original narrowly constrained narratives about the relationship between woodfuel use and social sustainability have been succeeded by a series of expansive counternarratives, many rooted in empirical studies. These seldom have woodfuel as their focus. Woodstove programs, for example, are thought to be less important for their impact in conserving woodfuels, but more for their health impacts because they reduce indoor smoke, and improve air quality (Imelda 2019, Sola *et al.* 2017). A more comprehensive view of the impact of gender on the use of forests and trees (including woodfuel) in development projects provides a much more nuanced perspective on the roles of men and women in the household economy (Kristjanson *et al*. 2019). There is an extremely rich body of literature about trees and local governance, which extends far beyond the singular use of woodfuel (cf. Chhatre and Agrawal 2008). A diversification in sources of household income (including from the sale of woodfuel) has been shown to increase resilience to environmental and other stresses and can improve social sustainability, while in turn strengthening social networks (Smith *et al*. 2017).

What is significant about all of these counternarratives is that nearly all of them place woodfuel supply and demand in a much wider context. Woodfuel is seldom the singular objective of social development initiatives or of policy measures which have emerged from these counternarratives. As such, they help direct our attention to how the problem might be reframed in a way which gives greater scope for more effective policy and project interventions.

NARRATIVES, COUNTERNARRATIVES AND WOODFUEL POLICY

We return to Emery Roe's original challenge where he argues that it is not enough just to displace a discredited narrative. This only increases uncertainty for development planners, and leaves decision makers without the means to make a

[10] One would think that measures catalyzed by the UN's Sustainable Development Goals (especially SDG7) would support better or more efficient woodfuel use. But SDG7 doesn't even mention woodfuel, focusing instead on electricity, 'clean' cooking fuels and technologies, and renewables. This omission, in the face of the overwhelmingly high level of wood energy consumption, perfectly makes the point that planners seem to have little clue how to design and implement energy policies which deal with woodfuel.

transition to whatever is to replace it. What effectively displaces a narrative are not just the facts which refute it, but a counternarrative which tells a better story and which offers viable alternative approaches and solutions, even expanding and building on elements of the original narrative.

With a few exceptions, arguably neither woodfuel narratives nor most of the emergent counternarratives which have superseded them have met this criteria. Policy makers have been almost uniquely ill-equipped to develop and act on the elements of a better woodfuel story which could sustainably reduce woodfuel consumption in a manner which results in better environmental, social or economic outcomes.

Many woodfuel policy recommendations seem to confuse what is needed (i.e. the technocratic response to a perceived problem) with what is possible (i.e. what could be achieved given the realities of the political economy). For example, while market deregulation or other efforts to legitimize woodfuel markets could be an important first step for allowing interventions which could improve the operation of supply chains, the political economy of deregulation make this an almost impossible objective. Bailis (2005) found that the net outlay of bribes which had to be paid to move a sack of charcoal across 10 to 15 separate checkpoints between Narok to Nairobi (around 150 km) exceeded its farmgate value. To deregulate this market would involve dismantling an extensive and complex system of patronage and corruption. So, while it may make a lot of sense to take steps to legitimize the woodfuel market, to recognize its critical role in income and employment, and to take measures to support it, the political economy challenges of doing so would be hugely challenging.

How did we get into this corner, where persistent but incomplete woodfuel narratives continue to inform household energy policies? Why are policy makers so unable to act on the elements of a 'better story' which could sustainably reduce woodfuel consumption in a manner which results in better environmental, social or economic outcomes? Part of the problem is surely the nature of policy making itself, to some extent rooted in 'linear' approaches where cause, effect and outcome become linked. The assumption inherent in this approach is that good information which is fed in at one end leads to good decisions at the other, implying that policy making itself is simply a series of technical steps. Adams and Sandbrook (2013), in their critique of evidence-based conservation, point out that most conservation decisions are not made through this type of linear process (whose effectiveness is controlled by the supply of expert information), but are highly political processes in which different actors struggle to influence outcomes.

This view gives rise to a second way of looking at policy making, which is to consider policies as the outcome of multiple and layered processes of negotiation and bargaining over time (Dobuzinkskis 1992). Decision-making may be informed less by clear and explicit policy objectives, and more by the outcome of negotiation and bargaining. Woodfuel policy may explicitly state the desire of a government to reduce consumption and to improve forest management, but multiple and competing interests, reflecting, say, the urban consumers' desire for cheap household energy make this outcome far less likely. The narratives persists, but the options governments have to act on these specific narratives are limited.

Keeley and Scoones (2003) add to this multilayered process the ways which the empowered co-opt knowledge, for example, from research or from project assessments, to mobilize a legitimizing discourse, and in so doing to provide support to 'official' policies. By reducing sometimes highly contingent and complex research results into simple narratives, data takes on a life of its own and becomes authoritative through association with particular organizations. And so narratives persist.

This gloomy conclusion, that there is little to be done, in the face of large and growing demands for woodfuel, rooted in the persistence of narrative and in long term structural characteristics of how subsistence demands and markets operate, is not where we wanted to end up. Nor indeed is it what we would conclude. Rather, the problem arguably would benefit from a broader reframing, which places woodfuel supply and demand considerations into a much wider context, reflecting more comprehensively rights of use and access to forests and trees.

CONCLUSIONS

Woodfuel use has not magically become a thing of the past, its use diminishing with an accelerated pace of economic development. Indeed, it remains a key feature of the domestic energy economy in most developing countries. And while many reassessments of the woodfuel supply/demand dynamic conclude something along the lines of "it's still a problem, but it's not the problem we thought it was," it is not clear that a better understanding of the problem has contributed to developing and implementing practical, viable, or specifically woodfuel-oriented solutions. Challenges to woodfuel orthodoxy through the development of counternarratives have played an important role in driving a research agenda, but the question remains whether or not policy makers are any better enabled by these counternarratives to understand and to tackle the problem of woodfuel. Arguably, they are not.

Is woodfuel a problem for rural producers? Of course it is when physical scarcities (defined by the absence of proximate tree cover) and economic scarcities (defined by the absence of labour, for example, to collect woodfuel, or the cash to buy it) converge. These may also pose contingent environmental and social costs. But in many cases, rural people are able to continue to produce woodfuel to meet local and regional demands, and irrespective of immediate and local environmental and other impacts, markets seem to adapt quickly if supplies become constrained, and producers move elsewhere to accommodate demand.

Is woodfuel a problem for the consumer? No doubt it is, when either income or supplies become constrained, but arguably, it is one of a thousand problems for which multiple and competing solutions need to be devised by highly adept, risk-spreading consumers.

Is woodfuel a problem for governments? If one takes the view that policies are best understood not by what policies say, but on the basis of what governments actually do, then issues of woodfuel supply and demand are seldom a priority. With a few important exceptions, woodfuel policies tend not to address the fundamental structural issues which would better enable them to affect the way woodfuels are produced and consumed.

So whose problem is it anyway?

Fundamentally, the problem needs to be reframed. Woodfuel is only one (albeit important) product from forests and trees. But by focusing myopically on this specific use, woodfuel narratives diminish the much more substantive role of forest and trees in the rural landscape and economy, in terms of ecosystem services, income and employment, and food security. It is good and well to talk about the problems of woodfuel supply and demand, but divorced from the reality of how tenure constructs mediate rights of use and access to forests and trees, this approach seems to miss the point. Indeed, the most significant measures taken to secure woodfuel supplies have had almost nothing to do with narratives or counternarratives about woodfuel *per se*. These include, specifically, tenure reforms and other measures which strengthen the rights to manage forests, trees, and woodlands by the communities and households best placed to do this, irrespective of what these resources are used for.

Woodfuel policies which promote regulatory measures to improve the capacity of the state to manage supplies are more likely to provide significant opportunities for rent seeking, rather than to improve forest cover, and this is especially so in governance constrained economies. Without more broadly addressing systemic governance constraints, these types of regulations are fairly pointless.

Finally, it is certainly the case that legitimizing woodfuel markets and improving income security for woodfuel producers could have important social and economic benefits, again, when these are addressed in the context of more broadly addressing systemic problems of local markets. Still, in the absence of greater clarity over rights of use and access to trees, forests, and woodlands, there is little certainty that these measures will improve the overall availability of woodfuel.

ACKNOWLEDGEMENTS

The author gratefully acknowledges discussions with Klas Sander and Andrew Tartar which stimulated some of the thinking behind this article, feedback from Nalin Kishor and M. Najeeb Khan on an earlier draft, and the views of several anonymous reviewers.

REFERENCES

ADAMS, W.M., and SANDBROOK, C. 2013. Conservation, evidence and policy. *Oryx* **47**(3): 329–335.

ARNOLD, M., KÖHLIN, G., PERSSON, R., and SHEPHERD, G. 2003. *Fuelwood revisited: What has changed in the last decade?* Center for International Forestry Research, Bogor.

ASFAW, A. and DEMISSIE, Y. 2019. Sustainable household energy for Addis Ababa, Ethiopia. *Consilience: The Journal of Sustainable Development* **8**(1): 1–11.

BRADLEY, P.N. 1991. *Woodfuel, women and woodlots. Volume 1: A basis for effective research and development in East Africa*. MacMillan Education Ltd., London.

BROADHEAD, J., BAHDON, J., and WHITEMAN, A. 2003. Woodfuel consumption modelling and results. Annex 2. In: FAO. 2003. *Past trends and future prospects for the utilization of wood for energy.* Global Forest Products Outlook Study Working Paper 5. FAO, Rome.

CASTRO, A.P. 1995. *Facing Kirinyaga: A social history of forest commons in southern Mount Kenya*. Intermediate Technology Publications. London. 152 pp.

CHAMBERS, R. 1983. *Rural development: Putting the last first.* Longman, London.

CHHATRE, A. and AGRAWAL, A. 2008. Forest commons and local enforcement. *Proceedings of the National Academy of Sciences* **105**(36): 13286–13291.

CHIDUMAYO, E.N. and GUMBO, D.J. 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: A synthesis. *Energy for Sustainable Development* **17**(2): 86–94.

DEWEES, P.A. 1989. The woodfuel crisis reconsidered: Observations on the dynamics of abundance and scarcity. *World Development* **17**(8): 1159–1172.

DEWEES, P.A. 1995. Trees and farm boundaries: Farm forestry, land tenure and reform in Kenya. *Africa* **65**(2): 217–235.

DOBUZINSKIS, L. 1992. Modernist and postmodernist metaphors of the policy process: Control and stability vs chaos and reflexive understanding. *Policy Sciences* **25**: 355–380.

DRAPER, S. 1975. *Forestry in rural development*. Rural Development Working Paper 2. World Bank, Agriculture and Rural Development Department, Washington, D.C. October 15.

ECKHOLM, E.P. 1975. *The other energy crisis: Woodfuel*. Worldwatch Institute, Washington, D.C.

FEKERTE, H. 1989. Women fuelwood carriers and the supply of household energy in Addis Ababa. *Canadian Journal of African Studies/Revue Canadienne des Études Africaines* **23**(3): 442–451, DOI: 10.1080/00083968.1989.10804269

FERNANDES, S.D., TRAUTMANN, N.M., STREETS, D.G., RODEN, C.A. and BOND, T.C. 2007. Global biofuel use, 1850–2000. *Global Biogeochemical Cycles* **21**(2): 1–15. GB2019, DOI:10.1029/2006GB002836

HIRSCHMAN, A.O. 1967. *Development projects observed*. Brookings Institution Press, Washington, D.C. Reissued in 1995.

HOBEN, A. 1995. Paradigms and politics: The cultural construction of environmental policy in Ethiopia. *World Development* **23**(6): 1007–1021.

HOSIER, R.H. and DOWD, J. 1987. Household fuel choice in Zimbabwe: An empirical test of the energy ladder hypothesis. *Resources and energy* **9**(4): 347–361.

IMELDA, I. 2019. *Cooking that kills: Cleaner energy, indoor air pollution, and health.* Working Paper 2019-02. Universidad Carlos III de Madrid, Getafe.

KEELEY, J., and SCOONES, I. 2003. *Understanding environmental policy processes: Cases from Africa*. Routledge, London.

KRISTJANSON, P., BAH, T., KURIAKOSE, A., SHAKIROVA, M., SEGURA, G., SIEGMANN, K., and GRANAT, M. 2019. Taking action on gender gaps in forest landscapes. Working Paper. Program on Forests (PROFOR), Washington, D.C. March.

LEACH, G. and MEARNS, R. 1988. *Beyond the woodfuel crisis. People, land and trees in Africa*. Earthscan, London.

MADUBANSI, M. and SHACKLETON, C.M. 2007. Changes in fuelwood use and selection following electrification in the Bushbuckridge lowveld, South Africa. *Journal of environmental management* **83**(4): 416–426.

MEADOWS, D.H., MEADOWS, D.L., RANDERS, J., and BEHRENS III, W.W. 1973. *The Limits to Growth*. Signet, New York.

MOGRABI, P.J., WITKOWSKI, E.T., ERASMUS, B.F., ASNER, G.P., FISHER, J.T., MATHIEU, R. and WESSELS, K.J. 2019. Fuelwood extraction intensity drives compensatory regrowth in African savanna communal lands. *Land Degradation and Development* **30**(2): 190–201.

NORONHA, R. 1981. Why is it so difficult to grow fuelwood? *Unasylva* **33**(131): 4–12.

O'KEEFE, P. and MUNSLOW, B. 1989. Understanding fuelwood: I. A critique of existing interventions in southern Africa. *Natural Resources Forum* **13**(1): 2–10.

OPENSHAW, K. 1974. Wood fuels the developing world. *New Scientist* **61**(883): 271–272. 31 January.

POTEETE, A.R. and RIBOT, J.C. 2011. Repertoires of domination: Decentralization as process in Botswana and Senegal. *World Development* **39**(3): 439–449.

RAI, J. 2019. Why are narratives that place the blame for deforestation on the rural poor so pervasive and so persistent? *Journal of Geography, Environment and Earth Science International* **20**(1): 1–15.

ROCHELEAU, D. 1990. Gender, complementarity and conflict in sustainable forestry development: A multiple user approach. Paper presented to the IUFRO World Congress, 5–11 August 1990, Montreal.

ROCHELEAU, D.E., STEINBERG, P.E., and BENJAMIN, P.A. 1995. Environment, development, crisis, and crusade: Ukambani, Kenya, 1890–1990. *World Development* **23**(6): 1037–1051.

ROE, E.M. 1991. Development narratives, or making the best of blueprint development. *World Development* **19**(4): 287–300.

SCHURE, J., INGRAM, V., SAKHO-JIMBIRA, M.S., LEVANG, P. and WIERSUM, K.F. 2013. Formalisation of charcoal value chains and livelihood outcomes in Central- and West Africa. *Energy for Sustainable Development* **17**(2): 95–105.

SEDANO, F., LISBOA, S.N., DUNCANSON, L., RIBEIRO, N., SITOE, A., SAHAJPAL, R., HURTT, G., and TUCKER, C. 2019. Monitoring forest degradation from charcoal production with historical Landsat imagery. A case study in southern Mozambique. *Environmental Research Letters*. July.

SMITH, H.E., HUDSON, M.D. and SCHRECKENBERG, K. 2017. Livelihood diversification: The role of charcoal production in southern Malawi. *Energy for Sustainable Development* **36**: 22–36.

SOKONA, Y., MULUGETTA, Y. and GUJBA, H. 2012. Widening energy access in Africa: Towards energy transition. *Energy Policy* **47**: 3–10.

SOLA, P., CERUTTI, P.O., ZHOU, W., GAUTIER, D., IIYAMA, M., SCHURE, J. and PETROKOFSKY, G. 2017. The environmental, socioeconomic, and health impacts of woodfuel value chains in Sub-Saharan Africa: A systematic map. *Environmental Evidence* **6**(1): 4.

SYAMPUNGANI, S., GELDENHUYS, C.J. and CHIRWA, P.W. 2016. Regeneration dynamics of miombo woodland in response to different anthropogenic disturbances: forest characterisation for sustainable management. *Agroforestry Systems* **90**(4): 563–576.

TIFFEN, M., MORTIMORE, M., and GICHUKI, F. 1994. *More people, less erosion: Environmental recovery in Kenya*. Wiley, Chichester. 311 pages.

TREDENNICK, A. and HANAN, N. 2015. Effects of tree harvest on the stable-state dynamics of savanna and forest. *The American Naturalist* **185**(5): E153–E165.

VAN DER KROON, B., BROUWER, R. and VAN BEUKERING, P.J. 2013. The energy ladder: Theoretical myth or empirical truth? Results from a meta-analysis. *Renewable and Sustainable Energy Reviews* **20**: 504–513.

WORLD BANK. 2011. *Wood-based biomass energy development for Sub-Saharan Africa: Issues and approaches*. Africa Renewable Energy Access Program. Washington, DC.

ZOMER, R.J., NEUFELDT, H., XU, J., AHRENDS, A., BOSSIO, D., TRABUCCO, A., VAN NOORDWIJK, M. and WANG, M. 2016. Global tree cover and biomass carbon on agricultural land: The contribution of agroforestry to global and national carbon budgets. *Scientific Reports* **6**: 29987.

ZULU, L.C. 2010. The forbidden fuel: Charcoal, urban woodfuel demand and supply dynamics, community forest management and woodfuel policy in Malawi. *Energy Policy* **38**(7): 3717–3730.

The future of planted forests

J.B. CARLE[a], A. DUVAL[b] and S. ASHFORD[c]

[a]*JB Carle and Associates, Mount Maunganui, Bay of Plenty, New Zealand*
[b]*Port Blakely Ltd, NZ Forestry, Tauranga, Bay of Plenty, New Zealand*
[c]*Summit Forests New Zealand Limited, Auckland 1010, New Zealand*

Email: carle.jim@gmail.com, aduval@portblakely.com, and sheridan.ashford@summitforest.co.nz

SUMMARY

Although planted forests have produced forest products for centuries, the past 4-5 decades has seen an increase in diversity of species, areas planted, growth rates, harvest yields, forest products and the acknowledgement of a wide range of ecosystem services. This paper highlights the potential role of planted forests towards the mid-21st Century through changing conditions including climate, indigenous forest resources, land availability, socio economic and environmental conditions, innovative forest and forest industries technologies, market demands for sustainability and legality and new innovations in green growth economies. Lessons learned from the past will assist in determining the issues, opportunities, and challenges facing the future of planted forests.

Keywords: planted, sustainability, circular bioeconomy, wood, ecosystem services

Futur des forêts de plantation

J.B. CARLE, A. DUVAL et S. ASHFORD

Bien que les forêts de plantation aient fourni des produits forestiers depuis des siècles, les 4-5 dernières décennies ont connu une augmentation de la diversité des espèces, des zones plantées, des taux de croissance, des quantités de récolte et des produits forestiers, ainsi qu'une reconnaissance d'un large éventail de services d'écosystèmes. Ce papier souligne le rôle potentiel des forêts de plantation en se projetant vers le milieu du XXième siècle au travers de conditions changeantes incluant le climat, les ressources des forêts indigènes, la disponibilité des terrains, les conditions socio-économiques et environnementales, les technologies forestières et d'industries forestières innovantes, les demandes du marché pour la durabilité et la légalité, et de nouvelles innovations dans les économies de croissance vertes. Les leçons tirées du passé vont aider à déterminer les questions, les opportunités et les défis auxquels fait face le futur des forêts de plantation.

El futuro de los bosques plantados

J.B. CARLE, A. DUVAL y S. ASHFORD

Aunque los bosques plantados han venido proporcionando productos forestales durante siglos, en las últimas cuatro o cinco décadas se ha observado un aumento de la diversidad de especies, de la superficie plantada, de las tasas de crecimiento, de los volúmenes de aprovechamiento, de los productos forestales y del reconocimiento de una amplia gama de servicios ecosistémicos. En este artículo se pone de relieve el papel que pueden desempeñar los bosques plantados hacia mediados del siglo XXI en unas condiciones cambiantes, como el clima, los recursos forestales autóctonos, la disponibilidad de tierras, las condiciones socioeconómicas y ambientales, las tecnologías innovadoras en materia de bosques e industrias forestales, las demandas del mercado en materia de sostenibilidad y legalidad y las innovaciones emergentes de las economías ecológicas de crecimiento verde. Las lecciones aprendidas en el pasado ayudarán a determinar las problemáticas, las oportunidades y los desafíos a los que se enfrenta el futuro de los bosques plantados.

INTRODUCTION

This paper highlights that planted forests and trees were cultivated by different cultures around the globe for millennia but the role of planted forests in sustainable management of forests throughout Europe gathered momentum from the 17th Century and expanded globally during the European colonial era. The early-mid 20th Century saw increasing collaboration between Government agencies and emerging international agencies and the processes demonstrated and guided the policy, legal, regulatory, institutional reforms, the technical and operational actions required for the transitions to reduce dependence on indigenous forest resources and increase the role of planted forests. In the latter half of the 20th Century, as the role of private sector investment in planted forests expanded, social and environmental safeguard challenges emerged that required more participatory and partnership approaches, including emergence of smallholder and out-grower schemes. This paper draws upon the outputs of international planted forests events in guiding trends and likely outcomes as reflected in the results of the Global Thematic Study on Planted Forests (FAO 2005) and the various Global Outlook Studies over the past two decades. The paper highlights key influences, lessons learned and challenges and opportunities that are guiding the increasing role of planted forests in the provision of forest products and ecosystem services in the future.

PAST PLANTED FORESTS CONTEXT

Early plantings

Records show Olive trees (*Olea europaea*) were planted in Greece as early as 3000–4000 BC; tamarisk (*Tamarisk aphylla*) in Israel about 2000 BC; myrrh (*Commiphora myrrha*) in Egypt and frankincense (*Boswellia* spp.) in Southern Arabia about 400 BC. The Chinese grew ornamental and fruit trees as long ago as 2000 BC and a forest service was established to preserve indigenous forests, reforest denuded lands and produce wood from 1100–256 BC (Shon-Ching Lee *et al.* 1948).

Fledgling planted forests in Europe and their colonies

Until the early 19th Century, planting in Europe was primarily reforestation of former forest areas with indigenous species. However, increasingly from that time afforestation of bare land was undertaken with pines (*Pinus pinaster* and *Pinus sylvestris*) and spruce (*Picea abies*) or conversion of broad-leaved forests to conifer. Increasingly, introduced species such as *Picea abies*, *Picea sitchensis*, *Pinus nigra*, *Pinus contorta*, *Pseudotsuga menziesii* and *Larix kaempheri* were planted widely across the UK and Europe. Other introduced species planted widely included *Eucalyptus globulus* in the Mediterranean region and *Pinus radiata* in northern Spain, Australia, Chile, New Zealand and South Africa. Planted forests spread to countries influenced by European colonizers in Asia, Africa and Latin America as a substitute wood resource (Evans 2009).

First half of the 20th Century: Government planting on State land

Government plantings on State land expanded during the first half of the 20th Century in all regions. Examples include: Australia (*Pinus radiata*, *P. elliottii*, *P. pinaster*, *Araucaria cunninghamii*), Brazil (*Eucalyptus* spp.), India (*Tectona grandis* and *Eucalyptus* spp.), New Zealand (*Pinus radiata and other Pinus* spp.), USA (*Pinus elliottii* and *P. taeda*), South Africa (*Pinus patula*, *P. elliottii*, *Acacia mearnsii* and some *Eucalyptus* spp.) and Kenya (*Pinus*, *Cupressus* and *Eucalyptus* spp.).

Increasing internationalism

After the Second World War, the establishment of the Food and Agriculture Organization of the United Nations (FAO) provided funds, development aid and technical support to Governments for planted forest investment demonstrations around the world. The increasing independence of countries and the declining influence of colonial powers altered economic and development policies to meet peoples' aspirations. Planted forest areas increased substantially as part of the development process in many developing countries. At this time, the Centre Technique Forestier Tropical; the Institute of Tropical Forestry; and Centro Agronomico Tropical de Investigacion y Esenanza (CATIE); and many universities and forestry colleges were established and added to the momentum in planted forest investments and increasing knowledge of silviculture, harvesting and utilization of wood from planted forests.

Increasing internationalism with respect to planted forests was led by the Fourth World Forestry Congress in India in 1954 which recommended that an international commission be set up on the use of introduced species for planting in the tropics, under FAO. The Seventh British Commonwealth Forestry Conference hosted in Australia and New Zealand in 1957 requested that a book be published to synthesize the experiences with planting of exotic species in commonwealth countries (Streets 1962). In 1957 a Sub-committee on Planting of Exotic (Eucalyptus and Pinus spp.) was established under the Asia Pacific Forestry Commission of FAO. Notable planted forest publications by FAO in the 1950's included Eucalypts for Planting (1955) and Poplars in Forestry and Land use (1958). In 1962 The Eucalyptus Clearing House (now the Australian Tree Seed Centre at CSIRO) was established in Australia to provide registered seeds and technical information for research and commercial *Eucalyptus* plantation expansion around the world (Palmberg-Lerche 2002).

Planted forests gain traction

FAO, International Union of Forest Research Organizations (IUFRO) and Australia hosted the World Symposium on

Man-made Forests and their Industrial Importance in Canberra in 1967 that resolved to increase use of new technologies, pursue genetic quality and diversity, expand growth and yield research and development, intensify silvicultural management inputs and invest in new wood industries to cater for the expanding role that planted forests would play in the future production of wood, fibre and woodfuel and/or environmental protection around the world (FAO 1967).

Many of the planted forests established in the 1950's and 1960's accelerated in the 1970's, new research and development was undertaken in improved germplasm, nursery practices, silviculture, harvesting, utilization and forest protection. Planting expanded rapidly and planted forests became enabled as priority actions in forest policies and strategies and incentives were given to encourage private sector and smallholder investment in planted forests production and utilization (IFF 1999). During this period plantings in Oceania, Europe and African countries expanded rapidly and China, India and Brazil embarked on ambitious planting programmes. This coincided with an increasing role of agroforestry and expansion in technical support, extension services and seedlings to smallholders and farmers for planting in woodlots, agroforestry plots, home gardens, shelter belts and along roadsides (Evans 2009). The International Council for Research in Agroforestry (ICRAF) was then established in 1978 to promote agroforestry research in developing countries (ICRAF 2020).

Emergence of social, environmental and economic challenges

Although the global planted forest resource expanded rapidly, in some developing countries a lack of Government resources required to undertake silvicultural management on planted forests on primarily State land caused failures or even abandonment, with examples from Africa including Cameroon, Gabon, Liberia and Zaire (Evans 2009). In other instances, where planted forest received little management the untended, unpruned and unthinned crops were retained well beyond their optimal harvest rotation. This was due to a lack of available resources and a lack of knowledge of the end use properties and potential, wood processing facilities and market acceptance of planted forest species. In other instances, the lack of engagement or partnership with local communities and indigenous peoples led to disrespect of the planted forest investments with displaced or disadvantaged peoples using fire as a protest and encroachment or illicit harvest to access land and provide income for poverty reduction and to meet livelihoods needs (Lexterra 2016, Malkamaki *et al*. 2018).

Planted forest investments in Malawi, Zambia, Tanzania, Kenya and Madagascar were sometimes suboptimal due to competition and uncertainty between agricultural and forestry land use exacerbated by the complexities between Government ownership and traditional/customary land ownership and land use; financial analyses inadequately reflected alternative land uses, the uncertainty of enduse wood processing and placing new forest products from planted forests on the market; and the low stumpage rates gave the Government low rates of return (World Bank 1977).

Initial private sector investment in planted forests

From the 1990's Government forest policies and international funding institutions encouraged private sector investment in planted forests in response to the growing world demand for wood, fibre and woodfuel. Private sector industrial planted forest investments also faced social and environmental issues that included conflicts in land tenure and traditional land use and competition with agriculture, displacement of people and in some instances, the wrong species planted by the wrong people, in the wrong places for the wrong reasons. This initially pitted private companies against local communities and their traditional access to natural resources and resulted in a loss of confidence by key stakeholders (Malkamaki *et al*. 2018). Experiences in Indonesia, Thailand, Vietnam and Malaysia in south east Asia have demonstrated that the expansion of planted forests by the private sector needed to incorporate participatory planning to take into account local livelihood practices, traditional resource tenure systems and settlement histories as they influence how communities respond to and participate in planted forest investments (Barney 2004). This approach required a rethinking of the roles and mechanisms of partnerships between the Government, the private sector and smallholders.

There are many different variations to models, but companies can provide smallholders with improved genetic stock seedlings, technical support, materials and access to markets Byron 2001, Carle 2007). The smallholders have the land, labour and generally give a commitment to deliver a planted forest crop to the company on maturity. The Government needs to have a clear and consistent enabling policy and implementation regulation. The companies need to bring investment and proven social and environmental responsibilities, and the willing smallholders need to be prepared to honour partnership agreements. In Africa, the Uganda Sawlog Production scheme successfully supported planting of more than 10,000ha of smallholder plantings; and in the Southern highlands of Tanzania, smallholders own about 139,000 ha of planted forests, the Government 36,000 ha and private companies, 20,000 ha (Jacovelli 2014; Dewees pers.com.).

Accelerated expansion of planted forests in the last half of the 20th Century

From the 1980's planted forest resources expanded rapidly in Chile, India, USA (Prestemon and Abt 2002), China (Zhang and Song 2006), Canada, Brazil and Indonesia (FAO 2010a). With population growth, the increased demand for wood, fibre and woodfuel could not continue to be met from natural forests and the restoration of degraded lands became increasingly important (Evans 2009). During this period there was a focus on intensification of management; improved germplasm and expansion in the application of biotechnology for vegetative propagation of clonal seedlings; more refined site-species matching; tailoring of nutrient applications based

on soil and foliar analyses; increased mechanization of site preparation, tending, and silviculture; increased recognition of the need for effective forest protection to reduce vulnerability to fire, insects, diseases and other pests to maintain and increase planted forest productivity and health in successive rotations; and the emergence of growth and harvest yield modelling based upon long term monitoring of permanent sample plots in planted forests with the purpose of production (IFF 1999).

During this period planted forest development for protective purposes accelerated for the restoration of degraded lands. In China planting of poplars and other species was adopted to combat desertification in the Three North Shelterbelt Programme and regreening of the watersheds, embankments and the flood plains of the Yangtze, Huai and Yellow Rivers in Central China (Carle and Ma 2005). Protective plantings of poplars and willows in the Parana delta were for flood control of Buenos Aires (Kollert, Carle and Rosengren 2014); watershed protection in highly erodible pumice soil landscapes (Rhodes 2001) and coastal sand dune restoration (Berg 2006), both in New Zealand.

TRENDS IN PLANTED FORESTS

Scope and concept

It was recognized by the expert consultative group guiding the Global Forest Resources Assessment 2005 on behalf of countries that the plantation forest definition from former assessments was inadequate in accounting for the planting of indigenous species in seminatural forests prevalent in European countries and Canada. FAO coordinated the dialogue that agreed on the planted forests scope, concept and definition as reflected in Figure 1 which has been used as the basis for the Global Planted Forests Thematic Study, 2005 and subsequent Global Forest Resources Assessments (FAO 2006a, 2008, 2010a and 2015).

According to the Global Planted Forests Thematic Study associated with the Global Forest Resources Assessment 2005, about half of seminatural forests were regenerated by assisted natural regeneration and half by planting of indigenous or native species. About 76 percent of the global planted forests area was for productive purposes and 24 percent for protective purposes (FAO 2006a). The ratio of productive/protective purposes by area percentage varied considerably between regions as displayed in Figure 2, with North, Central and South America and Oceania in the range 96/4; Africa and Europe, 80/20; and Asia, 65/35 with a strong influence of China combating desertification, flooding and flood plain restoration (FAO 2006a).

Planted forest area 1990–2015

Planted forest trend data from the FAO coordinated Global Forest Resources Assessment 2015 included past data for each reporting country by region for 1990, 2000, 2005, 2010 and 2015. These are summarized in Table 1 and displayed in Figure 3 giving regional and global totals.

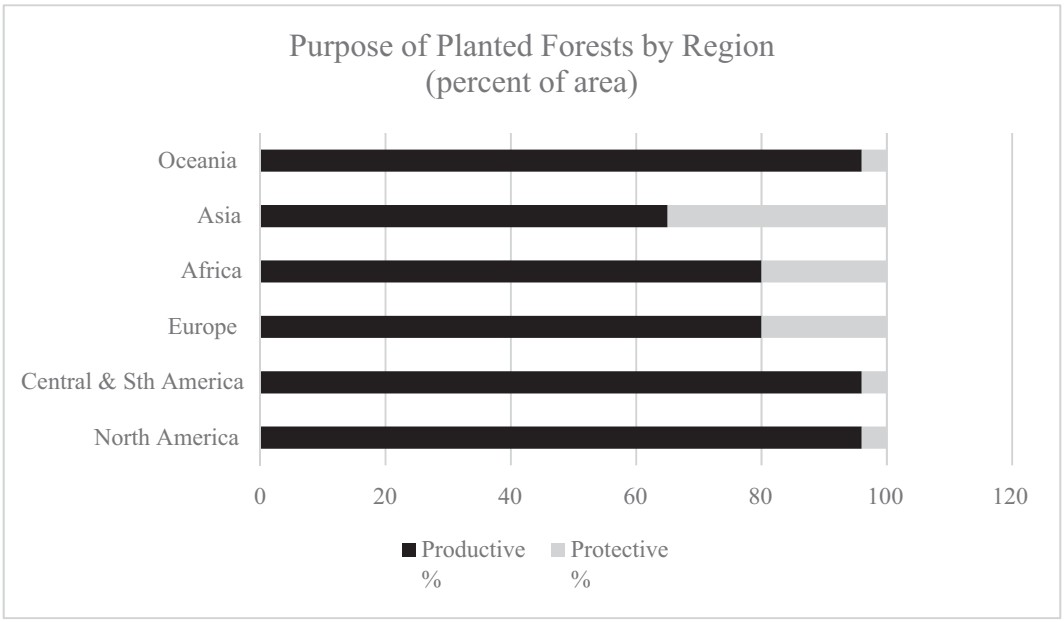
According to Global Forest Resources Assessment country reporting, from 1990–2015 the planted forest area, in millions of hectares, increased modestly in Africa (1.6 percent per year) and Europe (1.8 percent per year) which showed some signs of slowing in the latest 2015 reports. In comparison, the planted forest area increased more strongly in Oceania (3.4 percent per year), Central and South America and the Caribbean (3.4 percent per year), North America (3.5 percent per year) and Asia (3.1 percent per year). The global planted forest area from 1990–2015 expanded from 176.1 million hectares to 293.4 million hectares (2.7 percent per year); from 1990–2000 expanded at 2.4 percent per year; from 2000–2010 expanded at 2.7 percent per year and from 2010–2015 expanded at 1.2 percent per year (FAO 2010a, 2015). Changes in definitions and country interpretations and reporting make it difficult to compare data and draw conclusions on

FIGURE 1 *Scope and concept of planted forests*

Continuum of Forest Characteristics						**Non-forest**
Primary forest	**Modified natural forest**	**Semi-natural forest**		**Plantation forest**		**Trees outside forests**
		Assisted natural regeneration	**Planted**	**Productive**	**Protective**	
Forest of native species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed	Forest of naturally regenerated native species where there are clearly visible indications of human activities	Silvicultural practices for intensive management (weeding, fertilizing, thinning, selective logging)	Forest of native species, established through planting, seeding or coppice of planted trees	Forest of introduced species and in some cases native species, established through planting or seeding mainly for production of wood or non-wood goods	Forest of native or introduced species, established through planting or seeding mainly for provision of services	Stands smaller than 0.5 ha; trees in agricultural land (agroforestry home gardens, orchards); trees in urban environs and scattered along roads and in landscapes
			← **PLANTED FORESTS** →			

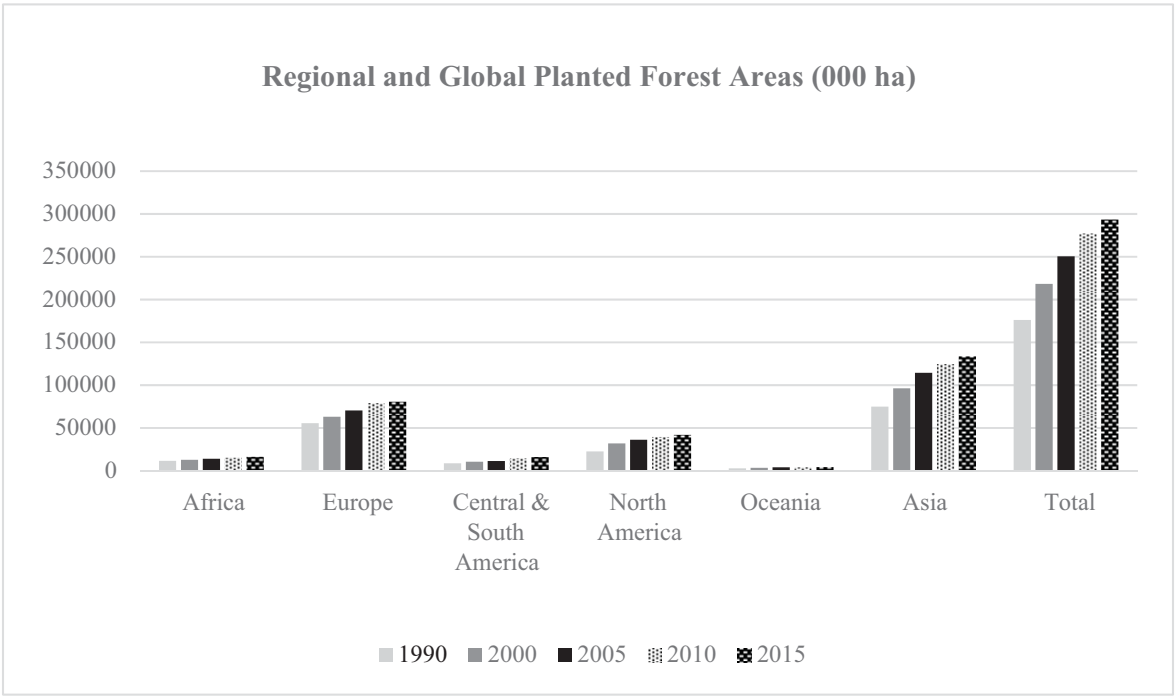
Source: FAO, 2005

FIGURE 2 *Purpose of planted forests by region*



Source: Planted Forest Thematic Study, FAO, 2006a

FIGURE 3 *Comparative distribution of regional and global planted forest area*



Source: Extrapolated from Global Forest Resources Assessment 2015 (FAO 2015)

rates of planted forest expansion. Of concern was an apparent drop in the rate of new planted forests in the period 2010–2015 to 1.2 percent per year. It has been estimated that the rate of increase of 2.4 percent per year was needed to meet future global demand and supply of wood and fibre and thus offset deforestation impacts on wood supply (Payn *et al*. 2015).

The top planted forest resources reported in 2015 in order by area (millions hectares) in each region by selected key countries included: Sudan (6.1), South Africa (1.8), Ethiopia (1.0) in the African Region; Russian Federation (19.8), Sweden (13.7), Poland (9.0), Finland (6.8) and Germany (5.3) in the European Region; Brazil (7.7), Chile (3.0), Argentina (1.2), Peru (1.2) and Uruguay (1.1) in the Central, South American and Caribbean Region; USA (26.4) and Canada (15.8) in the North American Region; New Zealand (2.1) and Australia (2.0) in the Oceania Region; and China (79.0), India (12.0), Japan (10.3), Indonesia (5.0), Ukraine (5.0) in the Asian Region (FAO 2010a, 2015).

TABLE 1 *Regional and global planted forest area*

Year	Regional and Global Planted Forest Areas (000 ha)						
	Africa	Europe	Central & South America	North America	Oceania	Asia	Global Total
1990	11705	55445	8818	22516	2741	74868	176093
2000	12796	63186	10503	31905	3460	96380	218230
2005	13929	70513	11521	36135	3988	114365	250451
2010	15355	78987	14506	39539	4225	124559	277171
2015	16329	80709	16195	42148	4357	133669	293407

Source: Extrapolated from Global Forest Resources Assessment 2015 (FAO 2015)

Planted forest species

There was a predominance of indigenous or native species plantings for production and protection forests in northern hemisphere countries whilst there is a predominance to plant introduced or exotic species for production plantings in southern hemisphere countries. Selected countries in the northern hemisphere that have significant planting of both indigenous and introduced species include Morocco, Senegal and Tunisia in the African Region; Albania, Denmark, France, Ireland, Portugal and Spain in the European Region; China, India, Iran and the Republic of Korea in the Asian Region. In comparison, in the southern hemisphere, Australia is the only country that planted about half in indigenous species and half in introduced species (FAO 2015). Figure 4 displays the percentage of introduced species by area in planted forests by region.

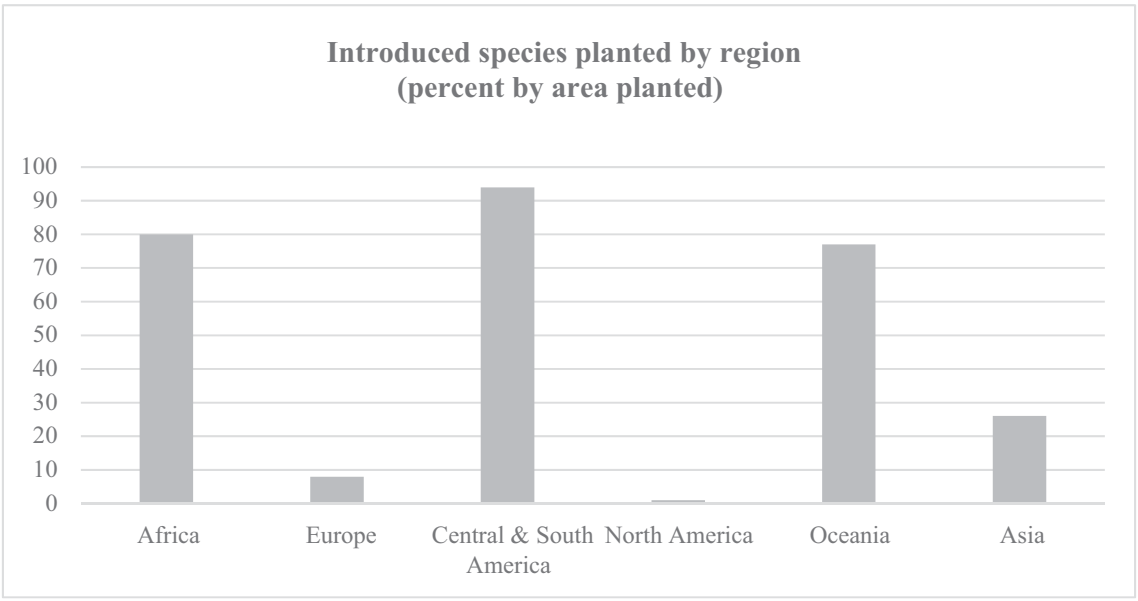
In the global assessment of planted forests, although not a comprehensive list, the main species reported by countries are detailed in Table 2 (FAO 2006a):

Ownership of planted forests

Between 1990 and 2005 public ownership of planted forests for productive purposes went from 70 percent in 1990 to 54 percent in 2000 and 50 percent by 2005. The private corporate ownership increased marginally from 17 percent in 1990, to 19 percent in 2000 and 2005. However, smallholder private ownership of planted forests increased from 12 percent in 1990, to 27 percent in 2000 and 32 percent by 2005. Although some variation was shown by different regions the overall trends were consistent (FAO 2006a).

In 1990 the public sector owned 82 percent of planted forests grown for protective purposes, but this proportion reduced to 73 percent by 2005. In 1990 the private corporate ownership was 8 percent and in 2005, 7 percent. However, the private smallholder ownership increased from 9 percent in 1990 to 20 percent in 2005 (FAO 2006a).

FIGURE 4 *Planted forests: introduced species planted by region*



Source: Extrapolated from Global Forest Resources Assessment 2015 (FAO 2015)

TABLE 2 *Main planted forests species planted by region*

Region	Main Species
Africa	*Acacia mellifera, A. nilotica, A. senegal, A. seyal, Eucalyptus grandis, E. nitens, Eucalyptus* spp., *Pinus elliottii, P. halepensis, P. patula, P. radiata*
Europe	*Betula pendula, Fagus sylvatica, Larix decidua, Picea abies, Picea sitchensis, P. nigra, Pinus pinaster, P. sylvestris, Populus* spp., *Pseudotsuga menziesii, Quercus robur, Robinia pseudoacacia*
Central and South America and Caribbean	*Eucalyptus* hybrids, *P. elliottii, Pinus radiata, Pinus taeda, Prosopis tamarugo* and *P. chilensis*
Oceania	*Eucalyptus globulus*, *Hevea brasilensis, Pinus radiata, Pinus* spp., *Swietenia* spp.
North America	*P. elliottii, Pinus taeda, Populus tremuloides*
Asia	*Acacia* spp., *Casuarina* spp., *Chamaecyparis obtusa, Cryptomeria japonica, Cunninghamia lanceolata, Eucalyptus* spp., *Hevea brasilensis, Larix kaempheri, Pinus massoniana, Pinus* spp., *Populus* spp., *Tectona grandis*

Source: Global planted forests thematic study: Results and analysis (FAO 2006a)

Governance of planted forests

Although there have been challenges with laws, regulations and policies relating to planted forests and trees in developing countries, inadequate implementation and monitoring of compliance was often an even greater challenge. Weak governance and political and economic instability resulted in high transaction costs that affected risk factors and the confidence to invest in planted forests (Barua *et al*. 2014).

A major study coordinated by FAO in 2003 evaluated the direct and indirect incentives and policy instruments that encouraged investments in planted forests in Australia, China, India, Indonesia, Malaysia, New Zealand, the Philippines, Thailand and USA. Although comparisons between countries were broad due to the contextual differences there was a general evolution in the types of incentives offered at different planted forest development stages. In all case study countries, the Government owned planted forests on State land at the outset to demonstrate planted forest silvicultural techniques and to achieve a critical mass to demonstrate the production and utilization of planted forest wood that stimulated private sector and smallholder interest to invest. Enabling the private sector (both corporate and smallholder) resulted in a gradual policy progression from providing free physical inputs; to grants and loans; to tax incentives; to joint venture arrangements; and finally, to creating an enabling policy, legal and regulatory environment and removing structural disincentives (Enters *et al*. 2004). Table 3 synthesizes case study country incentive reports.

TABLE 3 *Progression of policy incentives in planted forest case study countries*

Country	State planting	Cheap seedlings	Land grants	Nursery subsidies	Survival incentives	Grants to growers	Concessionary loans	Tax concessions	Joint ventures	Research + extension	Resource security	Enabling incentives
Australia	✓						✓	✓	✓	✓	✓	High
China	✓	✓				✓	✓			✓	✓	Medium
India	✓	✓	✓	✓	✓	✓	✓		✓	✓		Low
Indonesia	✓					✓	✓	✓		✓		Low
Malaysia	✓							✓		✓		Medium
NZ	✓	✓	✓			✓	✓	✓	✓	✓	✓	High
Philippines	✓		✓					✓				Low
Thailand	✓	✓				✓	✓			✓		Low
USA	✓	✓	✓			✓	✓	✓	✓	✓	✓	High

Source: Enters *et al*. 2004

Enabling national policies for planted forest development have occurred in South America (Brazil, Chile and Uruguay); Asia-Pacific (Australia, China, Malaysia, New Zealand and Vietnam) and Europe (United Kingdom, Spain and Portugal), there has been less use of incentives and enabling policies in governance of planted forests in the African region other than South Africa and Uganda (Forest Stewardship Council [FSC] *et al*. 2012).

The enabling incentives have included legal, policy, regulatory and institutional frames that encouraged investment and which have had cohesive and clear land, land use and crop ownership rights; responsible social and environmental safeguards; free and transparent access to markets to increase forest products values; transfer of research knowledge and technology through technical support and extension services to sustain productivity and sustainability; recognize the role that planted forests can play in mitigating the effects of climate change and disaster risk reduction; reduce biotic, abiotic and market risks; providing access to funds and fair markets; and building trust between partners and committing to transparent and equitable agreements were fundamental to the success of planted forests investments, particularly smallholder planted forests (Barney 2008, Nguyen 2011, Midgley *et al*. 2017, INDUFOR 2017, Nambiar *et al*. 2014, Nambiar 2019).

Government investment in planted forests

In the past Government investment in planted forests was to demonstrate to the private sector and smallholders how to grow a valuable forest resource for the wood industries sector to provide a range of products to consumers whilst substituting for the exploitation of indigenous forest resources. As Governments generally had insufficient resources to establish and manage planted forests, they often borrowed from development banks to do so. Lessons learned from past challenges showed that without enabling policy, legal and regulatory frames and sound technical and extension capacity, identified markets and financial and human resources to support these investments, then the results were socially, environmentally and economically suboptimal. The global reduction in government ownership of planted forests has occurred due to devolution of forest management to the private sector, forest communities and smallholder investors; the disappointing performance of Government owned planted forests; and the budget and human resource constraints. As a result, Governments have generally been increasingly focused on providing the enabling policy, legal and regulatory instruments and supporting institutional arrangements to encourage investment by alternative investors (Enters *et al*. 2004). The proportion of Government ownership of planted forests is likely to continue to decline in the future as investments by the private sector (corporate and smallholder) increase.

International investment in planted forests

An analysis of 40 plantation forest investments around the globe had international rates of return in excess of 5 percent without land costs. In about half the cases profits were made by buying land and growing wood from planted forest at an 8 percent discount rate. In industrialized, temperate countries planted forest investments yielded lower rates of return but were competitive with other land uses and stock market returns. In developing countries and countries in economic transition with higher levels of political and investment risk, more difficulty in doing business and more environmental regulation and transaction costs could yield the highest rates of return but investments were less predictable or assured than in industrialized countries (Cubbage *et al*. 2014). As Brazil and China have substantial domestic demand and market diversification so they have less dependence on export markets. New private sector, international investment fund opportunities are being sought in Brazil, Colombia, Ecuador, Uruguay and countries in Southeast Asia and Africa where land prices and cheaper labour can make potential returns on investment higher, as can the risks (Cubbage *et al*. 2014).

Finding the balance between investment returns and risks, difficulty of doing business, maturity and diversity of markets and the political and enabling stability will continue to challenge and reward forest investors and managers through the 21st Century (Cubbage *et al*. 2014). Although the level of international corporate investment in planted forests has increased significantly in recent decades the proportion (percentage by area) has remained similar at 17–19 percent (FAO 2006a). If Governments put in place enabling conditions for investment and particularly planted forest investment, the proportion of corporate private sector investment is likely to increase particularly in Asia and Central and South America.

Smallholder investment in planted forests

Smallholder investment in planted forests and trees already make a substantial contribution to national forest assets, wood production, exports, national incomes and in meeting sustainable land use and livelihoods of rural people. The contribution that smallholder investors make to economic development is grossly underestimated as the scattered, small holdings are difficult to survey accurately and harvesting does not always follow conventional silviculture, but rather meets livelihoods needs. Finland, Sweden, China, India, Indonesia, Vietnam, Malaysia, Thailand, Lao PDR, the Philippines, Brazil, Chile, Uruguay, Costa Rica, New Zealand, USA, Uganda, Mozambique, Rwanda, Swaziland, Tanzania, Zambia, South Africa, Ethiopia have, or are developing more robust smallholder investments in planted forests. Smallholder investment in planted forests has often been in response to successful incentive schemes to develop a critical mass of forest resources to establish forest-based industries, catalyse socioeconomic development, reduce poverty in rural areas, reduce pressure on natural forest resources and strengthen land tenure (FAO 2006a).

The recent expansion in smallholder investment in planted forests (both productive and protective purposes) and the promising future for continued expansion requires collaboration between the partners that include smallholders and their governments, financiers, industries and research and extension organizations. It is the authors' view that the proportion of smallholder planted forests and trees is likely to

continue to expand due to the availability of land, the potential returns of planted forests to supplement other smallholder income in rural areas and the contributions that planted forests make towards improving water quality and hillside erosion protection.

FUTURE ROLE OF PLANTED FORESTS

Guidance from international processes

International congresses in Chile (IFF 1999), New Zealand (UNFF 2003), Portugal (FAO *et al*. 2013) and China (FAO *et al*. 2018) brought specialists together to discuss topical issues and to provide guiding principles and strategic implementation practices to planted forest stakeholders on enhancing the future role of planted forests in sustainable forest management, green economies and restoration of landscapes.

Various guidelines for responsible management of planted forests were prepared through multi stakeholder processes and associated capacity building by international agencies (FAO, ITTO, CIFOR) and at the country level by both the public and private sectors to enhance the role of planted forests in the social, cultural, environmental and economic dimensions of landscape management and sustainable livelihoods and land use (FAO 2006b, CIFOR 2005, ITTO 1993). The guidelines were transposed into country and company specific policy, legal, planning and implementation contexts.

The role of planted forests in industrial roundwood production

During the past two decades, several global outlook studies have compared the future role of planted forest resources in industrial roundwood production (ABARE-Jaakko Poyry 1999)[1]; Brown 2000)[2]; (Carle and Holmgren 2008)[3]; (Penna 2010)[4]; FSC and INDUFOR 2012)[5]; FAO 2014)[6].

Outlook studies are used by policy and decision makers, investors, managers and planners to better understand the role that planted forest resources can play in the production, utilization and trade of forest products. As the 1999, 2000, 2008 and 2012 outlook studies were based on different definitions, datasets, growth and yield models, assumptions and modest, moderate and optimistic scenario analyses the results are not directly comparable, however, they can provide trends and indicative ranges of results. The estimated global industrial roundwood production in 2012 from plantation forests was estimated conservatively at 562 million m^3 or 33 percent and the planted component of seminatural forests at 208 million m^3 of the 1.7 billion m^3 global industrial roundwood production from all types of forests. The total global production of industrial roundwood from planted forests (plantation forests + planted component of seminatural forests) was estimated at 770 million m^3 or almost half (46 percent) of the 1.7 billion m^3 of industrial roundwood production from all types of forests in 2012 (FAO 2014).

The results for the modest, moderate and optimistic scenarios of the above outlook studies for plantation forests (according to the forest plantation definition prior to 2005) are given in Figure 5 and for planted forests (according to the new definition 2005) in Figure 6.

Based upon the Global Forest Resources Assessment (GFRA) 1990 data updated to 1995 and the definitions of the time, the ABARE outlook estimate of 116 million hectares of productive plantation forests in 2000 the industrial roundwood production was forecast at 624 million m^3 or 35 percent of global industrial roundwood production in 2000; 969 million m^3 or 44 percent in 2020 and 1,043 million m^3 or 46 percent in 2040 (ABARE and Jaakko Poyry 1999).

Also based upon the GFRA 1990 and definitions of the time, the FAO/Brown outlook estimated 124 million hectares of productive plantation forests would yield 22 percent of global industrial roundwood production in 1995, up to 34 percent in 2010, up to 46 percent in 2020 and up to 64 percent in 2050 (Brown 2000).

The Penna outlook study based upon the global planted forests thematic study data (FAO 2006a) and Carle and Holmgren study 2008 forecast that plantation forests could yield 736 million m^3 of industrial roundwood or 41 percent of global industrial roundwood in 2005 and up to 1,401 million m^3 or 77 percent in 2030 (Penna 2010).

The FSC outlook forecast, based upon the INDUFOR fast growing plantation forest datasets, estimated 520 million m^3 of industrial roundwood from their dataset of industrial plantation forests or 31 percent of global industrial roundwood production in 2012 and up to 2.0 million m^3 by 2050 (FSC and INDUFOR 2012).

The Carle and Holmgren outlook forecast, based upon the global planted forests thematic study data, estimated a global area of 271 million hectares of planted forests consisting 128 million hectares of plantation forest and 133 million hectares of planted component of seminatural forests. The industrial roundwood production potential from planted forests was 1,220 million m^3 or 66 percent of global industrial roundwood production in 2005 and up to 1.9 million m^3 in 2030 (Carle and Holmgren 2008 and Penna 2010).

---

[1] Global outlook for plantations (ABARE-Jaakko Poyry 1999) http://www.fao.org/forestry/42688-0a52e579757b86dd833ee20ba6e567078.pdf

[2] Global outlook for future wood supply from forest plantations (Brown 2000) http://www.fao.org/3/X8423E/X8423E00.htm

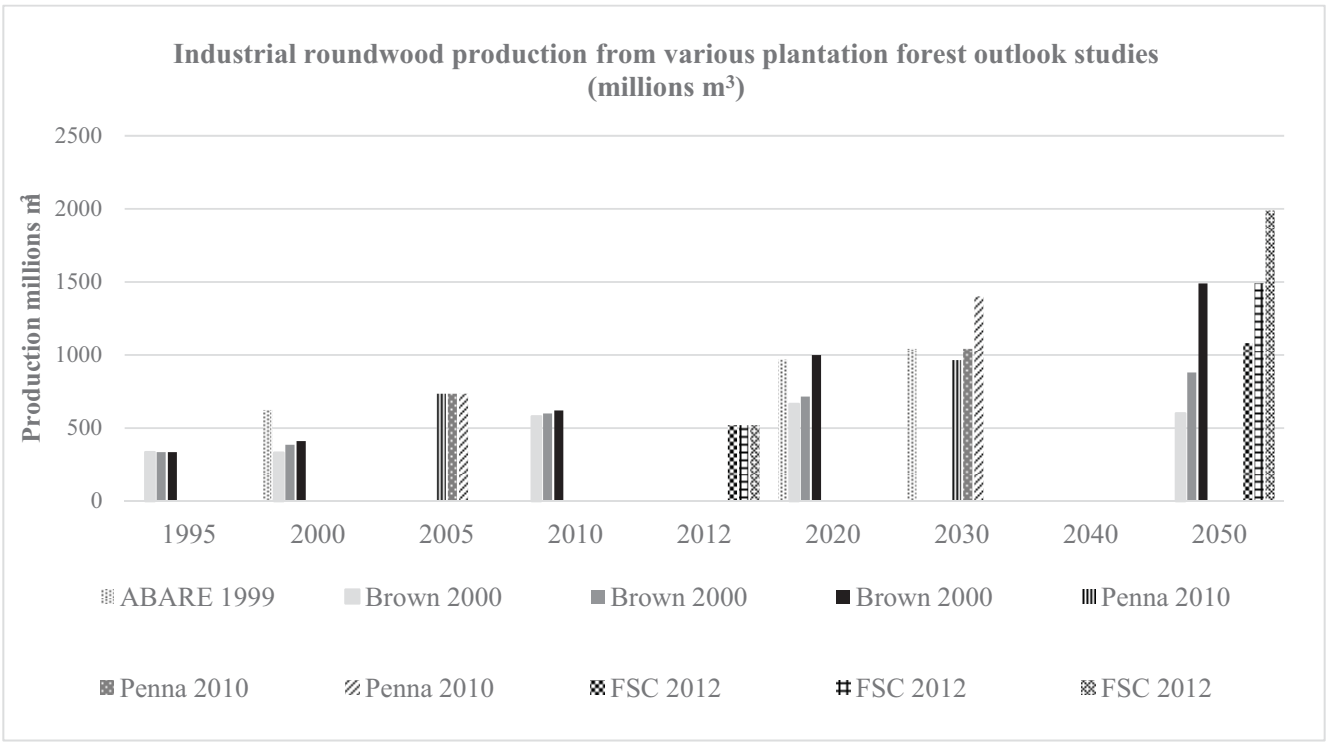
[3] Wood from planted forests: A global outlook 2005–2030 (Carle and Holmgren, 2008) http://www.fao.org/forestry/24492-0d26e5849f963ec2846872435fe0777c2.pdf

[4] Understanding FAO's wood supply from planted forests projections (Penna 2010): http://www.fao.org/forestry/42642-0aad8396ff459da7a9accf941e567ebb5.pdf

[5] Strategic review on the future of forest plantations (FSC and INDUFOR 2012): http://www.fao.org/forestry/42701-090e8a9fd4969cb334b2ae7957d7b1505.pdf

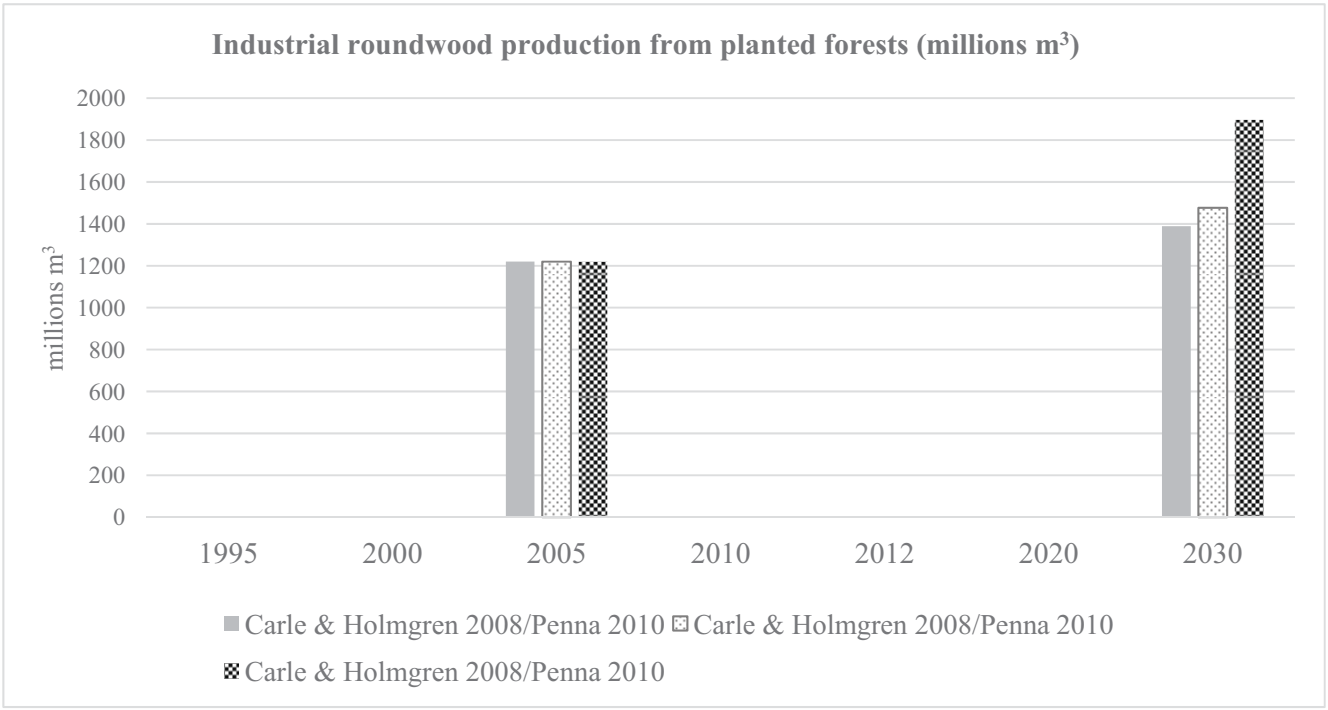
[6] Assessment of industrial roundwood production from planted forests (FAO 2014): http://www.fao.org/3/a-i3384e.pdf

FIGURE 5 *Comparison of Industrial roundwood production from various plantation forest outlook studies (plantation definition prior to 2005)*



Source: Author compilation from outlook studies

FIGURE 6 *Industrial roundwood production from planted forests*



Source: Author compilation from outlook studies with planted forests definition 2005+

The outlook studies conclude that despite the variation in results planted forests will continue to have an increasing role in the production of industrial roundwood globally towards the mid-21st Century. These highlight the importance of planted forests as the planted forest resources continue to expand whilst indigenous forest resources decrease due to deforestation or forest degradation on the one hand, or being designated for protection or conservation management purposes on the other.

KEY INFLUENCES ON THE FUTURE ROLE OF PLANTED FORESTS

Mitigating the effects of Climate Change

Expanding new planted forests to sequester and store carbon is an effective and economic way to rapidly reduce carbon dioxide from the atmosphere. Planted forests can provide multiple benefits as a reliable, renewable and climate-positive source of wood, fibre and fuel and ecosystem services, including reduction in greenhouse gas emissions and support the transition to a sustainable green, circular, bioeconomy. Forest restoration and reforestation remain the most effective strategies to mitigate the effects of climate change. It is estimated that there is potential for an additional 0.9 billion hectares of forest canopy cover globally that could store an estimated 205 giga tonnes of carbon (Bastin *et al*. 2019).

It has been estimated that natural climate solutions such as improved conservation, restoration, reforestation and expanded afforestation and improved land management can provide over a third of the cost-effective climate mitigation solutions needed by 2030. About a half of the land available globally for afforestation and reforestation is on the African continent where planted forests can potentially create positive social, environmental and economic benefits, however, this investment has yet to materialize, despite the Bonn Challenge[7] and the AFR100[8] target to restore 100 million hectares of deforested and degraded land across the continent by 2030. Responsibly managed planted forests integrated into the landscape provide opportunities to increase the supply of renewable raw materials, restore degraded ecosystems to build resilience and create value for people living nearby (Jeffries *et al*. 2018).

The global meeting hosted at FAO in 2017 on "Sustainable Wood for a Sustainable World[9]" concluded that sustainable wood chains were relevant for all 17 of the Sustainable Development Goals[10], especially for decent work and economic growth, SDG8; responsible consumption and production, SDG12; climate action, SDG13; and life on land, SDG15 (FAO 2017).

New technology

Countries in Europe, North America, Central and South America and Oceania have been leaders in the science and technology of plant breeding, gene mapping, genetic improvement, site-species matching, near to nature plantings, advanced silviculture and harvesting, maintaining sustainable productivity and the adaptation to climate change. It is the authors' view that the use of computers, particularly hand held computers, custom made software, unmanned aerial vehicles (drones), driverless vehicles, and satellite based systems are revolutionizing forest planning, management, monitoring, e-mapping, GIS database management and information systems, innovative new harvesting and transport systems, supply chain management, forest risk management and marketing, robotics and driverless harvesting and transport systems.

New green, circular bioeconomy technologies applied in planted forests will spread to all regions around the world. As a result, reforestation and new plantings will generally not only sustain current levels of productivity but likely, through improved management, increase growth and harvest yields and shorten rotation lengths so that wood, fibre and fuel will be produced more efficiently, despite the impacts of climate change and the associated impacts of insects, diseases, pests, fire and other biotic and abiotic agents (Payn *et al*. 2015).

Innovations in the use of wood

There is a renaissance in the use of wood in recognition that it is a renewable, environmentally neutral (if responsibly managed), resilient construction material that can be used for creative architecture and building purposes by adopting new wood technologies that open new opportunities for innovative designs and construction methods. With a growing global population and demand for wood products, the need for process innovations to minimize waste, minimize production costs and maximize yield will continue into the future. Societal demand for more natural, sustainable and renewable products is driving innovation in the 21st Century wood products industry (World Bank 2019).

New wood products and initiatives are promoting the use of wood as an alternative to concrete, steel, aluminium, plastic and other building materials with a much bigger carbon footprint (World Bank 2019). Architect, Alex de Rijke, director of London-based firm dRMM, recently noted that that *"the 17th century was the age of stone; 18th century was the peak of brick; the 19th century the era of iron; the 20th century the century of concrete and the 21st century will be the time for wood"*[11]. Increasingly a higher proportion of wood will be from sustainably managed and legally sourced

---

[7] http://www.bonnchallenge.org/content/challenge
[8] https://afr100.org/content/about-us
[9] http://www.fao.org/forestry/46700-0a274f69ab292a75be6ef89e8c4aa7566.pdf
[10] https://www.un.org/sustainabledevelopment/sustainable-development-goals/
[11] Alex de Rijke, director of London-based firm dRMM, November 2015: See: https://www.dezeen.com/2015/11/09/cross-laminated-timber-construction-architecture-timber-age/

planted forest resources as verified by FSC, Programme for the Endorsement of Forest Certification (PEFC) or other reputable, third party forest management and chain of custody certification or through Forest Law Enforcement Governance and Trade (FLEGT) approved voluntary partnership agreements with timber legality assurance systems for entry into European countries (World Bank 2019).

We are familiar with the traditional forest products like timber, structural panels, newsprint, pulp, paper and packaging. By breaking wood down to central components of cellulose, hemi-cellulose and lignin a whole range of new products are possible. Bath towels and disinfecting wipes produced from rayon are mainly cellulose; toothpaste and make up from carboxymethyl cellulose and xylitol; nail polish, leather finishes, ping pong balls, wood varnishes and printing inks are from nitrocellulose; many medications contain the wood component microcrystalline cellulose; many paints contain hyrdroxyethyl cellulose a gelling and thickening agent; LCD electronic screens contain wood component cellulose triacetate which acts as a polarizing film; wood based polyethylene terephthalate is used for soft drink bottles. Wood fibre has the potential to play a major role in providing lignin-based substrate for 3D printers as an affordable and renewable by-product of pulp mills. Liquid wood, an alternative to plastic is a thermoplastic material made from lignin as a by-product of pulping. Bioactive compounds from wood can be used for antibiotics, antioxidants and pesticides. Bio-oil can be produced from fast pyrolysis for industrial heating. Nanomaterials are being used in the textile industry to waterproof and make tear-resistant fabrics; when added to concrete to add tensile strength and in air filters and solar cells. Wood modification without chemicals through application of heat can alter the chemistry of wood to make it more durable and stable so that it can be used for decking, doors, windows, spas, saunas, fencing, outdoor furniture etc. Cross-laminated timber (CLT) gives strength in green building whilst exciting architects for innovative designs and multi-story wood construction which store carbon long-term. Stora Enso calculated that CLT panels can store 730kg of carbon per cubic metre (Jeffries 2018).

All these innovations in wood products and a growing movement towards a green, circular bioeconomy, lead to the fact that the demand for wood-based products is going to increase and therefore the proportion from planted forests will increase to grow more wood, fibre and fuel faster.

Competition for land

Planted forests are less than 2 percent of land use globally but vary considerably from country to country around the globe. It is anticipated that planted forests land use could double by 2050. Although they will produce the majority of global wood supply, they will generally not be the main form of land use in rural landscapes. Because of population, livestock and grain growth, increased food and associated agricultural demand and the evolving expansion in demand for bioenergy, planted forests compete for access to suitable land that will put pressure on land prices. As a result planted forests will increasingly be established in lands marginal for agricultural purposes that will require improved germplasm, management systems and technologies that will result in higher sustainable productivities to address social, environmental and economic challenges (FSC *et al*. 2015, Payn 2015).

As an alternative to establishing new planted forests in agricultural lands, in some instances, improved investment and management can improve the productivities and efficiencies of existing planted forests. A study of twenty-two plantation projects in ten African countries compared capital investments and performance between greenfield plantations established in bare land; brownfield plantations acquired and rehabilitated to improve their productivity; and smallholder plantations, often community based. Greenfield plantations were found to be expensive to develop and commercial financing was difficult to secure. Brownfield plantations, often owned by governments, showed the potential to increase wood supply through improved management to increase productivity through privatization reform that attracted responsible investors to purchase and manage these plantation forests more efficiently. Smallholder plantations were established cost effectively with diversified species and age classes resulting in positive development and climate impacts, particularly if linked to larger commercial plantations and wood processing industries (Criterion and INDUFOR 2017).

Environmental issues

In instances of good governance, the appropriate interlinked environmental and social policies, laws, regulations and guidelines were implemented and monitoring of compliance was undertaken. However, when weak governance exists, the reverse generally occurs. With appropriate planning and management, planted forests can be managed for resilience to climate change by diversifying the mosaic of land uses on the landscape, diversifying species, doing better site and species matching, undertaking regular forest protection and staggering harvesting coupes to fragment cutovers exposure. Planted forests also mitigate climate change by carbon sequestration, carbon sinks (above and below ground) and storage of carbon in wood products (World Bank 2019).

There is likely to be an increased risk of extreme weather events (winds, floods, droughts, extreme temperatures etc.) and associated vulnerability to insects, pests, diseases, wildfires and invasive plant species so the use of new technologies for monitoring, early warning, prevention, preparedness, emergency response and restoration following such events will be critically important to minimize impacts (Dell *et al*. 2012). Minimizing monocultures and narrow genetic base of planted forests (single or a few clones) can reduce vulnerability to biotic and abiotic risk factors. In habitats that experience seasonal drought, there are concerns that planted forests exacerbate water shortages that impact local communities as reported in South Africa and Ethiopia. Conversion of indigenous forests to establish planted forests is not an environmentally or socially responsible option and should be avoided. Responsible management of planted forests can minimize any negative environmental impacts and in some

instances of landscape restoration, can enhance the environmental impacts (FAO 2006b, Payn *et al*. 2015). Planted forests can contribute positively to forest conservation and reduce forest degradation of indigenous forests, however, good governance is necessary to minimize the risk of displacement effects and associated deforestation to maintain livelihoods in poor communities (Pirard *et al*. 2016).

Social issues

Population pressure for food security, poverty reduction and sustainable livelihoods, particularly in Africa and Asia, resulted in greater competition for land, that impacted access to land for planted forests. The lack of clarity between the statutory and customary (traditional) land use rights generally resulted in social tensions between planted forest investors and owners and the local communities, unless participatory and transparent processes were adopted. This has been common in Asia, the Pacific, Africa and South America where indigenous peoples have depended upon their customary rights for access to resources for their livelihoods that have overlapped with company agreements with statutory rights granted by the government. As a result, companies needed to resolve conflicts with local communities before planted forests could proceed successfully (Barney 2004, Lexterra 2016, Malkamaki *et al*. 2018).

It is the authors' view that failings of planted forests in the past have resulted in negative public biases against planted forests as a legitimate land use, so there is a need for planted forest investors to be more participatory, transparent and communicative with not only the key stakeholders, but also the general public.

Between 1990–2015 Europe had minimal population growth and a 37 percent increase in planted forest area; Central America had a 45 percent increase in population with a 17 percent increase in planted forest area; whilst Southern and Southeast Asia had large increases in both population and planted forests so land and future wood supply pressure is likely to be more intense (Payn *et al*. 2014). This trend is likely to continue particularly in countries with green growth economic policies in which society is increasingly demanding more wood, fibre, fuel and non-wood forest products and ecosystem services from responsibly managed, high productivity and sustainably managed planted forests.

Expansion of the global planted forest resource

The rate of expansion of planted forests 1990–2015 was 2.7 percent per year (176.1 to 293.4 million hectares), however, from 2010–2015 the rate lowered to 1.2 percent per year (FAO 2006a). The authors estimated that based upon maintaining the expansion rate of 2.7 percent the planted forest resource in 2020 would be 335.2 million hectares, by 2025, 383.0 million hectares and by 2030, 437.5 million hectares. Using the more conservative rate of expansion of 1.2 percent per year the planted forest resource in 2020 would be 316.5 million hectares, by 2025, 335.9 million hectares and by 2030, 355.5 million hectares. It is anticipated that the planted forest resource could double by 2050 (FSC *et al*. 2012, Payn *et al*. 2015).

The market demand for planted forest wood is increasing substantially, so the rate of expansion will depend heavily on the rate at which governments can adopt clear and cohesive policy, legal, regulatory and institutional frames; grant rights to available and accessible land without ownership conflicts and major environmental constraints; and encourage partnership agreements with clear statement of inputs, responsibilities, risks, and benefits. Additionally, the impacts of market dynamics and new technologies and biotic and abiotic risk factors, exacerbated by extreme weather events and climate change and the transfer of knowledge and technology from scientific research to development of planted forests will play critical roles (Payn *et al*. 2015).

The planted forests of the future will not replicate those of the past that focused heavily on wood production. Some planted forests will be managed for wood production but increasingly they are being managed for multiple purposes to provide a sustainable supply of wood products as well as a combination of ecosystem services such as conservation of biodiversity, sequestration and storage of carbon, soil and water protection, restoration of degraded landscapes, or recreation and amenity functions that provide alternative financial return options to investors through payment for ecosystem services (Maginnis *et al*. 2003).

Lessons learned

Some key lessons learned to enhance the role of planted forests:

- Planted forests require the critical enabling policy and legal frames that provide the security for private sector investment and clear and secure rights for land use and crop ownership, management harvesting, marketing and trading forest products.
- Planted forests have social and environmental impacts that require clear stakeholder participation, transparency and partnerships in planted forest investments.
- Planted forests have roles in reducing poverty, enhancing food security and sustainable livelihoods with responsible investments, planning and management.
- Planted forests can play critical roles in rehabilitation of degraded lands and provide ecosystem services, particularly carbon sequestration.
- Planted forests can be integrated into the mosaic of multiple land uses in landscape approaches.
- Planted forest resilience to biotic, abiotic and market risks can be enhanced by preventive operational practices, species diversity and silviculture to maintain stand productivity, vitality and viability.
- Planted forests can provide a wide diversification of forest products including traditional products, bioenergy and a wide range of new bio products.
- Planted forest investors can enhance their access to discerning markets that require proof of sustainability and legality through forest certification and legality verification.

Challenges and Opportunities

Population growth, competition for land, climate impacts, societal perceptions and governance which affect investment and management will remain significant challenges in the future of planted forest development. Protection of planted forest crops from insects, diseases, other pests, invasive species and wildfire, exacerbated by extreme weather events will remain a challenge to maintaining productivity and harvest yields. Access to forest certification will remain a challenge for planted forests owned by communities and smallholders until the certification systems revise their principles, standards and procedures (World Bank 2019).

Improved silvicultural management, brownfields investments, genetic improvement, increased focus on forest protection, social inclusion and new innovations in harvesting, transport and wood products processing for planted forest products are likely to increase the management options, financial performance and investment in productivity, health and sustainability in planted forests. The use of forest certification and legality verification schemes and the new generation planted forests platform will encourage responsible and inclusive management and more positive societal knowledge of the future role of planted forests in providing not only wood, wood based, fibre and fuel products but a range of critical services (Payn *et al*. 2015; Criterion and INDUFOR 2017).

Conclusions

Planted forests are likely to continue to expand and provide the social, environmental and economic benefits if good governance sets the stable enabling conditions for planted forest investments, including legal, policy, regulatory and institutional frames that encourage investment through cohesive and clear land, land use and crop ownership rights; responsible social and environmental safeguards; free and transparent access to markets to increase forest products values; transfer of research knowledge and technology through technical support and extension services to sustain productivity; recognize the role that planted forests can play in mitigating the effects of climate change and disaster risk reduction; reduce biotic, abiotic and market risks; providing access to funds and fair markets; and building trust between partners and committing to transparent and equitable partnership agreements.

The proportion of Government ownership of planted forests is likely to continue to decline in the future as investments by the private sector (corporate and smallholder) increase; corporate private sector investment is likely to increase particularly in Asia and Central and South America; and smallholder planted forests are likely to continue to expand due to the availability of land and the potential returns of planted forests to supplement other smallholder income in rural areas. Ownership and tenure of planted forests will be more diversified than in the past and will include a mix of financial investors, private smallholder and medium sized growers; lease arrangements between governments and companies; partnerships between strategic and financial investors as well as between companies and local landowners.

New green, circular, bioeconomy technologies applied in planted forests will spread to all regions around the world. As a result, reforestation and new plantings will generally not only sustain current levels of productivity but likely increase growth and harvest yields and shorten rotation lengths so that wood, fibre and fuel will be produced more efficiently and sustainably. There is a renaissance in the use of wood in recognition that it is a renewable, environmentally neutral, resilient construction material that can be used for creative architecture and building purposes by adopting new wood technologies that open new opportunities for innovative designs and construction methods. Additionally, by breaking wood down to central components of cellulose, hemicellulose and lignin a whole range of new innovative bioproducts are possible so that the demand for wood based products are going to increase substantially and the proportion from planted forests will need to increase to grow more wood, fibre and fuel faster.

It has been forecast that planted forests could increase from under 2 percent of global land use to about 4 percent by 2050. Because of population and livestock growth, increased food and associated agricultural demand and the evolving expansion in demand for bioenergy, planted forests will compete for access to suitable land that will put pressure on land prices and result in planted forests being established in marginal agricultural lands, adopting improved germplasm and management systems and adopting technologies that will result in higher sustainable productivities and adopting participatory process and partnerships to address social and environmental challenges.

REFERENCES

ABARE – JAAKKO POYRY. 1999. *Global outlook for plantations*, Australian Bureau of Agricultural and Resource Economics (ABARE) Research Report 99.9, Canberra, Australia. 82pp.

BARNEY, K. 2004. Re-encountering resistance: Plantation activism and smallholder production in Thailand and Sarawak, Malaysia. Paper published in *Asia Pacific Viewpoint* **45**(3): 325–339

BARNEY, K. 2008. Local vulnerability, project risk and intractable debt: The politics of smallholder Eucalyptus promotion in Salavane Province, Southern Laos. Chapter 13, Smallholder tree growing for rural development and environmental services, Springer Science, 2008. 263–286.

BARUA, S.K. and LEHTONEN, P. 2014. The great plantation expansion. International Tropical Timber Organization Forest Update 22/3 11–14.

BARUA, S.K., LEHTONEN, P. and PAHKASALO, T. 2014. Plantation vision: potentials, challenges and policy options for global industrial forest plantation development. *The International Forestry Review* **16**(2): 117–127.

BASTIN, J-F, FINEGOLD, Y., GARCIA, C., MOLLICONE, D., REZENDE, M., ROUTH, D., ZOHNER, C.M., CROWTHER, TC. 2019. The global tree restoration potential. *Science* **365**: 76–79.

BERG, P. 2006. The important role of trees in combating coastal erosion, wind and salt spray: A New Zealand case study. New Zealand coastal erosion study, August 2006. 11pp.

Brown, C. 2000. *The global outlook for future wood supply from forest plantations,* Working Paper No: GFPOS/WP/03, Forestry Policy and Planning Division, FAO, Rome, Italy. 99pp.

BYRON, R.N. 2001. Keys to smallholder forestry. *Forests, Trees and Livelihoods* **11**: 279–294.

CARLE, J. and HOLMGREN, P. 2003. Definitions related to planted forests. FAO, Rome, Italy. 14pp.

CARLE, J. 2007. Vulnerabilities of smallholder plantings. *Unasylva* **228**(58).

CARLE, J. and HOLMGREN, P. 2008. Wood from planted forests: A global outlook 2005–2030. *Forest Products Journal* **58**(12): 6–18.

CARLE, J. and MA, Q. 2005. Challenges of translating science into practice: poplars and other species in the Three North Region of China. *Unasylva* **221**(56): 31–37.

CIFOR. 2001. *Linking criteria and indicators to a code of practice for industrial tree plantation development in the tropics*. Centre for International Forestry Research (CIFOR), Bogor, Indonesia. 144pp.

CRITERION and INDUFOR. 2017. Allocating capital for maximum impact in Africa's plantation forestry sector. White Paper, Stellenbosch, South Africa. 58pp.

CUBBAGE, F., DONAGH, P. M, BALMELLI, G., OLMOS, V.M., BUSSONI, A., RUBILAR, R., DE LA TORRE, R., LORD, R., HUANG, J., HOEFLICH, V.A., MURARA, M., KANIESKI, B., HALL, P., YAO, R., ADAMS, P., KOTZE, H., MONGES, E., PEREZ, C.H., WIKIE, J., ABT, R., GONZALEZ, R. and CARRERO, O. 2014. Global timber investments and trends, 2005–2011. *New Zealand Journal of Forestry Science* **44**(Supp 1), 57. 12pp.

DELL, B., XU, D. and QUANG, T. 2012. Managing threats to the health of tree plantations in Asia. *New perspectives in plant protection*, InTech, China, Shanghai, China. 63–92.

ENTERS, T., DURST, P.B. AND BROWN, C. 2004. What does it take? The role of incentives in forest plantation development in the Asia-Pacific region. 278pp.

EVANS, J. 2009 (ed.). *Planted forests: uses, impacts and sustainability*. Published jointly by CABI and FAO, Viale delle Terme di Caracalla, Rome 00153, Italy, 213pp.

FAO *et al*. 2013. *Planted forests are a vital resource for future green economies*. Summary Report of the 3rd International Congress on Planted Forests, based upon three scientific workshops held in Bordeaux France, Dublin Ireland and Porto, Portugal and one plenary meeting in Estoril, Portugal, May 15–21, 2013. Pp17.

FAO. 1967. Report of the world symposium of man-made forests and their industrial importance. *Unasylva* **21**: 86–87.

FAO. 2004. *What does it take? The role of incentives in plantation forest development in Asia and the Pacific*. RAP Publication 2004/27, Asia Pacific Forestry Commission, FAO, Bangkok, Thailand. 278pp.

FAO. 2006a. *Global planted forests thematic study: Results and analysis*. Planted forests working paper 38, FAO, Rome, Italy. 178 pp.

FAO. 2006b. *Responsible management of planted forests: voluntary guidelines.* Planted Forests and Trees Working Paper 37/E, FAO, Rome, Italy. 73pp.

FAO. 2010a. *Global forest resources assessment 2010: Main report*. FAO Forestry Paper 163, FAO, Rome, Italy. 340pp.

FAO. 2010b. *Planted forests in sustainable forest management: A statement of principles.* A synthesis paper, FAO, Rome, Italy. 16pp.

FAO. 2014. *Assessment of industrial roundwood production from planted forests,* Planted Forests and Trees Working Paper Series, Working Paper FP/48/E, Forest Assessment, Management and Conservation Division and Forest Economics Policy and Products Division, FAO, Rome. 30pp.

FAO. 2015. *Global forest resources assessment 2015*: Desk Reference. FAO, Rome, Italy. 253pp.

FAO. 2017. *Sustainable wood for a sustainable world*. Global meeting report hosted jointly be FAO, CIFOR, the World Bank, WWF, ITTO and Finance Alliance for Sustainable Trade, FAO HQ, Rome, Italy. 26pp.

FAO, IUFRO *et al*. 2018. *Planted forests: a solution for green development*. Summary report of the fourth international congress on planted forests, Beijing, China, October 2018. 16pp.

FORESTRY STEWARDSHIP COUNCIL and INDUFOR. 2012. *Strategic review on the future of forest plantations,* INDUFOR assignment A-12-06869, ID 11914 for the FSC, Helsinki, Finland. 113pp.

HARWOOD, C.E. and NAMBIAR, E.K.S. 2014. Productivity of acacia and eucalypt plantations in Southeast Asia, trends and variations. *The International Forestry Review* **16**(2): 249–260.

ICRAF. 2002. *History of ICRAF and the World Agroforestry Centre.* ICRAF website. http://www.worldagroforestry.org/about/history

IFF. 1999. *Role of planted forests in sustainable forest management*. Report of the International Expert Consultation, April 6–10, 1999, Santiago, Chile. Pp17.

INDUFOR. 2017. *Future trends in smallholder plantation forestry*. INDUFOR short paper, Helsinki, Finland. 6pp.

ITTO. 1993. *ITTO Guidelines for the establishment and sustainable management of planted tropical forests*. ITTO Policy Development Series 4. International Tropical Timber Organization, Yokohama, Japan. 40pp.

JACOVELLI, P.A. 2014. The future of plantations in Africa. *The International Forestry Review* **16**(2): 144–159.

JEFFRIES, B. (ed). 2018. New generation plantation platform review. Prepared by the new generation platform participants in consultation with academia and WWF. 31pp.

KOLLERT, W., CARLE, J. and ROSENGREN, L. 2014. Poplars and willows for rural livelihoods and sustainable

development. Chapter in the FAO and CABI book *Poplars and willows: trees for society and the environment*, Isebrands, J.G. and Richardson, J (ed). 577–602.

LEXTERRA. 2016. The progress of forest plantations on the farmers' territories in the Nacala Corridor. Case study paper of the Green Resources Mozambique by Lexterra, Maputo, Mozambique. 68pp.

MAGINNIS, S., JACKSON, W. 2003. *The role of planted forests in forest landscape restoration.* Paper presented at the UNFF intersessional experts meeting on the role of planted forests in sustainable forest management, New Zealand, 2003. 28pp.

MALKAMAKI, A., D'AMATO, D., HOGARTH, J., KANNINEN, M., PIRARD, R., TOPPINEN, A., WEN, Z. 2018. A systematic review of the socio-economic impacts of large-scale tree plantations, worldwide. Article in *Global Environmental Change* **53**: 90–103.

MIDGLEY, S.J., STEVENS, P.R. and ARNOLD, R.J. 2017. Hidden Assets: Asia's smallholder wood resources and their contribution to supply chains of commercial wood. *Australian Forestry* **80**(1): 10–25.

NAMBIAR, E.K.S 2019. Re-imaging forestry and wood business: Pathways to rural development, poverty alleviation and climate change mitigation in the tropics. *Forest Ecology and Management* **448**: 160–173.

NAMBIAR, E.K.S. and HARWOOD, C.E. 2014. Productivity of acacia and eucalypt plantations in Southeast Asia, bio-physical determinants of production opportunities and challenges. *The International Forestry Review* **16**(2): 225–248.

NAMBIAR, E.K.S., HARWOOD, C.E., Nugyen, D.K. 2014. Acacia plantations in Vietnam: research and knowledge application to secure a sustainable future. *Southern Forests* **2014**: 1–10.

NGUYEN, Q.T. 2011. Chopping for chips: An analysis of wood flows from smallholder plantations in Vietnam. Working Paper 65, CIFOR, Bogor, Indonesia. 25pp.

OVERBEEK, W. and KROGER, M. 2012. *An overview of industrial tree plantations in the global south: Conflicts, trends and resistance struggles.* Environmental Justice Organizations, Liabilities and Trade (EJOLT) Report No. 3, June 2012. 100 pp.

PALMBERG-LERCHE, C. 2002. *Forest genetic resources: International and Australian perspectives.* Forest Genetic Resources Working Paper FGR/36E, FAO, Rome, Italy. 26pp.

PAYN, T., CARNUS, J-M., FREER-SMITH, P., KIMBERLEY, M., KOLLERT, W., LIU, S., ORAZIO, C., RODRIGUEZ, L., SILVA, L.N., WINGFIELD, M.J. 2015. Changes in planted forests and future global implications. *Forest Ecology and Management* **352**: 57–67.

PENNA, I. 2010. *Understanding the FAO's wood supply from planted forests projections,* University of Ballarat Centre for Environmental Management Monograph Series 2010/01, University of Ballarat, Victoria. 32pp.

PIRARD, R., DAL SECCO, L., WARMAN, R. 2016. Do timber plantations contribute to forest conservation. *Environmental Science and Policy* **52**: 122–130.

PRESTEMON, J.P. and ABT, R.C. 2002. The Southern timber market to 2040. *Journal of Forestry* **100**: 102–128.

REED, F.L.C. 1983. Forest renewal in Canada. *Commonwealth Forestry Review* **62**: 169–177.

RHODES, D. 2001. Rehabilitation of deforested steep slopes on the east coast New Zealand's north island. *Unasylva* 207, Vol. 52, 2001/4. 15pp.

RISI. 2016. Eucalyptus sawlog market outlook. Special market analysis study. RISI, 201pp.

SHON-CHING LEE and NGON HAN. 1948. Forestry in China. *Unasylva* 6, Vol, 2. 1948.

STREETS, R.J. 1962. Exotic Forest Trees in the British Commonwealth, Clarendon Press, Oxford, UK

TURNBULL, J.W. 2002. Tree domestication and the history of plantations. Published in Squires, V.R. (ed.). *The role of food, agriculture, forestry and fisheries and the use of natural resources.* Encyclopaedia of Life Support Systems developed under the auspices of UNESCO, Eolss Publishers, Oxford, UK. 9pp.

UNFF. 2003. *The role of planted forests in sustainable forest management.* The UNFF Intersessional Experts Meeting, 25–27 March 2003. Wellington, New Zealand. 18pp.

WORLD BANK. 1977. *Project performance audit report Kenya forest plantation project*. Report No. 1485, Operations Evaluation Department, The World Bank, Washington DC, USA. 40pp.

WORLD BANK. 2019. Sustaining forest landscapes and livelihoods: Partnerships and opportunities for a new green forest economy in Lao PDR. Green growth advisory programme for Lao PDR. World Bank, Vientiane, Lao PDR. 70pp.

ZHANG, Y.X. and SONG, C.H. 2006. Impacts of afforestation, deforestation and reforestation on forest cover in China from 1949 to 2003. *Journal of Forestry* **104**: 383–387.

"Wood Security": the importance of incentives and economic valorisation in conserving and expanding forests

G. DIETERLE[a] and A. KARSENTY[b]

[a]*Executive Director, International Tropical Timber Organization (ITTO), Yokohama, Japan*
[b]*Senior Researcher, at the French Agricultural Research Center for International Development (CIRAD), Montpellier, France*

Email: dieterle@itto.int, alain.karsenty@cirad.fr

SUMMARY

Tropical forest degradation is a major source of greenhouse-gas emissions, but international forest and climate policies are yet to respond decisively to this. In some regions, as a result of population growth, climate change and forest degradation, the increased need for wood, whether for timber or fuelwood, will exceed the sustainable supply capacity of natural forests and plantations, potentially accelerating deforestation processes. As with the issue of food security, a problem of "wood supply security" is emerging in several developing countries. This issue is poorly understood by most international initiatives focused on climate or biodiversity, which want to conserve forests but neglect the importance of the productive role of forests to support this conservation through their sustainable use. Solutions exist, but a number of barriers, starting with unclear tenure rights and short-sighted policy choices, prevent the large-scale deployment of these ones. Putting investment back at the forefront of the international agenda and setting the right incentives for producers is necessary to overcome these barriers and create the conditions for achieving future results sought by the "results-based payments" schemes such as REDD+, currently favoured by donors. Beyond the production side, the role of the global demand and the consumers is critical, and trade policies should evolve significantly to favour sustainable and deforestation-free productions.

Keywords: Tropical forests, wood security, sustainable forest management, incentives, investment, deforestation-free supply chains

«Sécurité ligneuse»: l'importance des incitations et de la valorisation économique pour conserver et étendre les forêts

G. DIETERLE et A. KARSENTY

La dégradation des forêts tropicales est une source majeure d'émission de gaz à effet de serre mais les politiques forestières et climatiques internationales n'ont pas encore trouvé de réponse décisive à ce problème. Dans certaines régions, du fait de la croissance démographique, des changements climatiques et de la dégradation des forêts, le besoin croissant de bois d'œuvre ou de bois-énergie va dépasser les capacités de production durable des forêts naturelles et des plantations, accélérant potentiellement les processus de déboisement. A l'instar de la question de la sécurité alimentaire, un problème de sécurité des approvisionnements en bois émerge dans plusieurs pays en développement. Ce problème est mal appréhendé par la plupart des initiatives internationales sur le climat et la biodiversité qui veulent la conservation des forêts mais n'accordent pas assez d'importance à leur rôle productif pour aider à cette conservation à travers une utilisation durable. Des solutions existent, mais de nombreux obstacles, à commencer par la confusion autour des droits fonciers et les politiques à courte vue, empêchent leur mise en œuvre à grande échelle. Remettre l'investissement en haut des agendas internationaux et proposer des incitations adaptées aux producteurs, est nécessaire pour surmonter ces obstacles et réunir les conditions pour obtenir les résultats recherchés par les mécanismes de «paiement aux résultats» comme REDD+, actuellement en vogue chez les donateurs. Au-delà de l'importance d'agir sur la production, le rôle de la demande globale et des consommateurs est déterminant, et les politiques commerciales doivent évoluer significativement pour favoriser les productions durables et «zéro déforestation».

"Seguridad del suministro de madera": la importancia de los incentivos y la valoración económica en la conservación y expansión de los bosques

G. DIETERLE y A. KARSENTY

La degradación de los bosques tropicales es una de las fuentes principales de emisiones de gases de efecto invernadero, pero las políticas internacionales forestales y sobre el clima todavía no han respondido con resolución. En algunas regiones, como resultado del crecimiento demográfico, el cambio climático y la degradación de los bosques, el aumento de la demanda de madera, ya sea de aserrío o de leña, excederá la capacidad de suministro sostenible de los bosques naturales y las plantaciones, lo que podría acelerar los procesos de deforestación. Al igual que con la cuestión de la seguridad alimentaria, en varios países en desarrollo está surgiendo un problema de "seguridad del suministro de

madera". La mayoría de las iniciativas internacionales centradas en el clima o la diversidad biológica, que desean conservar los bosques pero descuidan la importancia de la función productiva de los bosques para apoyar esta conservación mediante su utilización sostenible, no comprenden bien esta cuestión. Existen soluciones, pero una serie de barreras como la falta de claridad en los derechos de tenencia y unas opciones miopes en cuanto a políticas, impiden su despliegue a gran escala. Es necesario volver a poner la inversión al frente de la agenda internacional y establecer incentivos adecuados para los productores, a fin de superar esas barreras y crear las condiciones para lograr los resultados futuros que buscan los sistemas de "pagos por resultados" como el de REDD+, que los donantes ven favorablemente en la actualidad. Más allá del aspecto de la producción, el papel de la demanda mundial y de los consumidores es fundamental, y las políticas comerciales deberían evolucionar de manera significativa para favorecer las formas sostenibles de producción y libres de deforestación.

INTRODUCTION

Several major international initiatives have emerged over the past thirty years to try to curb deforestation and degradation of forests. The fight against deforestation dates back to the mid-1980s with the launch of the Tropical Forest Action Plan (TFAP) on the joint initiative of FAO, UNDP, the World Bank and WRI, and its national variations in the form of programming exercises and project "shopping lists". Many other initiatives, multilateral or bilateral, public or private, have emerged since then. The UNFF, established in 2000, is the last avatar of a couple of multilateral initiatives aiming at implementing the Forest Principles associated with the Agenda 21 adopted at the UN conference in 1992 and with the ambition to prepare an international Forest Convention. The diverging views among countries on the desirable use of forests and the reluctance of some developing countries to any international law that could reduce their right on their natural resource, ruined this ambition (Lipschutz 2000). Forests issues has been addressed by other international agreements, the "climate dimension" within the UNFCC, the biodiversity ones within the CBD and the timber trade through the International Timber Trade Agreement (2006). It resulted into a fragmented international regime (Humphreys 2009), likely to remain as such given the tension between forests as resources reserve – under sovereignty of States and various property rights of land users – and forests as ecosystem services provider – services that can be considered as global public goods (Karsenty and Pirard 2007).

Forest certification has been launched by civil society organizations and private actors in the 1990's. FLEGT initiative, designed to eliminate illegal timber from international trade, is a public scheme focused on bilateral agreements (the Voluntary Partnership Agreements, or VPAs). All these initiatives are sectoral, forest-centered. Since the main direct drivers of deforestation are agriculture and cattle ranching, it became necessary to broaden the perspective, from forest policies to forest-related policies (Singer 2008), all public or private policies that have impacts on forests. REDD+, as a "hands-off" results-based payment scheme for curbing emissions related to national forest cover, allows for thinking beyond the forest sector boundaries. The last initiatives in date, promotion of deforestation-free supply chains for agricultural productions focus deliberately outside the forestry sector to protect the forests.

With REDD+, the dominant idea is that the tension between forests-resources and forest-services, or, putting more conventionally, between development and forest conservation, can be overcome only by compensating developing countries for the foregone revenues of not converting their forests into other land-uses. In other words, rich countries would have to pay the "opportunity costs" of forest conservation to developing countries, as it was suggested, notably by the Stern Review (Zenghelis 2006). This "opportunity cost" framing is implicitly expressed in this economic statement of an influential REDD+ analyst: "*REDD+ countries have an incentive to reduce deforestation up to the point where the marginal cost of reductions (i.e. the national supply curve of REDD) is equal to the international compensation, for example, the market price for REDD+ credits*" (Angelsen 2008:59). Such a framing of the debate is, however, tricky, as it suggests an entire transfer of burden to industrialized countries through their willingness to pay and departs from the principle of "common but differentiated responsibilities" adopted in Rio 1992.

This framing through the exclusive lens of opportunity costs has been softened since the inception of REDD+ in 2005 and the influential Stern Review. It became clear that the opportunity costs of not developing industrial agriculture (oil palm, soy, rubber. . .) was high and likely to escalate with the growing demand of food and the, expected, limited access to new lands if REDD+ was to succeed. The McKinsey report (2009) was very significant on this respect: paying the opportunity cost was only affordable with food crops oriented small-scale farmers (see also Ickowicz *et al.* 2017). And again, the McKinsey report suggested that, given "ethical considerations", payments to such farmers would be well beyond the (low) opportunity costs. Moreover, the opportunity cost is only one part of the story. To estimate the likely cost of REDD+, one have to factor in the cost of investments needed to, say, clarify land tenure, adoption of forest-friendly (and more productive) agricultural practices, design and monitor incentive schemes for farmers, rebuild an affective administration to implement policies, etc. (Fischer *et al.* 2011, Gregersen *et al.* 2012, Angelsen *et al.* 2012, Thompson *et al.* 2017).

If opportunity costs are too high, with respect to the price of carbon credits and/or the willingness to pay of developed countries, another way to frame the issue is to consider that payments will encourage governments already committed to protect their forests, and will serve as policy arguments for forest protectors against the forest conversion lobbies. Such a reframing of the issue emphasizes the multiple benefits of forests, as a bundle of renewable resources and as a support

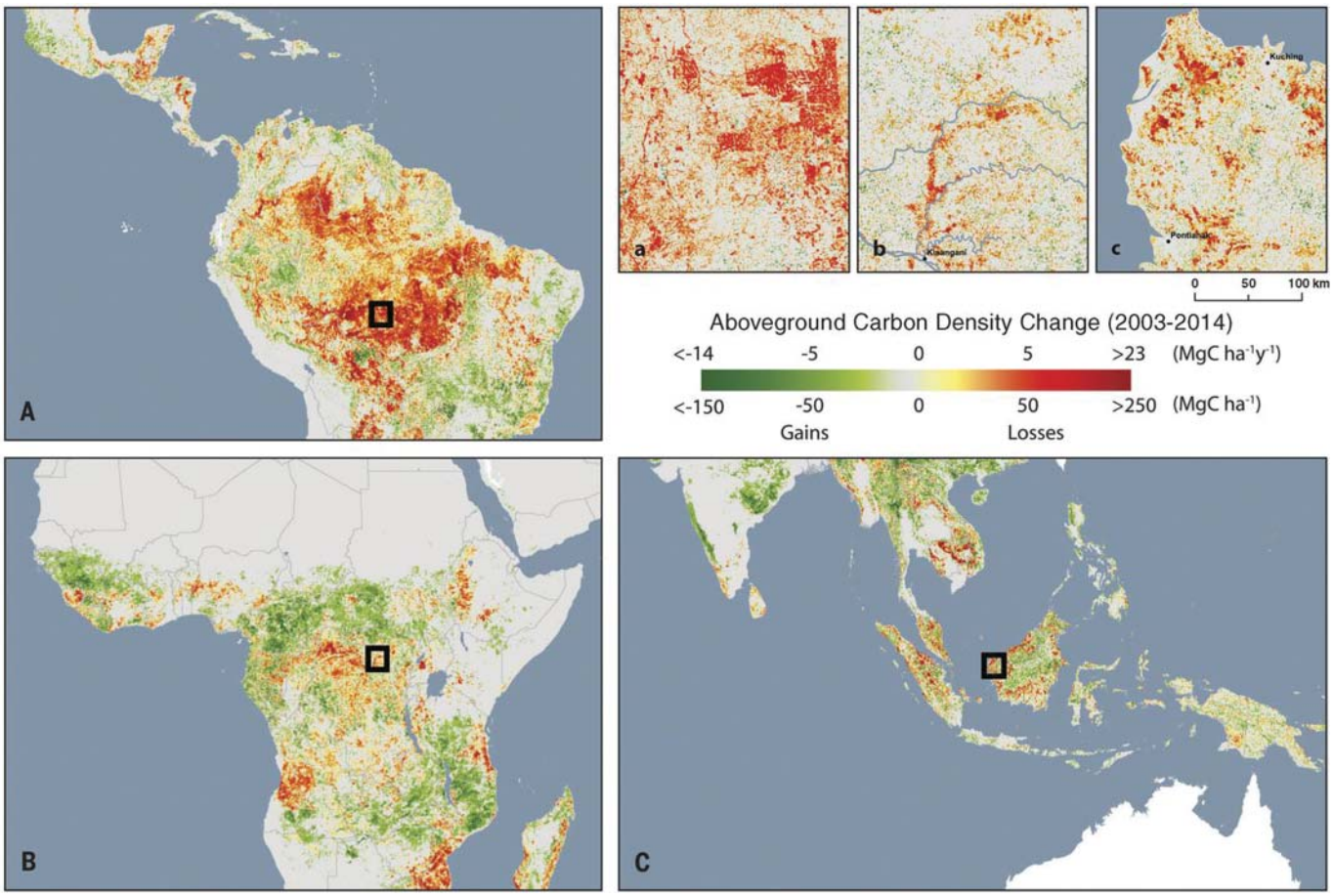
for ecosystem services, to orient national policy choices *vis-à-vis* the forests, rather than fueling expectations about financial compensations for the highly uncertain opportunity cost of not converting forests (and potential perverse incentives associated). In that respect, economic valorization of forest resources, starting with wood, should be put back into the conversation and reflections on the barriers to investment and the needed incentives for producers to engage into better practices is necessary.

This article analyzes the growing demand of wood, either for timber or energy, its consequences in terms of forest degradation, and the needed response in terms of investment for "wood security", through more efficient practices of the forest industry and forest restoration. Investment is a necessary but not sufficient condition for change, if various barriers are not removed. Beyond the over-debated issue of public governance, the article insists on two critical policy elements needed to overcome barriers: sharing rights on forest resources and design appropriate incentives. Finally, the article take stock of the promising initiatives aiming at promoting deforestation-free supply chains for timber and agricultural products, and propose the use of modulated custom tariffs to provide a commercial advantage to certified deforestation-free products.

TROPICAL FOREST DEGRADATION HAS BEEN UNDERESTIMATED

The latest research suggests that forest degradation is at least as big a problem for carbon dioxide (CO_2) emissions as actual deforestation. As shown in Figure 1, forest degradation is advancing rapidly, especially in the peripheries of the big tropical forests (e.g. the Amazon, the Congo Basin and Borneo) and in drier areas where people must satisfy their daily needs for wood and non-wood products (e.g. southern and western Africa). Forest degradation is estimated to account for 50–70% of CO_2 emissions in the tropics (depending on the method of calculation) (Erb *et al.* 2018). Yet international forest policy is not yet paying sufficient attention to degradation and its impacts on human communities and the natural environment. It is rapidly becoming evident that the take-up of agricultural land cannot be blamed as the sole driver of forest-related emissions and that consideration must also be given to other important factors, such as daily demand for woodfuel and timber among local communities, a lack of expertise in forestry management, a failure to invest, illegal practices, and reduced forest vitality due to climate change. Forestry agencies and forest-related institutions could address at least some of these factors.

FIGURE 1 *Change in carbon density in tropical forests (Baccini* et al. *2017)*



POPULATION GROWTH BOOSTS DEMAND FOR WOOD

The lower productivity of tropical forests due to climate change will coincide with an expected dramatic increase in demand for wood products and wood energy in coming decades, especially in Africa. This additional demand will increase at least as fast as demand for food. We should be talking not only about food security but also about what we can call in mirror, "wood security" because wood products and wood energy are just as essential as daily nutrition and clean water for satisfying people's basic needs.

The forecasts are extremely worrying: on the one hand, the global population will grow rapidly and, on the other, forestry stocks will dwindle swiftly. The annual supply gap for wood is projected to rise to as high as 6 billion m^3 by 2050. Analyses by the World Bank, including case studies in selected tropical countries (Figure 2), indicate that this supply gap will affect large swathes of the tropical regions by the middle of the century (World Bank 2017).

WOOD'S ROLE IN A SUSTAINABLE BIOECONOMY

One reason why this trend is so worrying is that, as a consequence, the use of sustainably grown wood as a substitute for non-renewable materials and energy will be unable to play its full role in countering global warming. This role could be considerable, as shown by an analysis by the German government and recent studies by the World Bank and by Yale University (De Galbert, Dieterle *et al.* 2013, Oliver *et al.* 2014) (see also Figure 3): the substitution effects of using more wood products (in construction and furniture, etc.) are greater than using forests as a carbon sink alone, especially given the growing vulnerability of these sinks in the context of global warming, with extreme events such as hurricanes and "mega fires".

After many years where harvested wood products (HWP) were treated as emissions, the IPCC, in particular in the latest Special Report (IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems 2019*),* and also UNFCCC finally recognise the important mitigation role they play as part of a bio-based and circular economy.

SAVING TROPICAL FORESTS THROUGH INVESTMENT AND INCENTIVES

There is an urgent need for more analysis because the conclusion is clear: forest protection measures alone will be insufficient to save key tropical forests. Rather, sustainable-use strategies, incentives and investments will be necessary to satisfy the predicted additional demand. A failure to act would be irresponsible, and it would have adverse consequences for sustainable development in many tropical countries due to:

- the greater use of non-renewable resources, especially in connection with rapid urbanisation in the tropics;
- the rising pace of forest degradation to satisfy daily needs for wood and wood energy;
- the pressure to fill supply gaps with imports from temperate countries running wood surpluses; and
- the loss of jobs and income, especially in rural regions, combined with a faster pace of migration.

As it is, countries producing tropical wood already face tangible disadvantages. For one thing, tropical wood suffers from a poor image and is associated with deforestation,

FIGURE 2 *Projected wood supply gap, selected tropical countries (Chart: World Bank, PROFOR, CIF. 2017)*

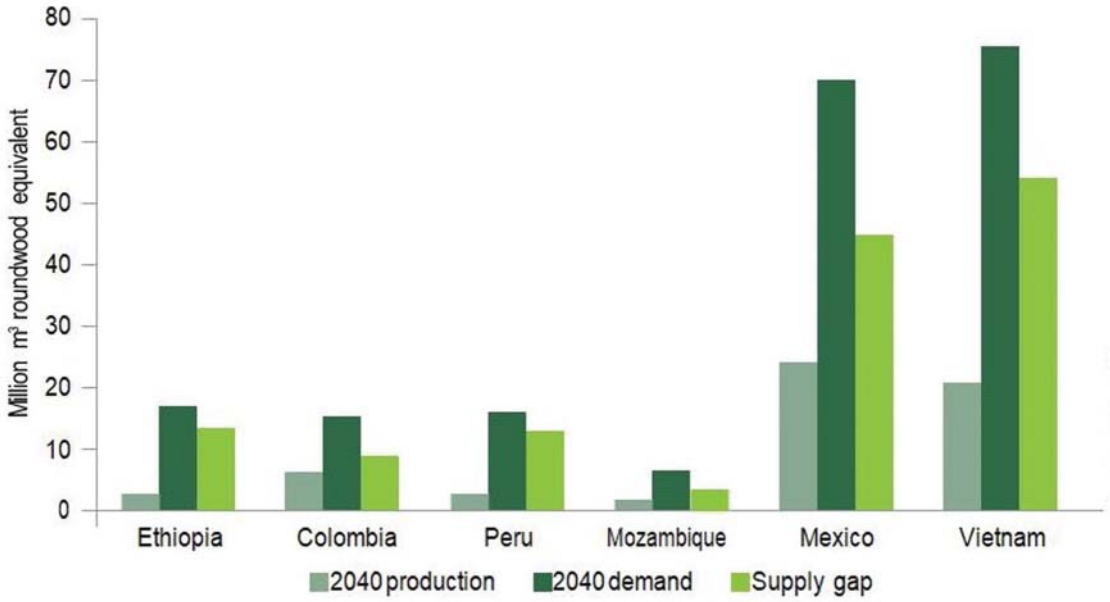
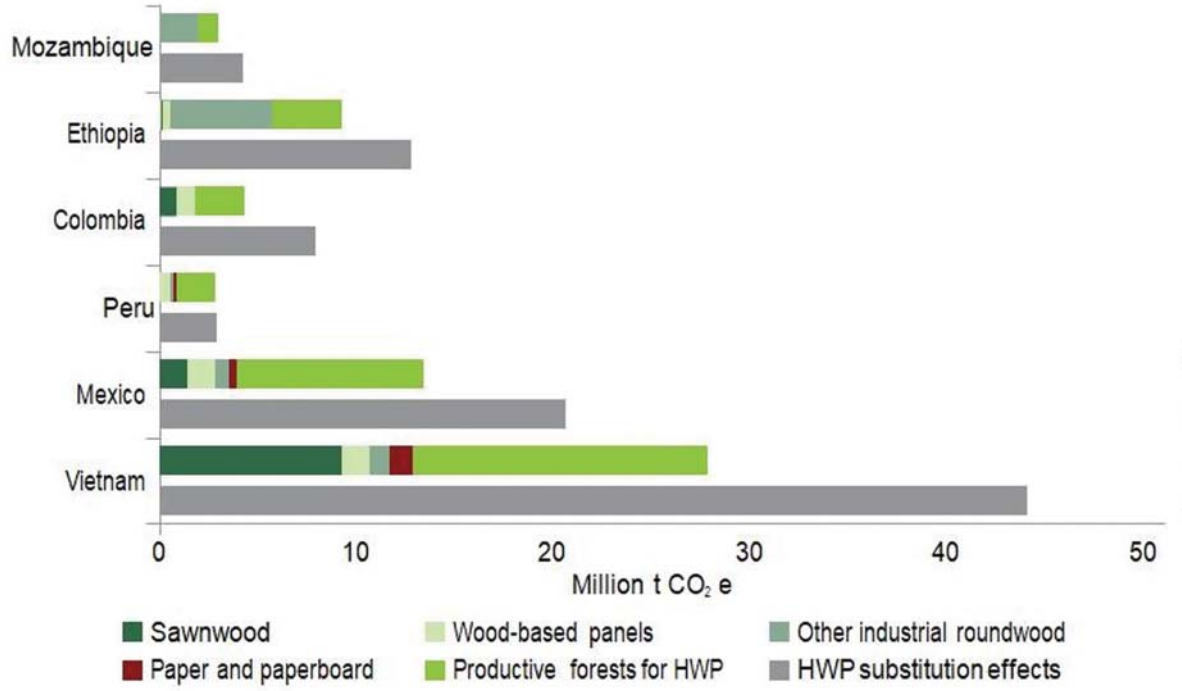


FIGURE 3 *Climate potential of sustainable forest management and use in selected tropical countries (Chart: World Bank, PROFOR, CIF. 2017)*



degradation and corruption. As a result, tropical wood producers attempting to produce sustainable timber experience considerable disadvantages and risks (Table 1).

Landscape restoration founded on sustainable added value

What is urgently needed, therefore, is massive investment in:

- forestlands rights' and tenure clarification;
- forest landscape restoration and reforestation
- the efficient management of existing forests and reducing losses from unsustainable harvesting practices; and
- better protection of high-conservation-value forests.

Forest restoration and reforestation are of utmost importance. Tree plantations are necessary to feed the growing demand of fuelwood and timber the natural forest would not be in capacity to supply. However, tree plantations are often oriented towards softwoods for pulp and paper production or fast-growing species in monocultures that often replace

TABLE 1 *Consumer–producer dynamics in the trade of tropical wood*

Consumers	Producers
• Public and political acceptance for tropical wood has declined substantially (illegal practices, deforestation etc.) • Consumer countries (e.g. Australia, European Union member states, Japan, New Zealand, the Republic of Korea and the United States of America) have toughened up their legality requirements • Proof of legality and sustainability is becoming the norm in a growing number of consumer countries • The wood industry is increasingly shifting investments to "safe" tropical countries to meet legality and sustainability requirements • Major consumer countries (e.g. China and India) are seeking self-sufficiency by investing in their own forest resources • Demand for tropical hardwoods has declined due to improved mechanical and chemical wood-processing technologies for non-tropical softwoods • Private-sector initiatives for deforestation-free supply chains are putting tropical producers under pressure	• Tropical wood producers find it difficult to compete with illegal, unsustainable operators • The European Union Timber Regulation and the United States of America's Lacey Act are having an effect, and tropical timber has less access to western markets • China's Green Supply Chain Initiative has further reinforced legality and sustainability requirements • Balance-of-trade deficits are increasing due to bigger imports to meet demand for wood in tropical countries • Countries are shifting towards the use of non-renewable resources as forests are depleted • Pressure on forests is increasing from local communities • Conflicts and migration flows are increasing to secure access to wood resources • There is a lack of skilled labour, knowledge and technology

degraded natural forests when land-use planning is not designed or enforced (Kröger 2014). In Indonesia, the pulp sector continues to rely on natural forests for timber rather than using idle lands (Obidzinski and Dermawan 2012) and comparable situation took place with pine plantations in Chile (Nahuelhual *et al.* 2012). And when, in addition, tree plantation management is inadequate, the ecological impact of such plantations may prove disastrous for soils (acidification) and underground water reserves, along with biodiversity impoverishment (Jackson *et al.* 2015).

A big challenge in this new era is to provide forest owners with the right incentives for developing long-lived multispecies plantations and uneven-aged high stand harvests. Long-term tenure security is key, but financial incentives such as tax or fee rebates, subsidised loans and/or payments for results, as well as support for capacity building and skill development, including for certification, would be needed to counter the preference for short term of many forest owners. In places where population density is increasing rapidly, most future trees will be grown in agroforestry systems, which may or may not include timber trees. Here, too, incentives are needed to encourage timber production in sustainable agroforestry systems. Guaranteeing tree tenure to the people who planted them would be a first-order incentive (for a long time in Côte d'Ivoire, for example, timber trees were state property and allocated to loggers, leading farmers to remove them from their fields). Financial incentives and "future" contracts with industrial buyers for guaranteeing profitable outlets are policy options worthy of consideration.

Traditional reforestation is generally expensive (USD 1500 per ha or more) and, especially in semi-arid areas, the survival rate of planted trees is often low. In the Sahel, tree survival rates in reforestation initiatives was around 20% in the 1970s (Wade *et al.* 2019). The high mortality was due principally to low rainfall, but additional factors, such as planting shock and termites, contributed to these disappointing results.

An alternative is natural regeneration, whether assisted or not (assisted natural regeneration involves tending the seedlings and young shoots that establish naturally in an area). In addition to a lower overall cost, natural regeneration promotes local genetic and functional diversity. The plant and animal species that return and establish are adapted to the site, promoting ecological interactions. In this way, naturally regenerated forests contribute to connectivity, biodiversity conservation and resilience. In Niger, for example, there is a dynamic of local-farmer reforestation on fallows, encouraged by the collective organisation of villages. The costs of projects to support assisted natural regeneration are significantly lower than for traditional afforestation on dedicated land (the World Resources Institute indicates an average cost of USD 20 per ha in Niger; Reij and Winterbottom 2017). In many developing countries, the main difficulty comes where land rights are uncertain and leaving land to a process of natural regeneration can be interpreted as a sign of legal vacancy – potentially enabling squatter invasions. It must also be possible to protect regenerating areas from livestock, requiring local collective action for landscape management. If the issues of land tenure and collective action can be addressed, we agree with Wade *et al.* (2018) that natural regeneration is a viable, cost-effective alternative to tree planting if increasing biomass production is the desired outcome.

Sharing rights on forestlands

Selective harvesting in the tropics allows the multiple use of forestlands and represents a compromise between productive use and maintaining biodiversity. However, the transition from specialised land use (i.e. land sparing) to the sustainable management of several resources and overlapping use rights on a given piece of land (i.e. land sharing) is a big challenge in the tropics. Traditional forest concessions involve the allocation of commercial rights to timber only, thus excluding other resources – which sometimes are allocated to other economic operators. Combining the sustainable commercial use of several resources (e.g. non-timber forest products, genetic resources and trophy hunting) on the same concession area and developing agroforestry in degraded or non-forested areas of concessions can create more financial value per unit area. It would only be socially acceptable, however, if the benefit is shared equitably with local communities who claim customary tenure rights within concession areas (Karsenty and Vermeulen 2017).

Participatory mapping of all the areas of customary tenure, whether or not they overlap with forest concessions or protected areas, is a first step in the political recognition of local tenure rights. Having multiple "layers" of tenure rights is not only a characteristic of customary tenure regimes (where rights to trees may differ from rights to land, for instance), it is also a promising way to address the increasing claims of various resource users invoking different sources of legitimacy to support their claims. Some certified concessionaires in Gabon have made significant steps toward a more equitable sharing of timber revenues through participatory mapping exercises on the entire forest concession. Public regulation has institutionalized such timber revenue sharing directly inspirited by the experience of a pioneer concessionaire (Karsenty and Vermeulen 2017).

The recognition of such rights is also a first step towards the inclusive governance of forest concessions, including area-explicit criteria for benefit sharing. It might be a promising avenue for building new relationships between the industry and local communities and a new paradigm for multi-resource development in natural landscapes.

Efficient management practices

Another undervalued option for restoring landscapes or limiting forest landscape degradation is the wider adoption of management practices oriented towards the efficient use of resources in forests managed for timber, wood-based energy and non-timber forest products. For example, a recent study by Ellis *et al.* (2019) on the potential of reduced-impact logging (RIL) to reduce carbon emissions showed impressive results, especially when harvest intensity is significant. It found that the full adoption of well-known RIL practices

would reduce logging emissions by 44% (equivalent to 366 million tonnes of CO_2) and deliver 4% of the nationally determined contributions to the Paris Agreement on climate change in tropical countries while maintaining timber supplies. Achieving these outcomes requires careful planning of skid trails to reduce collateral damage; training on directional felling along narrow hauling roads; and a shift to low-impact skidding equipment.

Ellis *et al.* (2019) propose incentivising logging operators and companies to adopt these practices. An obstacle to adoption is the common practice of subcontracting logging, sometimes with perverse incentives embodied in contract agreements (e.g. payments based on volumes supplied, without regard to work quality). Public regulations generally do not address this issue, but forest management certification does. This is another reason to consider positively the use of forest management certification in public policies.

The current global push towards forest and landscape restoration is in the right direction, but the focus is still mostly on outcomes for climate and the environment, and there is insufficient attention on ensuring commercial and cost viability and the creation of employment and income.

There is a need, therefore, to "beef up" international forest and climate policy if the forest-related Sustainable Development Goals are to be achieved by 2030. The measures envisaged under REDD+ must be updated to include massive incentives and appropriate conditions to promote sustainable investments by private entities and local authorities (Table 2), as well as ensuring just forest rights; providing more support for vocational training and technical knowledge; and taking action to counter corruption and illegal logging. In many countries, sustainable forest management (SFM) is still considerably more expensive than unsustainable practices and therefore cannot compete with business-as-usual approaches.

Economic and social incentives for sustainability and inclusive governance

As paradoxical as it may seem, tropical forests can be conserved through sustainable use and the responsible consumption of forest products. Indeed, a large reason for the existing high rates of deforestation and degradation has been the lack of competitiveness of SFM. If we consider forest management certification as a proxy for SFM, studies suggest that it brings net potential gains. A 2015 WWF study estimated that it cost almost USD 5 per m^3 to prepare companies for certification (including the cost of the audit itself) in a natural tropical forest and another USD 3.5 per m^3 per year to maintain the certification. The same study assessed the annual financial benefits at around USD 6.03 per m^3 of roundwood equivalent production, outstripping average annual costs and estimated opportunity costs. Operators in the tropics show the largest annual net benefits.

These financial benefits, however, rely partly on achieving a price premium for certified timber, but not all markets offer such a premium. Where it does exist, it is, on average, around 5–10% of the FOB price (Oreade Brèche-PPECF 2017), although it can be higher for some species and markets (e.g. hardwoods in northern Europe). Actually, a significant part of the timber from certified concessions is sold without mentioning certification in local markets or when exported to emerging markets (except when the importer, such as a wood processor in China, intends to re-export the finished product to Western Europe or North America). It means that even a high price premium might not represent a sufficient incentive for remaining certified if it applies only to a small portion of production.

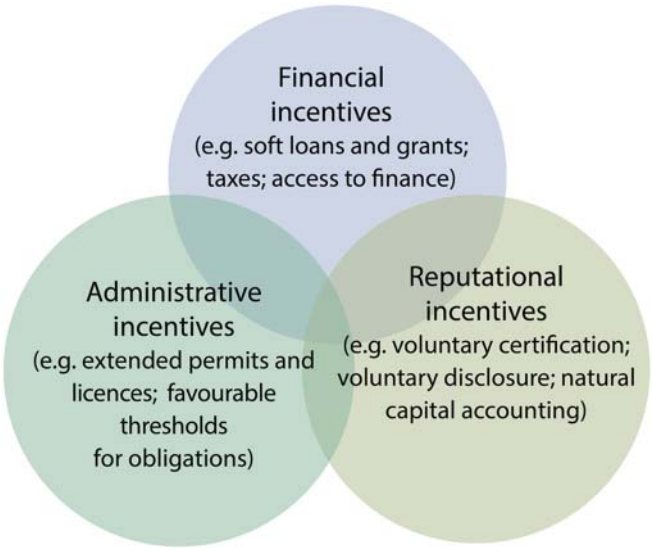
International financing institutions have been hesitant to tackle the issue of macro-economic incentives and financial instruments in natural resource use, even though creating a level playing field would be more cost-efficient and effective than complex compensation payments to governments. Well-established, practical instruments such as the certification of SFM and tracking technologies for deforestation-free supply chains are already available for verifying legality and sustainability. Donor organisations could expand their toolsets to enable the implementation of verifiable incentive mechanisms aimed at encouraging the sustainable use of natural resources in the tropics. With domestic and emerging-country markets for tropical timber increasing their share of the tropical timber trade, the price premium "bet" is losing ground. If sustainable timber prices are not high enough to bring about massive changes in management practices, governments and donors must think about alleviating the costs of sustainably produced timber. Subsidies have been used in the Borneo Initiative since 2011. This project, funded by Dutch companies and government, contributes two dollars per hectare to FSC-certified companies (Bartley 2014). This is likely to have contributed to the figure of 3 million hectares FSC certified in Indonesia in 2018, of which 2.8 million are production natural forests. However, international public donors are generally reluctant about direct subsidies to logging companies, when they do not have internal policies prohibiting them.

An important lever, among others, for creating a level playing field for economic operators who otherwise cannot compete against unsustainable business-as-usual practices is the use of taxation or other financial incentives such as subsidised and guaranteed loans or specific grants. Reducing forest taxes or providing other tangible benefits for those timber producers who implement responsible forest management

TABLE 2 *Intrasectoral factors influencing investment decisions*

- Framework conditions in terms of forest policies, laws and institutions
- Risks (e.g. corruption, illegal competition, reliability of contracts)
- Reliability of land rights and use
- Access to markets, infrastructure and logistics
- Access to information
- Technological skills, expertise, productivity
- Legal and bureaucratic constraints
- Transaction costs

FIGURE 4 *Overview of incentives for promoting sustainable forest management and supply chains*



practices might be a way to incentivise even those who cannot expect a price premium in their markets (Karsenty 2019).

Forest management certification might be used by governments to target those who will benefit from fiscal or other financial advantages. Donors could conclude bilateral agreements with national governments about budgetary support for compensating foregone fiscal revenues, complementing payments for results under REDD+ phase 3. Figure 5 provides a diagrammatic example of how such a scheme could work.

In many tropical countries, an important obstacle to the implementation of incentive mechanisms on the ground is the limited physical and human capacity – especially in small and medium-sized enterprises – for building or participating in legal and sustainable supply chains from the forest to the market. This includes a lack of capacity in landscape-oriented forest management planning; efficient and environmentally friendly production; tracking, verification and documentation tools; and access to responsible business partners. It is imperative, therefore, that incentive mechanisms are underpinned by technical assistance, training and capacity building for those economic actors committed to making a change.

Even a well-designed incentive scheme will be useless, however, if producing countries do not engage firmly against illegal logging, which not only undermines the rule of law but also makes legal and sustainable timber production uncompetitive. In this respect, the efforts of the European Union (EU) to tackle illegal timber imports through both the 2013 EU Timber Regulation (which criminalises the importation of illegal timber into EU countries) and voluntary partnership agreements (VPAs) between the EU and several tropical timber producing countries can be considered an important step in the right direction. Applied alone, however, VPAs do not seem sufficient to level the playing field between the most committed forest operators and business-as-usual practitioners (Carodenuto and Cerutti 2014, Hansen *et al.* 2018, Rutt *et al*. 2018). Combining fiscal incentives for SFM and sustained policies to reduce illegal logging might be a promising avenue.

CONTAINING FOREST LOSSES THROUGH TRADE IN LEGAL AND DEFORESTATION-FREE SUPPLY CHAINS

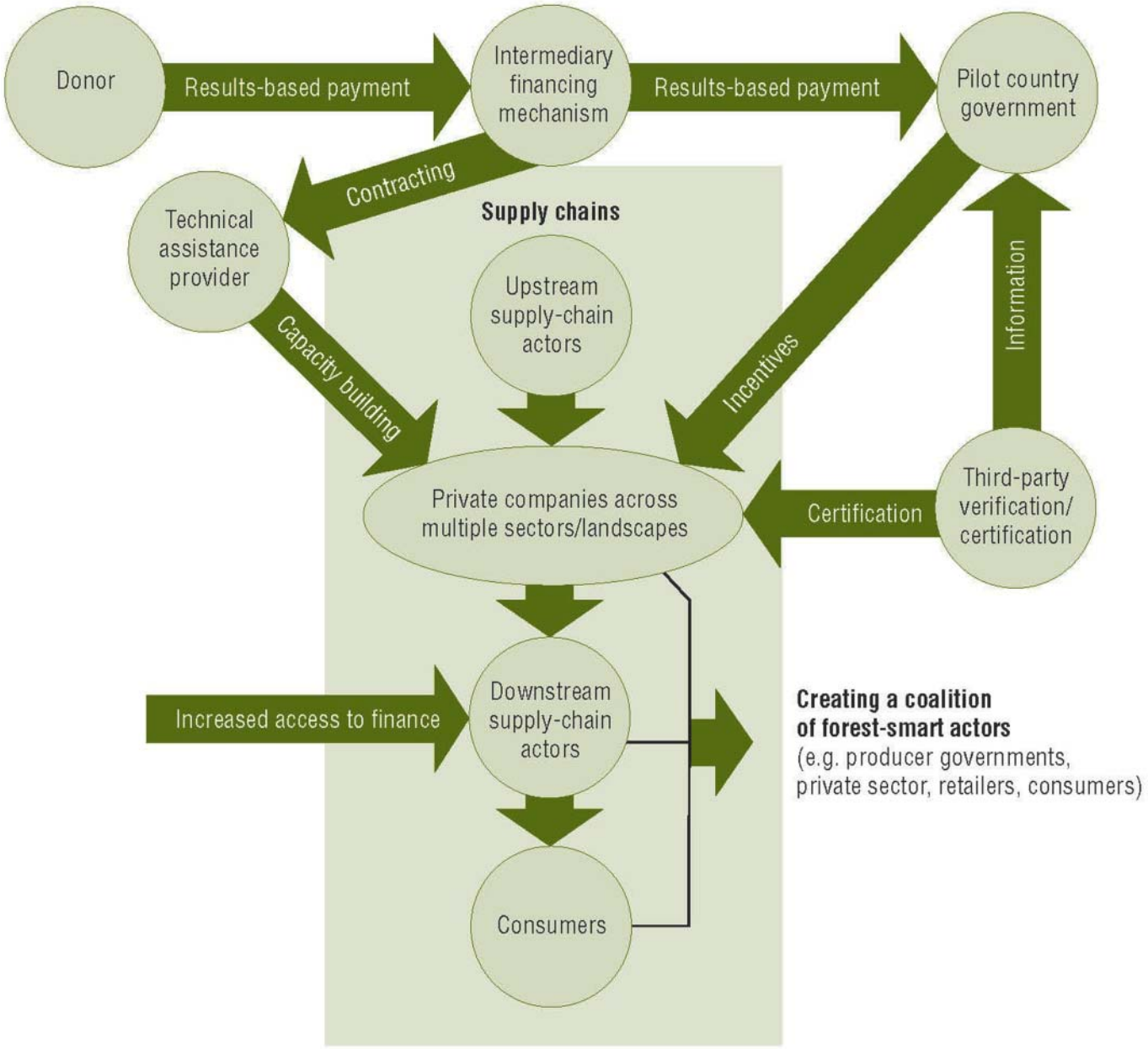
We can derive some optimism from the willingness now being shown in the private sector and international trade to set up legal and sustainable deforestation-free supply chains for food and wood products. Consumer countries have a major responsibility for encouraging sustainability among tropical wood producers. The EU Timber Regulation appears to be having an impact, even if it is implemented unevenly by member states. According to a study by WWF UK, there has been a sharp fall in recent years in the percentage of potentially illegal wood and wood products, with current estimates putting it at 15%. China, Europe's biggest trading partner for wood products and the world's largest importer of tropical wood (Figure 6), has adopted the national Green Supply Chains Strategy as part of its new "ecological civilisation" philosophy, not least because of louder demands from various sales markets. In early 2020, China issued a fist draft of a new forest law that adds a prohibition on buying illegally sourced timber. The current version doesn't go far enough to establish a legal framework for requiring supply chain due diligence to prevent purchasing, trading, or importing illegal sourced timber, but this firt move of the largest timber buyer's country is full of promises.

In June 2018, twelve corporate industry leaders with an estimated combined trading volume of USD 14 billion joined, with support from ITTO (Dieterle 2018), to form the Global Green Supply Chain initiative (GGSC). Later, in October 2019, ITTO in partnership with industry associations and private-sector partners convened an international forum in Shanghai, China (ITTO 2020). There, more than 200 private sector companies, including 34 large timber-purchasing companies from different regions of the world agreed to expand this voluntary network to promote recognition of the economic, social and environmental values of forests and the incorporation of legality and sustainability in all forestry operations. The GGSC network is open to all interested parties worldwide and is expected that it has high potential to change the forest industry's image and will become a motor for promoting sustainability of tropical forest management.

Economic incentives for deforestation-free agricultural commodities

Policies aiming at halting deforestation solely through free-deforestation supply chains face a couple of difficulties, however. One is the limited capacity of companies to trace products back to individual producers and land parcels when the production is spread among myriad small-scale farmers. This difficulty is evident in similar efforts to trace cocoa and natural rubber to their smallholder origins, often in situations where land registers are almost non-existent. In Côte d'Ivoire and Ghana, for example, both of which are major cocoa

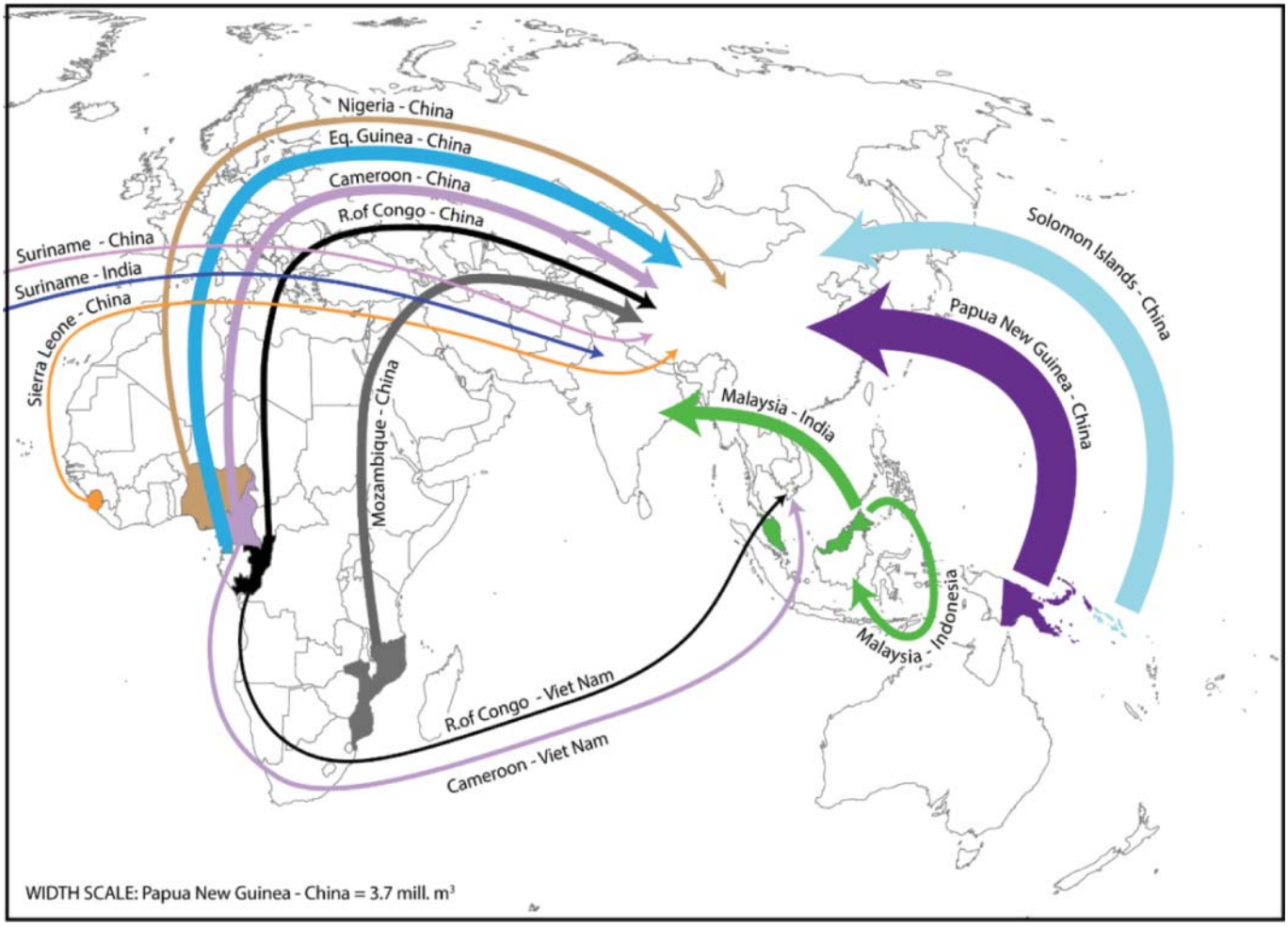
FIGURE 5 *Illustrative example of how an incentive scheme could work to promote sustainable forest management*



producers, identifying the producer and the corresponding plot is sometimes very difficult. Companies generally can track production to the level of cooperatives, which often collect their cocoa beans from mixed sources. Unclear land tenure makes full traceability challenging.

A second difficulty lies in the fact that deforestation is not always attributable to a single driver or a single commodity chain controlled by committed companies. Charcoal, food crops for local consumption, and urbanisation are also major drivers of deforestation and degradation. It is necessary, therefore, to combine deforestation-free supply chains and landscape/territorial policies to address other drivers (Biénabé *et al.* 2017). Land-use planning and establishing legal status for land uses is certainly the most necessary policy tool, but incentives are also needed to change individual and collective land-use practices to help people choose conservation, agroforestry and forest restoration rather than conversion to monocultures. Countries such as Costa Rica have shown the potential of national payment schemes for environmental services (PES) funded mainly by domestic resources (74% of the budget) through earmarked fees on fuel (around USD 11.6 million per year) and water distribution (around USD 3.6 million per year) (Porras *et al.* 2018). Even the poorest countries have the capacity to levy small fees on large basis consumption practices (e.g. on phone units, beverages, and access to social networks), thereby showing political will to protect trees and forests from land conversion (Karsenty 2015). In such cases, the international community of donors is likely to provide complementary funding – as in Costa Rica, where donors provided around 40% of the annual

FIGURE 6 *Major Trade Flows: Tropical Industrial Roundwood, 2018 (million m³) (Chart: ITTO, 2019)*



budget of the PES programme in its early stages (Porras *et al.* 2018). One could expect international transfers to cover a larger share of the budget gap in least-developed countries.

The international trade should not be overlooked. Today, sustainable and unsustainable (e.g. those for which production entailed deforestation) commodities attract the same taxes or duties (i.e. export taxes and import tariffs). The World Trade Organization (WTO) principle of non-discrimination applies to "similar products", without taking into account the production process and method (PPM) when it is "non-product-related" (i.e. where the production methods leave no trace in the final product, even though the method used harms the global environment). Adopting commercial measures such as lower tariffs for deforestation-free commodities and higher tariffs for the others (a principle called "feebates", for fees and rebates) might prove difficult under current WTO rules. Negotiating the evolution of WTO rules about non-product-related PPM should be a priority for changing the relative prices of deforestation-free imported commodities and others. Product certifications are gradually evolving to take into account the zero-deforestation principle, using the high carbon stock (HCS) criterion proposed by several organisations. For example, the Round Table for Sustainable Palm Oil's certification scheme for palm oil has applied the zero-deforestation principle since 2018 and considers the HCS criterion in its new certificates. Other product certification schemes (e.g. for cocoa and soy) are likely to follow suit and adopt the HCS criterion to implement the zero-deforestation principle. The use of feebates in tariffs would surely consolidate this move (Heine *et al.* 2017).

It is crucial that tropical food and wood producers, importers, processors and consumers work closely together because deforestation-free supply chains require intricate dovetailing and the documented tracking of products, from the field or the forest to the shop. For many tropical agriculture and wood businesses, this will be a major challenge.

CONCLUSION

In some tropical regions, as a result of population growth, climate change and forest degradation, the increased need for wood, whether for timber or fuelwood, will exceed the sustainable supply capacity of natural forests and plantations, potentially accelerating deforestation processes. As with the issue of food security, a problem of "wood supply security" is emerging in several developing countries, even if on a global scale there is no shortage of wood in sight.

This issue is poorly understood by most international initiatives focused on climate or biodiversity, which want to conserve forests but neglect the importance of the productive role of forests to support this conservation through the sustainable use of various resources, starting with wood. Solutions exist to exploit without destroying, to increase wood resources and their mobilization without harming biodiversity, to increase the added value associated with sustainable management operations in production forests, to verify the legality and sustainability of wood marketed through traceability systems...

A number of barriers prevent the large-scale deployment of these solutions. Many are institutional and reflect a lack of technical and organizational capacity in developing countries, both in government and in enterprises, especially SMEs. And sometimes it is primarily a lack of political will to combat illegal logging in order to level the playing field and make profitable the investment in SFM.

The international forest regime has evolved from initial technical forestry expertise perspective to environmental economics considerations. This broadening of perspectives is welcome, but its main policy outcome has focused more on the principle of compensation (the opportunity cost of conserving forests) than on the investment needed for incentives (envisaged notably in "results-based payments" mechanisms such as REDD+) to really work. Putting investment back at the forefront of the international agenda is necessary to create the conditions for achieving future results. Investment also means putting in place the financing instruments necessary to offer producers incentives to manage sustainably. In that respect, taxation can play a significant role, whether to collect earmarked revenues for financing incentive-oriented programmes or to promote good practices and certified production through differentiated rates.

One of the conditions for incentivizing the poorest producers and users, is the recognition and the protection of their access and use rights to the forest resources, and a more equitable sharing of the benefits of the exploitation of these resources. This is not only a matter of justice, this is also necessary so that people can obtain income from the sustainable exploitation of these resources and are not forced to operate illegally, thus making it impossible to regulate the use of these resources. Here again, instruments such as participatory mapping of customary areas exist to initiate the institutionalization of the different layers of rights over the same spaces, share the benefits of economic activities and lay the foundations for inclusive governance of concessions and protected areas. Recent legislations in tropical countries are timidly beginning to take these dimensions into account, but much remains to be done before a better balance of rights is achieved.

While the principle of the productive use of wooded resources regains some legitimacy with the development of forest certification and the FLEGT initiative, international public opinion and decision-makers have become increasingly aware that the fate of tropical forests lays out outside the forest sector, more specifically in the dynamics of agriculture and animal husbandry. Demand for deforestation-free commodities is increasing and voluntary initiatives of corporations are promising. However, there too, there are barriers related to the uncertain land tenure situation and smallholders' lack of assets for transforming their practices while keeping their revenues. Again, investment in land tenure clarification and assets-building PES targeting smallholders will be critical for fostering changes. On the other hand, international trade policies of importing countries should evolve to promote a more responsible consumption of forest-risky commodities. Producer and consumer countries share a responsibility for conserving and expanding tropical forests. After all, their impacts on the environment, the climate and prosperity do not stop at national borders, and we all stand to benefit.

REFERENCES

ANGELSEN, A. 2008. How do we set the reference levels for REDD payments? In: ANGELSEN, A. (ed.) *Moving ahead with REDD: Issues, options and implications*. CIFOR, Bogor.

ANGELSEN, A., BROCKHAUS, M., SUNDERLIN, W. and VERCHOT, L. 2012. *Analysing REDD+ – Challenges and Choices*. CIFOR, Bogor.

BACCINI, A., WALKER, W., FARINA, M., HOUGHTON, R., CARVALHO, L. and SULLA-MENASHE, D. 2017. Tropical forests are a net carbon source based on aboveground measurements of gain and loss. *Science* **358**(6360): 230-23410.1126/science.aam5962

BARTLEY, T. 2014. Transnational governance and the re-centered state: Sustainability or legality? *Regulation & Governance* **8**(1): 93–109.

BIÉNABÉ, E., DUTILLY, C., KARSENTY, A., and LE COQ, J.-F. 2017. Ecosystem services, payments for environmental services, and agri-chains: what kind of regulation to enhance sustainability? In: BIÉNABÉ, E. and RIVAL, A. (eds). *Sustainable Development and Tropical Agri-Chains*, Springer.

CARODENUTO, S. and CERUTTI, P.O. 2014. Forest Law Enforcement, Governance and Trade (FLEGT) in Cameroon: Perceived private sector benefits from VPA implementation. *Forest Policy and Economics* **48**: 55–62.

DE GALBERT, M., SCHMIDT-PRAMOV, F., DIETERLE, G. and LARSON, G. 2013. Widening the scope of forest-based mitigation options in the tropics – the role of forests in substituting for fossil energy sources and moving towards a greener economy. https://www.unece.org/fileadmin/DAM/timber/publications/ Forest_INFO_Billboard/Widening_the_scope_of_forest_based_mitigation_-_June_2013.pdf.

DIETERLE, G. 2018. Global green supply chains will help ensure forest sustainability. *Tropical Forestry Update* **27**(2): 3–6.

ELLIS, P.W., *et al.* 2019. Reduced-impact logging for climate change mitigation (RIL-C) can halve selective logging emissions from tropical forests. *Forest Ecology and Management* **438**: 255–266.

ERB, K.-H. *et al*. 2018. Unexpectedly large impact of forest management and grazing on global vegetation biomass. *Nature* **553**(7686): 73–76.

FISHER, B., LEWIS, S., BURGESS, N. *et al.* 2011. Implementation and opportunity costs of reducing deforestation and forest degradation in Tanzania. *Nature Climate Change* **1**: 161–164.

GREGERSEN, H., EL LAKANY, H., KARSENTY, A. and WHITE, A. 2010. *Does the opportunity cost approach indicate the real cost of REDD+? Rights and realities of paying for REDD+*. https://rightsandresources.org/wp-content/exported-pdf/reddbriefdraftjune28.pdf (last accessed 29.04.2020).

HANSEN, C.P., RUTT, R. and ACHEAMPONG, E. 2018. 'Experimental' or business as usual? Implementing the European Union Forest Law Enforcement, Governance and Trade (FLEGT) Voluntary Partnership Agreement in Ghana. *Forest Policy and Economics* **96**: 75–82.

HEINE, D., FAURE, M.G. and LAN, C-C. 2017. *Augmenting forest sustainability certificates with fiscal instruments*. Rotterdam Institute of Law and Economics (RILE) Working Paper Series 2015/7. https://ssrn.com/abstract=2617815

HUMPHREYS, D. 2009. Forest Politics: The Evolution of International Cooperation. Earthscan.

ICKOWITZ, A., SILLS, E. and DE SASSI, C. 2017. Estimating smallholder opportunity costs of REDD+: a pantropical analysis from households to carbon and back. *World Development* **95**: 15–26.

INTERNATIONAL TROPICAL TIMBER AGREEMENT. 2006. United Nations, Treaty Series, vol. 2797, p.75; Doc. TD/TIMBER.3/12.

IPPC. 2019. *IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems*, approved draft August 2019.

ITTO. 2019. *Biennial Review and assessment of the world timber situation 2017–2018*. Yokohama, Japan. www.itto.int. ISBN 978-4-86507-049-1

ITTO. 2020. *Report of the International Forum Together Towards Global Green Supply Chains: A Forest Products Industry Initiative.* Yokohama, Japan. www.itto.int

JACKSON, R. *et al*. 2005. Trading water for carbon with biological carbon sequestration. *Science* **310**: 1944–7.

KARSENTY, A. 2015. Using PES to achieve "zero deforestation" agriculture, *Perspective* **36**, CIRAD, Montpellier.

KARSENTY, A. 2019. Certification of tropical forests: A private instrument of public interest? A focus on the Congo Basin, *Forest Policy and Economics* **106**: 101974.

KARSENTY, A. and VERMEULEN, C. 2017. Toward "Concessions 2.0": articulating inclusive and exclusive management in production forests in Central Africa, *International Forestry Review* **19**(S2 – Special issue on forest concessions in Africa)

KARSENTY, A. and PIRARD, R. 2007. Forêts tropicales: la question du bien public mondial et la quête d'instruments économiques multilatéraux pour un régime international, *Revue Forestière Française* **59**(5): 537–545.

KNAUF, M. *et al.* 2015. Modelling the CO_2 effects of forest management and wood usage on a regional basis. *Carbon Balance and Management* **10**(13).

KRÖGER, M. 2014. The political economy of global tree plantation expansion: a review. *Journal of Peasant Studies* **41**(2): 235–261.

LIPSCHUTZ, R.D. 2000. Why is there no international forestry law: an examination of international forestry regulation, both public and private. *UCLA Journal of Environmental Law & Policy* **19**: 153.

MCKINSEY & COMPANY. 2009. Pathways to a Low-Carbon Economy. http://www.mckinsey.com/clientservice/ccsi/pathways_low_carbon_economy.asp

NAHUELHUAL, L., A. CARMONA, A. LARA, C. ECHEVERRÍA and GONZÁLEZ, M. 2012. Land-cover change to forest plantations: Proximate causes and implications for the landscape in south-central Chile. *Landscape and Urban Planning* **107**(1): 12–20.

OBIDZINSKI, K. and DERMAWAN, A. 2012. Pulp industry and environment in Indonesia: is there sustainable future? *Regional Environmental Change* **12**: 961–966.

OLIVER, C.D., NASSAR, N.T., LIPPKE, B.R. and MCCARTER, J.B. 2014. Carbon, fossil fuel, and biodiversity mitigation with wood and forests. *Journal of Sustainable Forestry* **33**(3): 248–275.

ORÉADE-BRÈCHE 2017. *Étude d'évaluation des coûts et des bénéfices liés à la certification forestière dans le bassin du Congo.* PPECF-COMIFAC, Yaoundé.

PIRARD, R., DAL SECCO, L. and WARMAN, R. 2016. Do timber plantations contribute to forest conservation? *Environmental Science & Policy* **57**: 122–130.

PORRAS, I., BARTON, D.N, MIRANDA, M. and CHACÓN-CASCANTE, A. 2013. *Learning from 20 years of Payments for Ecosystem Services in Costa Rica*. International Institute for Environment and Development, London.

REIJ, C. and WINTERBOTTOM, R. 2017. Can we restore 350 million hectares by 2030? Blog, 15 February. World Resources Institute. https://www.wri.org/blog/2017/02/can-we-restore-350-million-hectares-2030.

RUTT, R.L., MYERS, R., RAMCILOVIC-SUOMINEN, S. and MCDERMOTT, C. 2018. FLEGT: Another 'forestry fad'? *Environmental Science & Policy* **89**: 266–272.

SINGER, B. 2008. Putting the national back into forest-related policies: the international forests regime and national policies in Brazil and Indonesia. *International Forestry Review* **10**(3): 523–537.

THOMPSON, D.Y., SWALLOW, B.M. and LUCKERT, M.K. 2017. Costs of lost opportunities: Applying non-market valuation techniques to potential REDD+ participants in Cameroon. *Forests* **8**(3): 69.

WADE, T.I., NDIAYE, O., MAUCLAIRE, M., MBAYE, B., SAGNA, M., GUISSÉ A. and GOFFNER, D. 2018. Biodiversity field trials to inform reforestation and natural resource management strategies along the African Great Green Wall in Senegal, *New Forests* **49**: 341–362.

WORLD BANK, PROFOR, CIF. 2017. *Harnessing the potential of private sector engagement in productive forests for Green Growth*. Washington, DC.

WWF. 2015. *Profitability and sustainability in responsible forestry economic impacts of FSC certification on forest operators*. www.panda.org/forests

ZENGHELIS, D. 2006. Stern Review: The economics of climate change. London, England: HM Treasury, 686–702.

Protected and other conserved areas: ensuring the future of forest biodiversity in a changing climate

K. MacKINNON, K. RICHARDSON and J. MacKINNON

IUCN/World Commission on Protected Areas, Rue de Mauverney 28, 1196 Gland, Switzerland

Email: kathy.s.mackinnon@gmail.com; karrichardson@gmail and jameslachlanmackinnon@gmail.com

SUMMARY

Biodiversity loss and climate change are two of the greatest environmental challenges of our times and are inextricably interlinked. The most significant drivers of forest and biodiversity loss are habitat loss and fragmentation due to land use changes and overexploitation. These changes will be exacerbated by climate change with increasing land degradation and more conversion of forests to meet increasing demands for agriculture and forest resources. Protected areas are the cornerstones of biodiversity conservation. Currently terrestrial protected areas cover about 15 percent of the world's land surface but this is inadequate to fully represent global biodiversity, with many forest ecosystems poorly represented in protected area networks. Ensuring effective biodiversity conservation post-2020 will require both expansion of formal reserve systems and recognition and support for other effective conservation measures, under a diverse range of governance and management regimes. Expanding forest conservation efforts will not only protect biodiversity but is increasingly recognised as an efficient and cost-effective strategy to help societies to cope with climate change and its impacts.

Keywords: protected areas, OECM, forest biodiversity, climate change, natural solutions

Aires protégées et autres zones de conservation: assurer l'avenir de la biodiversité forestière dans un climat changeant

K. MACKINNON, K. RICHARDSON et J. MACKINNON

La perte de la biodiversité et le changement climatique sont deux des plus grands défis environnementaux de notre époque et sont inextricablement liés. Les principaux facteurs de perte de la biodiversité et des forêts sont la perte d'habitats et la fragmentation dues aux changements d'utilisation de la terre et à la surexploitation. Ces changements seront exacerbés par le changement climatique avec une dégradation grandissante des terres et une conversion accrue des forêts pour pourvoir aux demandes croissantes de l'agriculture et en ressources forestières. Les aires protégées sont la pierre angulaire de la conservation de la biodiversité. Les aires terrestres protégées recouvrent actuellement environ 15% de la surface terrestre du globe, mais ceci est inadéquat pour représenter complètement la biodiversité globale, maints écosystèmes forestiers étant pauvrement représentés dans les réseaux des aires protégées. Pour assurer une conservation efficace de la biodiversité au-delà de 2020, il faudra une expansion des systèmes de réserve formels ainsi qu'une reconnaissance et un soutien des autres mesures de conservation efficaces, sous l'égide d'un éventail de régimes de gouvernance et de gestions divers. L'élargissement des efforts de conservation forestière ne protègera pas seulement la biodiversité, mais est également de plus en plus reconnu comme une stratégie efficace et rentable pour aider les sociétés à pouvoir supporter le changement climatique et ses impacts.

Áreas protegidas y otras áreas de conservación: garantías de futuro para la biodiversidad forestal en un clima cambiante

K. MACKINNON, K. RICHARDSON y J. MACKINNON

La pérdida de la biodiversidad y el cambio climático son dos de los mayores desafíos ambientales de nuestros tiempos y están inextricablemente interrelacionados. Los factores más importantes que impulsan la pérdida de los bosques y de la diversidad biológica son la pérdida y la fragmentación de los hábitats debido a los cambios de uso de la tierra y a la sobreexplotación. Estos cambios se verán exacerbados por el cambio climático, debido al aumento de la degradación de la tierra y a una mayor conversión de bosques para satisfacer la creciente demanda de recursos agrícolas y forestales. Las áreas protegidas son la piedra angular de la conservación de la biodiversidad. En la actualidad, las áreas terrestres protegidas abarcan alrededor del 15 por ciento de la superficie terrestre del mundo, pero esto no es suficiente para representar plenamente la biodiversidad mundial, ya que muchos ecosistemas forestales están apenas representados en las redes de áreas protegidas. Para garantizar una conservación eficaz de la biodiversidad después de 2020 será necesario ampliar los sistemas oficiales de reservas y reconocer y apoyar otras medidas de conservación eficaces, en el marco de una amplia gama de regímenes de gobernanza y gestión. La ampliación de los esfuerzos de conservación de los bosques no sólo protegerá la diversidad biológica, sino que se reconoce cada vez más como una estrategia efectiva y eficaz en relación al.

INTRODUCTION

Climate change and biodiversity loss are two of the greatest environmental challenges of our times and are inextricably interlinked. Climate change will impact adversely on both natural habitats and their attendant biodiversity. Even a 1.5 to 2 degree C global temperature rise, as anticipated by the Paris Agreement on Climate, will cause modifications to ecosystem functions and species distributions and any rise beyond this level will cause significantly more changes to occur (Bellard *et al.* 2012, IPBES 2019, UNFCCC 2015, IPCC 2019). Conversely, protecting natural ecosystems, including forests, can help to save biodiversity, remove carbon from the atmosphere and protect carbon stores and sinks (IPBES 2019).

Biological diversity underpins ecosystem functioning and the provision of ecosystem services essential for human welfare and well-being, yet biodiversity is under increasing threat globally (IPBES 2019). Forest ecosystems are some of the most biologically-rich ecosystems but are threatened by overexploitation, fragmentation and conversion due to logging, mining and expanding agricultural frontiers. It is estimated that around 30 percent of global forest cover has already been cleared, while another 20 percent has been degraded (Mackey *et al.* 2014, IPBES 2019, Curtis *et al.* 2018). Approximately 1.3 million hectares of forests are being lost every year and much of the rest has been fragmented, leaving only about 15 percent intact (FAO 2016). These intact areas are often especially important for both biodiversity and carbon storage (Strassburg *et al.* 2010), yet only one fifth of these remaining forests lie within protected areas (www.protectedplanet.org).

Protected areas are the cornerstones of biodiversity conservation and more critical than ever in a time of changing climate as ecosystem-based approaches are increasingly recognised as efficient and cost-effective strategies for helping societies to cope with, mitigate, and adapt to, climate change and its impacts (CBD 2019). This paper focuses on how enhanced protection of forests, under different governance and management regimes, can deliver multiple benefits for biodiversity conservation, climate change mitigation and adaptation and more sustainable development.

CONSERVING FORESTS

Protected areas are widely recognised as one of the most effective ways to conserve biodiversity and reduce forest loss (Lopoukhine and Dias 2012, Woodley *et al.* 2012, Watson *et al.* 2014). Accordingly, in 2010 the Parties to the Convention on Biological Diversity (CBD) adopted a new Strategic Plan for Biodiversity with 20 headline targets to be achieved by 2020 (the Aichi Targets). Aichi Target 11 specifically identifies the need to expand global protected area coverage to at least 17 percent of terrestrial and inland water habitats, including forests (Box 1). It seems likely that the coverage elements of Target 11 will be achieved by 2020 although there is much still to do on other quality elements (Gannon *et al.* 2019). Successfully meeting increased protected area coverage will also contribute towards other Aichi Targets to reduce the rate of loss and fragmentation of all natural habitats (Target 5), sustainably manage forests (Target 7), and protect habitats which deliver ecosystem services and protect carbon stocks (Targets 14 and 15). Achieving Target 11 will also contribute to the Sustainable Development Goals (SDGs), especially SDG 15 to protect, restore and sustainably use terrestrial ecosystems, sustainably manage forests and halt and reverse land degradation and to SDG 13 on action to combat climate change.

Box 1 Aichi Target 11

By 2020, at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape.

By late 2019, terrestrial protected areas covered 15.0 percent of the world's land area, including areas of boreal, temperate and tropical forests (www.protectedplanet.org, Gannon *et al.* 2019). Although some countries have already protected 17 percent of their land area, many habitats and species are still poorly represented or not recorded within the global protected area network. Only 22 percent of extant primary forest is found within IUCN Protected Areas Categories I–VI; this is approximately 5 percent of natural forest cover (Mackey *et al.* 2014). At present only 43 percent of the 823 terrestrial ecoregions meet the 17 percent target and less than half (46 percent) of currently-identified Key Biodiversity Areas (KBAs) lie within protected areas (Gannon *et al.* 2019). Achieving ecological representation will therefore require a substantial increase in protected area coverage and some hard decisions on land use, especially for lowland forests, which are currently poorly protected and have high potential for agricultural production for food and energy crops (FAO 2018). As countries negotiate a new post-2020 Global Biodiversity Framework there is good scientific evidence for a minimum area-based target of at least 30 percent of secure natural ecosystems with some authors calling for 50 to 70 per cent protection or even higher (Buscher *et al.* 2016, Dinerstein *et al.* 2019, Woodley *et al.* 2019, CBD 2020).

Aichi Target 11 specifically recognises that there are also many areas beyond gazetted national and regional protected area networks that contribute to the effective in-situ conservation of biodiversity. These Other Effective Area-based Conservation measures (OECMs), defined by CBD Decision 14/8 in 2018, are not recognised as formal protected areas but nevertheless deliver effective biodiversity conservation even though conservation may not be a core management objective (Jonas *et al.* 2018, IUCN/WCPA 2019). Potential OECMs may include indigenous and community conservation areas

(ICCAs), protected watersheds and well-managed, biodiversity-rich forests that could play an important role in both biodiversity conservation and climate change initiatives. Identifying and supporting OECMs is likely to become a major contribution to conservation in the post-2020 Global Biodiversity Framework.

Recognition of OECMs provides the opportunity to engage and support indigenous and community groups, as well as private sector stakeholders and government agencies in forest conservation efforts. A mapping exercise by Garnett *et al.* (2018) estimated that indigenous peoples manage or have tenure rights over at least 38 million sq.km of land in 87 countries. This represents over a quarter of the world's land surface and some 37 percent of all remaining natural habitats, and ecologically-intact landscapes, including large forest areas; however the study does not provide detailed information on governance or the nature of land use. Recognising the subset of such areas that deliver biodiversity outcomes as OECMs – if local communities wish to do so – will support existing efforts that already contribute to conservation, while respecting human rights and a diversity of governance and management approaches. The Dayak Kenyah people in the interior of Indonesian Borneo, for instance, protect and manage areas of primary forest with valuable timber and non-timber forest products under customary laws that limit access and activities. Recognising these *tana' ulen* areas as OECMs could provide an incentive for communities to continue to conserve these areas (Eghenter 2018).

Establishing a fully representative and effectively managed system of protected areas and OECMs that cover a range of governance and management types will strengthen the existing formal protected area networks and contribute to achieving biodiversity conservation targets by enhancing ecological representation and protection of areas especially important for biodiversity (Jonas *et al.* 2018). A study across 10 countries showed that around 80 percent of 754 unprotected KBAs outside formal protected areas were at least partly covered by one or more potential OECMs and over half were wholly covered (Donald *et al.* 2019). Recognising and supporting diverse governance and management approaches in biodiversity-rich forests may also deliver greater local community and biodiversity benefits, while also lowering rates of deforestation and degradation (Ricketts *et al.* 2010, Virkkala *et al.* 2014, Oldekop *et al.* 2016, IPBES 2019).

Protected Forests as Natural Solutions to Climate Change

Forests cover some 35 percent of the world's land surface but store 50 percent of terrestrial carbon in soil and above-ground biomass. Boreal forests, which represent 30 percent of all forests, store the largest amount of terrestrial carbon, the majority of it in deep soils which are seasonally frozen (Pan *et al.* 2011, Kurz *et al.* 2013, Gauthier *et al.* 2015, Bradshaw and Warkentin 2015). Another 20 percent of this carbon is found in the tropical forests of the Amazon Basin, Congo Basin, Mesoamerica, and Indonesia (Walker *et al.* 2014, Kapos *et al.* 2008). Mangroves cover only a small part of the globe but store approximately four times more carbon per hectare than tropical forests (Laffoley and Grimsditch 2009, Scharlemann *et al.* 2014). Twenty-five percent of all mangroves have been lost in the last 20 years, contributing as much as 10 percent of the carbon released due to global deforestation annually (Hutchison *et al.* 2014).

Given that food production is estimated to increase by 50 percent between 2010 and 2050 (FAO 2018) there is likely to be a substantial increase in forests converted for agriculture over the next decades. The amount of carbon that enters the atmosphere when forests are burned, land is cleared, soil is disturbed, and wetlands are drained is estimated to be about one-third of the total carbon dioxide emissions entering the atmosphere each year (IPCC 2016, IPBES 2019). Forest loss and degradation accounts for approximately 12 percent of overall total carbon dioxide emissions (Le Quéré *et al.* 2018). Recent data suggest that deforestation and associated emissions are increasing (www.globalforestwatch.org). When boreal forests in permafrost zones and northern peatlands are disturbed, for example, they also release large quantities of methane, a very potent greenhouse gas (Buckley and Hillerislambers 2019). Increased fires and respiration in tropical forests due to climate change are also increasing emissions of carbon to the atmosphere (Hadden and Grelle 2017). Protecting as much of the most vulnerable carbon-rich ecosystems in as intact a state as possible is therefore a crucial mitigation strategy.

There is growing evidence that protected areas, ICCAs and OECMs can be useful tools for protecting areas important for carbon storage and climate stabilisation (Griscom *et al.* 2017, Bertzky *et al.* 2019, Dinerstein *et al.* 2019). A conservative estimate suggests that protected areas globally store over 312 Gt carbon or 15 percent of the terrestrial carbon stock but the degree to which carbon stocks are protected varies among regions and under different management regimes (Kaposi *et al.* 2008, Scharlemann *et al.* 2010). Studies in Mexico, one of the 10 countries with the highest mangrove deforestation rates in the world, show that mangrove protection and restoration can be an effective strategy to mitigate climate change. For example, the carbon stocks in the mangroves of Sian Ka'an reserve store the equivalent of about 40–46 percent of the total carbon dioxide emissions of Mexico during 2009 (Adame *et al.* 2013).

Furthermore, it has been estimated that indigenous lands in remaining natural habitats store more than 293 gigatons of carbon globally (Garnett *et al.* 2018). Many indigenous territories overlap with carbon-rich forests that are some of the areas of highest biodiversity globally, including the tropical forests of the Amazon, Congo Basin, Malaysia and Indonesia (Dinerstein *et al.* 2019). If OECMs are also taken into account, this amount would increase significantly. In the Western Amazon, deforestation rates were calculated to be 2.8 and 2 times lower in indigenous lands of the Bolivian and Colombia Amazon, respectively, when compared to areas outside (Walker *et al.* 2014).

The Amazon and Congo Basin, the two largest remaining areas of tropical rainforests, together cover 1.1 billion hectares, have high rates of endemism and represent large carbon

stocks, estimated at more than 200,000 million tons (Dinerstein *et al.* 2019). Maintaining intact forest cover in these regions is critical not only for biodiversity conservation and carbon storage but it also plays a major role in influencing regional climate and rainfall patterns. For example, federal and state-managed protected areas and indigenous conserved areas in the forests of the Brazilian Amazon, now cover more than 30 million hectares, protect a carbon stock of 4.5 billion tonnes and are likely to prevent an estimated 670,000 km^2 of deforestation by 2050, representing 1.8 billion tonnes of avoided carbon dioxide emissions (Soares-Filho *et al.* 2010, World Bank 2010). Similarly, protected areas in Bolivia, Venezuela and Mexico contain 25 million ha of forest and are estimated to store over 4 billion tonnes of carbon. The REDPARQUES network for cooperation between protected area agencies in 19 Latin American countries has led the way in recognising the importance of protected areas as solutions for mitigation and adaptation to climate change (Guevara *et al.* 2016, Smith *et al.* 2019). Partners are working together to use spatial mapping to identify climatic conditions, climate risk and opportunities to expand and enhance resilience in the Amazon's protected areas network (Guevara *et al.* 2016).

Protected Areas Helping People to Cope with Climate Change

Climate change will not only lead to further biodiversity loss but will also impact on human livelihoods and welfare (World Bank 2010, Ripple *et al.* 2017). Food security, water stress, land degradation and risks from natural disasters will be exacerbated by rising temperatures, more erratic rainfall, extreme climatic events and rising pressure to exploit forests to extract natural resources and clear land for agriculture. The impact will be especially hard in some of the poorest and least developed countries, leading to increased pressure on natural resources, and possibly leading to large-scale human migration (MacKinnon 2016). By protecting forests and other natural habitats, protected areas and OECMs have a key role to play in helping people cope with climate change and its impacts (Dudley *et al.* 2010, 2011, 2017, Lopoukhine *et al.* 2012).

Higher temperatures and more erratic rainfall patterns associated with climate change will affect the supply of, and demand for, water resources in many regions. Well-managed protected areas can play a critical role in maintaining water supplies for agriculture, domestic use and energy (Dudley *et al.* 2010, World Bank 2010, Harrison *et al.* 2016). Functioning natural ecosystems can help to maintain water quality and regulate water availability through filtration, groundwater renewal and maintenance of natural flows. Some of the world's largest cities including Mumbai, New York, Sofia, Dar es Salaam, Melbourne, Tokyo and Sydney receive a significant proportion of their drinking water supplies directly from nearby forest protected areas (Stolton and Dudley 2010). Appreciation of the value of intact forests in maintaining downstream water supplies for agricultural irrigation led to the establishment of the 300,000-hectare Dumoga-Bone national park in North Sulawesi, Indonesia and expansion of forest protected areas in Madagascar (World Bank 2010). In Colombia, 60 percent of the country's power supply comes from hydroelectricity that is generated from rivers in protected areas in the Andes (Stolton and Dudley 2010).

Forest protected areas and OECMs will also become more valuable as climatic events become more severe, helping to reduce the impact of natural hazards and disasters and buffering vulnerable communities against all but the most severe flood and tidal events, landslides, and storms (Dudley *et al.* 2013, Stolton and Dudley 2010). Intact mangroves provide coastal protection and reduce the damage caused by tsunamis and hurricanes, while also harbouring vital fish nurseries. An initial investment of US$1.1 million in Vietnam to plant and protect mangrove forests as a buffer against storms is estimated to have saved more than $7.3 million a year in sea dyke maintenance and significantly reduced the loss of life and property during Typhoon Wukong in 2000 in comparison with other areas (Dudley *et al.* 2010). Protected mangroves in the Sundarbans of Bangladesh and India, as well as Guinea-Bissau are all valued for their role in buffering storm surges and tidal waves (Stolton and Dudley 2010). Indeed, protecting and restoring natural habitats may be more cost effective for reducing disaster risk than investing in hard infrastructure alone (Talberth *et al.* 2013). In Switzerland, 17 percent of forests are managed to stop avalanches, a service valued at US$2–3.5 billion per year (Dudley *et al.* 2013). Flood management strategies in Argentina incorporate protection of natural riverine forests to complement early-warning systems and hard infrastructure along the Parana River, protecting rich biodiversity in the floodplains, as well as human settlements (World Bank 2010). Similarly, Japan is restoring coastal forests to protect shorelines from tidal surges in areas affected by the Sendai earthquake and tsunami (MacKinnon 2016).

Restoring Forest Landscapes

Natural ecosystems are becoming increasingly fragmented and many protected areas have become isolated "islands" within more intensively-used production lands. Climate change and increased pressure on land and natural resources will require new strategies for conservation and improved protected area planning and design, including better protection of areas that are both biodiversity-rich and important carbon stores (MacKinnon 2016, Dinerstein *et al.* 2019). Large intact protected areas covering altitudinal gradients will allow many species to adapt to a changing climate by providing refugial habitat and the room needed for species to move and respond to changing local conditions. Recognition and support for OECMs will protect additional carbon stocks and strengthen the formal protected area network. These conservation areas will need to be supplemented by greater efforts to maintain and restore habitat connectivity in the wider landscape, as well as better land use planning for more 'biodiversity-friendly' practices in surrounding landscapes (Worboys *et al.* 2010, MacKinnon 2016).

Restoration will become an increasingly important part of biodiversity management, both within protected areas, OECMS and adjacent lands to restore degraded lands and

maintain ecological networks. The US Fish and Wildlife Service, for example, has used carbon offsets to plant more than 8 million native trees within 30,000 acres of wildlife refuges over 10 years. As these forests mature, they are expected to sequester more than 9 million tons of carbon, helping to reduce greenhouse gas emissions and restore critical wildlife habitat (Keenleyside *et al.* 2012). In Indonesia ecological restoration of previous logging concessions has the potential to significantly expand the conservation estate – see Box 2.

Box 2 Harapan Rainforest: Ecological restoration in Sumatra

Over the last century biodiversity-rich lowland rainforest on Sumatra has dwindled from 16 million hectares to a mere 500,000 hectares and the island's lowland forests are still under threat, especially for conversion to oil palm. Although Sumatra has some important protected areas, most are in hilly regions and even those national parks and reserves are threatened by agricultural encroachment and illegal logging. In 2004, new legislation created the opportunity for production forests to be restored and managed for conservation. Subsequently Harapan Rainforest, 98,000 hectares of valuable lowland forest in a former logging concession, became the first ecosystem restoration concession in Indonesia. The area is managed by a private partnership consisting of three NGOs: Burung Indonesia, Birdlife International and the Royal Society for Protection of Birds with a management licence for 100 years.

Harapan Rainforest is at the forefront of one of the most exciting conservation opportunities in Indonesia. Although previously partially logged, the area retains some good-quality lowland rainforest, a habitat type that is poorly represented in the formal protected area network. Natural regeneration and limited planting with native species are allowing the forest to recover. The area supports a rich variety of wildlife, including populations of tigers, clouded leopard, elephants, Malay tapir, six species of primates and at least 235 species of birds including six species of hornbills. The Harapan model of ecosystem restoration is now being expanded to other former logging concessions sites, making a significant contribution to Indonesia's efforts to safeguard forests and biodiversity, and to mitigate climate change through reducing greenhouse gas emissions from deforestation and degradation. Harapan Rainforest is not designated as a protected area, but its management objectives and effective conservation outcomes fit well with the criteria of OECMs as described in Aichi Target 11.

Source: Utomo and Walsh 2018

Restoration of logged and degraded forests could reduce greenhouse gas emissions significantly by 2030 (Griscom *et al.* 2017), but also enhance biodiversity conservation by ensuring additional habitat for species and restoring connectivity between fragmented areas of forest and protected areas (Ferez *et al.* 2015). A recent study suggests that tree planting could be one of the most effective strategies to mitigate climate change, with up to 0.9 billion hectares of land available globally for planting trees with the potential to remove 200 gigatonnes of CO_2 from the atmosphere. This equates to two thirds of anthropogenic greenhouse gas (GHG) emissions since the industrial revolution and one quarter of all CO_2 in the atmosphere (Bastin *et al.* 2019). While this proposal may be overoptimistic because of the challenges of water availability, complex land rights etc., the New York Declaration on Forests – an update of the Bonn Challenge – aims to bring 150 million hectares of degraded and deforested land into restoration by 2020 and 350 million hectares by 2030. By 2016, commitments for forest restoration under this initiative included 63.3 million hectares in Africa, 23.6 million hectares in Latin America and 22.4 million hectares in Asia (Smith *et al.* 2019).

Many countries are now planning major efforts to create and restore new forests. However, any reforestation or afforestation efforts for carbon sequestration need to consider likely impact on biodiversity and other ecosystems services. Planting trees on native grasslands or reforesting with monocultures of exotic species, for example, may give carbon sequestration benefits but would be detrimental for biodiversity (Smith *et al.* 2019). If well planned and targeted, however, reforestation initiatives could be an effective way to reverse biodiversity loss and enhance connectivity, as well as help to mitigate climate change and protect or enhance other ecosystem services such as water production.

Funding Protection and Restoration of Forests

Establishing new, better managed and better connected protected areas to enhance biodiversity conservation and assist with climate change mitigation will have significant costs. Estimates for a truly representative and effectively managed global protected area system range widely from US$34–79 billion annually (Butchart *et al.* 2012, McCarthy *et al.* 2012). It is hard to get an accurate figure for current levels of funding for protected areas globally but estimates for biodiversity conservation overall have been suggested at US$4–10 billion per year (Barbier *et al.* 2018). Detailed studies on sustainable financing in 20 Latin American countries suggest that protected areas could be well managed for much less (Bovarnick *et al.* 2010), but it is clear that many protected area systems are inadequately funded for effective management (Watson *et al.* 2014, MacKinnon 2016).

Most protected areas draw at least part of their funding from national budgets but in many developing countries these are supplemented with international funds. The Global Environment Facility (GEF) has been one of the largest funding mechanisms for protected areas worldwide, investing over 25 years in establishing and improving the management of 3,300 protected areas covering 860 million hectares, an area larger than Brazil and many of these protected areas lie within tropical forests. In addition, the GEF has helped 60 countries implement system-wide finance strategies for protected areas through conservation trust funds, payment for ecosystem services (PES), revolving funds and other sustainable financing (see www.thegef.org). Compared to estimated

needs, however, these funds are modest and much more needs to be done to mainstream biodiversity conservation into different economic sectors and development plans.

It is clear that protected areas can never be adequately funded from conservation funds alone and new financing will need to be identified linked to economic benefits and national development agendas. The socio-economic benefits from provision of ecosystem services, especially water security and carbon storage and sequestration, could more than justify the costs of conservation and sustainable management of natural ecosystems. The value of ecosystem services in terms of water regulation and supply has been estimated as US$2–3 trillion globally (Costanza *et al.* 1997, De Groot *et al.* 2012) yet very little of this potential value is invested in protecting natural habitats. One promising trend is the implementation of payment for ecosystem services schemes to compensate protected areas, upstream communities, indigenous peoples and private landowners for maintaining forests and other water-regulating habitats, such as those being implemented in Colombia, Ecuador, Mexico and Nicaragua (World Bank 2010). Since 1997, Costa Rica has invested over US$100 million in PES schemes to maintain biodiversity and carbon stocks. More than 80 percent of these payments are supporting conservation in national parks, biological corridors and strategic water catchments, with each hectare of forest estimated to be worth between US$40–100 for the service provided in protecting watersheds (World Bank 2010).

After a decade of debate and planning, the importance of forests was finally recognised in the UNFCCC's Paris Agreement in 2015, with Reducing Deforestation and Forest Degradation plus conservation, sustainable management of forests and enhancement of forest carbon stocks (REDD+) recognised as an important intervention to achieve global targets for reducing GHG emissions. Under REDD+, developing countries will receive Results-Based Payments (RBPs) for reductions in forest-based GHG emissions that they achieve and REDD+ is expected to become one of the main avenues for countries to access climate finance for protecting or improving management of forests. The UNFCCC has specifically recognised the global Green Climate Fund (GCF) as a funding channel for REDD+ RBPs. The GCF makes investments in eight strategic results areas, one of which is forests. As of April 2019, GCF had approved funding of US$300 million (with US$330 million in co-finance) to 15 projects related to forests (including both mitigation and adaptation projects) covering 32 countries. These projects are expected to reduce 70 $MtCO_2$ over 10 years of implementation (www.greenclimate.fund). In February 2019, in the context of the pilot programme for REDD+ RBPs, GCF approved its first payment for REDD+ results to Brazil for reducing emissions from deforestation and forest degradation in the period 2014–2015. This was an important milestone for REDD+ as it was the first payment for REDD+ results following the UNFCCC decisions.

While REDD+ is likely to become more important in the future, there are a number of other climate funds specific to, or relevant to forests, including the BioCarbon Fund, Forest Carbon Partnership Facility, Forest Investment Programme and Pilot Programme for Climate Resilience (World Bank 2010). Bilateral climate funding also often targets forests. For example, under the Norway-Guyana partnership, Norway agreed to provide financial support of up to US$250 million until 2015 for results achieved by Guyana in limiting emissions from deforestation and forest degradation (www.guyanareddfund.org, accessed 8 July 2019). Elsewhere, finance for protecting forests has been acquired from private sources interested in the voluntary carbon market. For example, in Madagascar the protected areas of Makira, the Ankeniheny-Zahamena Corridor and the Fandriana-Vondorozo Corridor all have forest carbon projects recognised under the Voluntary Carbon Standard and have been partly funded based on their contribution to reducing GHG emissions (www.verra.org, accessed 8 July 2018).

Implementing REDD+ to support forest and biodiversity conservation is not without its challenges, including threats from other measures intended to address climate change. It has been estimated, for instance, that between 44–118 million ha of additional land will be needed to meet the biofuel demand by 2030 (Lambin and Meyfroidt 2011, Bertzky *et al.* 2019) with tropical forests being cleared to plant oil palm for "cleaner" biofuels. In megadiversity countries with lowland tropical forests such as Brazil and Indonesia, the increased demand for biofuel is emerging as a serious threat to biodiversity and protected areas (World Bank 2010, Smith *et al.* 2019). At the same time, REDD+ payments are made at a national level and may be targeted to high priority sites for tackling deforestation to reduce carbon dioxide emissions rather than to protected areas and other sites that reflect biodiversity conservation values. Moreover, investments in carbon-rich forests could lead to displacement of pressures to other ecosystems such as less carbon-rich forests and protected areas or non-forest ecosystems such as savannas or wetlands (Miles and Kapos 2008).

Engendering increased support and targeted funding for conservation of forests and other biodiversity-rich ecosystems will depend on greater appreciation of the role that well-managed protected areas can play as effective parts of national strategies to reduce vulnerability to climate change and support more sustainable development (MacKinnon *et al.* 2011, Lopoukhine *et al.* 2012, MacKinnon 2016). The costs of expanding and strengthening protected area networks are high, but many protected areas could be justified for their socio-economic benefits alone (Dudley *et al.* 2011). To be able to make the case to policy makers, developers, private sector and the general public, it will be important to get better valuations of the economic and social benefits generated by individual protected areas and national networks (Kettunen and Ten Brink 2013, Varcoe *et al.* 2015). Integrating natural resource and ecosystem service values into economic frameworks and national accounts would further highlight the value of forests and nature and contribute to better development planning.

Mainstreaming Biodiversity Conservation into Climate Change and Development Strategies

Adaptation projects, anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, are becoming an increasingly important part of the development agenda, especially in developing countries most at risk from climate change. Much of the investment for adaptation will be directed to hard infrastructure and technological solutions but investments in hydropower, irrigation dams, reservoirs and sea walls can all have high environmental costs due to loss of habitats and disruption of ecological flows. Maintaining natural ecosystems and services through establishing and managing protected areas can be a smart investment option, particularly for those countries with large intact ecosystems, since investments in habitat restoration and/or hard infrastructure are likely to be far more costly (Talberth *et al.* 2013).

Countries are already committed to expand their protected area systems for effective biodiversity conservation. Measures to recognise protected areas and restore native forests as ecosystem-based solutions to climate change have been formally recognised in work programmes under both the Conventions on Climate Change (UNFCCC) and Biodiversity (CBD) as well as in local and national strategies to address the causes of climate change. Countries as diverse as India and Colombia are undertaking research to quantify the 'carbon capture' potential and provision of ecosystem services by protected area landscapes (MacKinnon 2016). Mexico is creating biological corridors to link protected areas and adapting management to include a mixture of core areas and buffer zones based on climate vulnerability assessments (MacKinnon *et al.* 2012). Several countries, including Colombia, Guyana, India and Madagascar, have included protected areas in their climate change strategies (Laurans *et al.* 2016). Colombia, for example, committed to increase protected area coverage by 2.5 million hectares as part of their National Determined Contribution (NDC) under UNFCCC. Many of these new protected areas are forests managed by indigenous and local communities.

Making protected areas and OECMs a key part of national and local responses to climate change and other environmental challenges can help to promote biodiversity conservation, reduce rates of deforestation, protect carbon-rich habitats, ensure more sustainable land management and increase the resilience of vulnerable human communities (Dinerstein *et al.* 2019, MacKinnon *et al.* 2020). Protecting, managing and restoring forests and nature can play an important role in underpinning development to achieve the multiple goals of the SDGs and safeguard the ecosystem services and biodiversity that contribute to human well-being and welfare (MacKinnon 2016).

Efforts to halt biodiversity loss and to stabilise climate require a rapid reduction in land conversion and more effective protection of natural habitats, including the following measures:

1. Create more and larger protected areas to enhance ecological representation and improve ecosystem resilience particularly in areas with both high biodiversity and high carbon storage or where ecosystem services are under threat, such as in tropical lowland forests, boreal forests, mangroves and swamp forests.
2. Identify and support forest OECMs and the governance and management regimes which contribute to their effective biodiversity conservation. OECMs will contribute to enhanced ecological representation, protection of important biodiversity areas, enhanced connectivity and avoided deforestation.
3. Strengthen management of protected areas under the full range of governance types to avoid forest loss and degradation and to maintain ecosystem services such as carbon, water, and biodiversity values. The IUCN Green List standard provides an effective mechanism for evaluating and strengthening management of protected and conserved areas (IUCN 2017).
4. Connect protected areas and OECMs within landscapes to expand habitat under some form of conservation management, including buffer zones, biological corridors, and ecological networks to protect ecosystem services and build resilience to climate change.
5. Restore degraded and fragmented forest habitats within, and around, protected and conserved areas to enhance biodiversity, carbon and other ecosystem services and restore connectivity.
6. Integrate protected areas within broader development policies, planning, and programmes including Climate Change and Disaster Risk Reduction Strategies and spatial planning, to identify places where protected areas are providing essential ecosystem services and where there are social and economic benefits from protecting forests as "green" infrastructure within development plans.
7. Improve economic valuation of services and benefits from individual sites and forest conservation to underpin arguments for strengthened support and innovative financing strategies for protected area networks, including payments for ecosystem services, carbon funds and financing through major development projects.

The important role that protected areas and OECMs can play in addressing both the biodiversity and climate change crises has led to a concerted call for more ambitious targets for area-based conservation post-2020. The "Nature Needs Half" initiative proposes inclusion of 50 percent of all ecoregions in the global protected area network while many other players are calling for protection of at least 30 percent of the Earth's land surface and more sustainable management of production landscapes (Buscher *et al.* 2016, Dinerstein *et al.* 2019). Enhanced protection of remaining forests, with special emphasis on those areas which are most biodiversity and carbon-rich, will not only safeguard biodiversity but could also be the cheapest and fastest measure for reducing deforestation and addressing climate change. Twenty-five years after

the three Rio Conventions came into being, it seems timely that countries should explore and build on synergies among efforts to address biodiversity loss, climate change and land degradation. Better protection, management and restoration of native forests will be an important part of the story.

REFERENCES

ADAME, M., KAUFFMAN, J., MEDINA, I., GAMBOA, J., TORRES, O., CAAMAL, P., REZA, M. and HERRERA-SILVEIRA, J.A. 2013, J. Carbon stocks of tropical coastal wetlands within the karstic landscape of the Mexican Caribbean. *PLoS One* **8**(2): e56569. doi:10.1371/journal.pone.0056569. http://dx.doi.org/10.1371/journal.pone.0056569.

BARBIER, E.B., BURGESS, J.C. and DEAN, T.J. 2018. How to pay for saving biodiversity. *Science* **360**: 486–488.

BASTIN, J.-F., FINEGOLD, Y., GARCIA, C., MOLLICONE, D., REZENDE, M., ROUTH, D., ZOHNER, C.M. and CROWTHER, T.W. 2019. The global tree restoration potential. *Science* **365**(6448): 76–79.

BELLARD, C., BERTELSMEIER, C., LEADLEY, P., THUILLER, W. and COURCHAMP, F. 2012. Impacts of climate change on the future of biodiversity. *Ecology Letters* **2012**: 1–13.

BERTZKY, M., BROCK, R.C., MILES, L., and KAPOS, V. 2019. Climate change mitigation using terrestrial ecosystem: Options and biodiversity impacts. In: LOVEJOY, T.E., and HANNAH, L. (eds.) *Biodiversity and Climate Change: Transforming the Biosphere*. Yale University Press, New Haven, USA. pp 310–322.

BOVARNICK, A., FERNANDEZ BACA, J., GALINDO, J. and NEGRET, H. 2010. *Financial Sustainability of Protected Areas in Latin America and the Caribbean: Investment Policy Guidance*. United Nations Development Programme and The Nature Conservancy. New York, USA. 162 pp.

BRADSHAW, C.J. and WARKENTIN, I.G. 2015. Global estimates of boreal forest carbon stocks and flux. *Global and Planetary Change* **128**: 24–30.

BUCKLEY, L.B. and HILLERISLAMBERS, J. 2019. Temperate and Boreal Responses to Climate Change. In: LOVEJOY, T.E., and HANNAH, L. (eds.) *Biodiversity and Climate Change: Transforming the Biosphere*. Yale University Press, New Haven, USA: pp. 221–230.

BUSCHER, B., FLETCHER, R., BROCKINGTON, D., SANDBROOK, C., ADAMS, W.M. *et al.* 2016. Half-Earth or Whole Earth? Radical ideas for conservation, and their implications. *Oryx* **51**(3): 407–410. 10.1017/S0030605316001228

BUTCHART, S.H.M., SCHARLEMANN, J.P.W., EVANS, M.I., QUADER, S., ARICO, S., ARINAITWE, J., BALMAN, M., BENNUN, L.A., BERTZKY, B., BESANCON, C. and BOUCHER, T.M. 2012. Protecting Important Sites for Biodiversity Contributes to Meeting Global Conservation Targets. *PLoS One* **7**(3): e32529.

CBD. 2019. *Voluntary guidelines for the design and effective implementation of ecosystem- based approaches to climate change adaptation and disaster risk reduction and supplementary information*. Convention on Biological Diversity Technical Series No. **93**. Montreal, 156 pages.

CBD. 2020. *Zero Draft of The Post-2020 Global Biodiversity Framework.* Open-Ended Working Group on the Post-2020 Global Biodiversity Framework. https://www.cbd.int/doc/c/efb0/1f84/a892b98d2982a829962b6371/wg2020-02-03-en.pdf

COSTANZA, R., D'ARGE, R., DE GROOT, R., FARBER, S., GRASSO, M., HANNON, B., LIMBURG, K., NAEEM, S., O'NEILL, R.V., PARUELO, J. and RASKIN, R.G. 1997. The value of the world's ecosystem services and natural capital. *Nature* **387**: 253–260.

CURTIS, P., SLAY C.M., HARRIS, N.L., TYUKAVINA, A. and HANSEN, M.C. 2018. Classifying drivers of global forest loss. *Science* **361**(6407): 1108–1111.

DE GROOT, R., BRANDER, L., VAN DER PLOEG, S., COSTANZA, R., BERNARD, F., BRAAT, L., CHRISTIE, M., CROSSMAN, N., GHERMANDI, A., HEIN, L. and HUSSAIN, S. 2012. Global estimates of the value of ecosystems and their services in monetary units. *Ecosystem Services* **1**: 50–61.

DINERSTEIN, E., VYNNE, C., SALA, E., JOSHI, A.R., *et al.* 2019. A Global Deal for Nature: Guiding principles, milestones and targets. *Sci. Adv.* **5**: eaaw2869.

DONALD, P.F., BUCHANAN, G.M., BALMFORD, A., BINGHAM, H., COUTURIER, A.R., DE LA ROSA JR, G.E., GACHERU, P., HERZOG, S.K., JATHAR, G., KINGSTON, N. and MARNEWICK, D. 2019. The prevalence, characteristics and effectiveness of Aichi Target 11's "other effective area-based conservation measures" (OECMs) in Key Biodiversity Areas. *Conservation Letters* **2019**: e12659.

DUDLEY, N., STOLTON, S., BELOKUROV, A., KRUEGER, L., LOPOUKHINE, N., MACKINNON, K., SANDWITH, T. and SEKHRAN, N. (eds). 2010. *Natural Solutions: Protected Areas Helping People to Cope with Climate Change.* IUCN-WCPA, TNC, UNDP, WCS, World Bank and WWF, Gland, Switzerland. 130 pp.

DUDLEY, N., KRUEGER, L., MACKINNON, K., and STOLTON, S. 2011. Ensuring That Protected Areas Play an Effective Role in Mitigating Climate Change. In: *Ecological Consequences of Climate Change: Mechanisms, Conservation, and Management* BEEVER, E.A. (ed.) CRC Press/Taylor & Francis Group. 237 pp.

DUDLEY, N., MACKINNON, K. and STOLTON, S. 2013. Reducing vulnerability: the role of protected areas in mitigating natural disasters. In: RENAUD, F.G., SUDMEIER-RIEUX, K. and ESTRELLA, M (eds.) *The Role of Ecosystems for Disaster Risk Reduction.* United Nations University Press, Tokyo, Japan. 512 pp.

DUDLEY, N., ALI, N. and MACKINNON, K. 2017. *Natural solutions: protected areas helping to meet the sustainable development goals*. IUCN/WCPA, Gland, Switzerland.

DUDLEY, N., JONAS, H., NELSON, F., PARRISH, J., PYHALA, A., STOLTON, S. and WATSON, J.E.M. 2018.

The essential role of other effective area-based conservation measures in achieving big bold conservation targets.: *Global Ecology and Conservation* **15**: e00424.

EGHENTER, C. 2018. Indigenous effective area-based conservation measures: conservation practices among the Dayak Kenyah of North Kalimantan. *PARKS* **24** Special Issue: 69–78.

FEREZ, A.P.C., CAMPOE, O.C., MENDES, J.C.T. and STAPE, J.L. 2015. Silvicultural opportunities for increasing carbon stock in restoration of Atlantic forests in Brazil. *Forest Ecology and Management* **350**: 40–45.

FAO. 2016. *State of the World's Forests 2016. Forests and agriculture: land-use challenges and opportunities.* FAO, Rome, Italy. 126 pp.

FAO. 2018. *The future of food and agriculture – Alternative pathways to 2050.* FAO, Rome. 224 pp.

GANNON, P, DUBOIS, G., DUDLEY, N., ERVIN, J., FERRIER, S., GIDDA, S., MACKINNON, K., RICHARDSON, K. SCHMIDT, M., SEYOUM-EDJIGU, E. and SHESTAKOV, A. 2019. Editorial Essay: An update on progress towards Aichi Biodiversity Target 11. *PARKS* **25**(2): 7–18. DOI: 10.2305/IUCN.CH.2019.PARKS-25-2PG.en

GARNETT, S.T., BURGESS, N.D., FA, J.E., FERNANDEZ-LLAMAZERES, A., MOLNAR, Z., ROBINSON, C.J., WATSON, J.E.M, ZANDER, K.K. *et al.* 2018. A spatial overview of the global importance of indigenous lands for conservation. *Nature Sustainability* **1**: 369–374. 10.1038/s41893-018-0100-6

GAUTHIER, S., BERNIER, P., KUULUVAINEN, T., SHVIDENKO, A.Z. and SCHEPASCHENKO, D.G. 2015. Boreal forest health and global change. *Science* **349**: 819–822.

GRISCOM, B.W., ADAMS, J., ELLIS, P.W., HOUGHTON, R.A., LOMAX, G., MITEVA, D.A., SCHLESINGER, W.H., SHOCH, D., SIIKAMÄKI, J.V., SMITH, P. and WOODBURY, P. 2017. Natural climate solutions. *Proceedings of the National Academy of Sciences* **114**(44): 11645–11650.

GUEVARA, O., PRUSSMANN, J., SUAREZ, C. and VERGARA, A. 2016. *Vulnerability and climate risk analysis of the Amazon biome and its protected areas*. IUCN, FAO, RedParques, UNEP, WWF.

HADDEN, D., and GRELLE A. 2017. Net CO2 emissions from a primary boreo-nemoral forest over a 10-year period. *Forest Ecology and Management* **398**: 64–173.

HANSEN, M.C., POTAPOV, P.V., MOORE, R., HANCHER, M. *et al.* 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science* **342**: 850–853.

HARRISON, I.J., GREEN, P.A., FARRELL, T.A., JUFFE-BIGNOLI, D., SÁENZ, L. and VÖRÖSMARTY, C.J. 2016. Protected areas and freshwater provisioning: a global assessment of freshwater provision, threats and management strategies to support human water security: Protected areas and freshwater provisioning. *Aquatic Conservation: Marine and Freshwater Ecosystems* **26**: 103–120.

HOWARD, J., SUTTON-GRIER, A., HERR, D., KLEYPAS, J., LANDIS, E., MCLEOD, E., PIDGEON, E. and SIMPSON, S. 2017. Clarifying the role of coastal and marine systems in climate mitigation. *Frontiers in Ecology and the Environment* **15**: 42–50.

HUTCHISON, J., MANICA, J., A., SWETNAM, R., BALMFORD, A., and SPALDING, M. 2014. Predicting global patterns in mangrove forest biomass. *Conservation Letters* **7**: 233–240. http://dx.doi.org/10.1111/conl.12060.

IPBES. 2019. Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. BRONDIZIO, E. S, SETTELE, J., DÍAZ, S. and NGO, H.T. (eds). IPBES Secretariat, Bonn, Germany.

IPCC. 2014. *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Pachauri, R.K. and Meyer, L.A. (eds.). IPCC, Geneva, Switzerland. 151 pp.

IPCC. 2019. *Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse gas fluxes in Terrestrial Ecosystems Summary for Policymakers.* IPCC, Geneva, Switzerland. 41pp.

IUCN. (2017). *IUCN Green List of Protected and Conserved Areas: Standard, Version 1.1.* Gland, Switzerland: IUCN.

IUCN/WCPA 2019. *Guidelines for Recognising and Reporting Other Effective Area-based Conservation Measures*. IUCN, Gland, Switzerland. 46 pp.

JONAS, H., MACKINNON, K., DUDLEY, N., HOCKINGS, M., JENSEN, S., LAFFOLEY, D. MACKINNON, D., MATALLANA-TOBON, C.L., SANDWITH, T., WAITHAKA, J. and WOODLEY, S. 2018. Editorial Essay. Other Effective Area-based Conservation Measures: From Aichi Target 11 to the Post 2020 Biodiversity Framework. *PARKS* **24**, Special Issue on OECMs: 9–16.

KAPOS, V., BAVILIOUS, C., CAMPBELL, A. DICKSON, B., GIBBS, H., HANSEN, M., LYSENKO, I., MILES, L., PRICE, J., SCHARLEMANN, J.P.W. and TRUMPER, K. 2008. *Carbon and Biodiversity: A Demonstration Atlas*. United Nations Environment Programme–World Conservation Monitoring Centre. Cambridge, U.K. 197 pp.

KEENLEYSIDE, K., DUDLEY, N., CAIRNS, S., HALL, C.M., STOLTON, S. and VALENTINE, P. 2012. *Ecological restoration for Protected Areas. Principles, Guidelines and Best Practices.* IUCN, Gland, Switzerland 133 pp.

KETTUNEN, M. and TEN BRINK, P. 2013. *Social and Economic Benefits of Protected Areas – an Assessment Guide.* Routledge. 275 pp.

KURZ, W.A., SHAW, C., BOISVENUE, C., STINSON, G., METSARANTA, J., LECKIE, D., DYK, A., SMYTH, C. and NEILSON, E. 2013. Carbon in Canada's boreal forest – a synthesis. *Environmental Reviews* **21**: 260–292.

LAFFOLEY, D. and GRIMSDITCH, G. (eds.) 2009. *The Management of Natural Coastal Carbon Sinks.* IUCN, Gland, Switzerland. 64 pp.

LAURANS, Y., RUAT, R. and BARTHELEMY, P. 2016. Counting on nature: how governments plan to rely on ecosystems for their climate strategies. *Issue Brief* **5**: 2016.

LE QUÉRÉ, C., ANDREW, R.M., FRIEDLINGSTEIN, P., SITCH, S., HAUCK, J., PONGRATZ, J., PICKERS, P.A., KORSBAKKEN, J.I., PETERS, G.P., CANADELL, J.G. and ARNETH, A. 2018. Global carbon budget 2018. *Earth System Science Data* **10**: e4.

LOPOUKHINE, N. and DE SOUZA DIAS, B.F. 2012. What does Target 11 really mean. *PARKS* **18**(1): 5–8.

LOPOUKHINE, N., CRAWHALL, N., DUDLEY, N., FIGGIS, P., KARIBUHOYE, C., LAFFOLEY, D., LONDOÑO, J.M., MACKINNON, K. and SANDWITH, T. 2012. Protected areas: providing natural solutions to 21st Century challenges. S.A.P.I.E.NS. *Surveys and Perspectives Integrating Environment and Society* **5**(2). http://journals.openedition.org/sapiens/1254

LOVEJOY, T.E. 2019. Regreening the Emerald Planet: The Role of Ecosystem Restoration in Reducing Climate Change. In: LOVEJOY, T.E., and HANNAH, L. (eds.) *Biodiversity and Climate Change: Transforming the Biosphere*. Yale University Press, New Haven, USA. pp. 326–331.

MACKEY, B., DELLASALA, D.A., KORMOS, C., LINDENMEYER D., KUMPEL, N., ZIMMERMAN, B., HUGH, S., YOUNG, V., FOLEY, S., ARSENIS, K., and WATSON J.E.M. 2014 Policy Options for the World's Primary Forests in Multilateral Environmental Agreements. *Conservation Letters* https://doi.org/10.1111/conl.12120

MACKINNON, K. 2016. Sound investments: Protected areas as natural solutions to climate change and biodiversity conservation. In JOPPA, L.N., BAILLIE, J.E.M. and ROBINSON, J.G. (eds). *Protected Areas: Are They Safeguarding Biodiversity*? Wiley- Blackwell. pp 49–65.

MACKINNON, K., DUDLEY, N. and SANDWITH, T. 2011. Protected areas: helping people to cope with climate change. *Oryx* **45**: 461–462.

MACKINNON, K., DUDLEY, N. and SANDWITH, T. (eds.). 2012. *Putting Natural Solutions to Work: Mainstreaming Protected Areas in Climate Change Responses* BfN-Skripten, Bonn, Germany. 95 pp. http://www.bfn.de/0502_skriptliste.html

MACKINNON, K., SMITH, R., DUDLEY,N., FIGGIS, P., HOCKINGS, M., KEENLEYSIDE, K., LAFFOLEY, D, LOCKE, H., SANDWITH, T., WOODLEY, S. and WONG, M. 2020. Strengthening the Global System of Protected Areas post-2020: A Perspective from the IUCN World Commission on Protected Areas. *Parks Stewardship Forum* **36**(2). https://escholarship.org/uc/psf

MCCARTHY, D.P., DONALD, P.F., SCHARLEMANN, J.P., BUCHANAN, G.M., BALMFORD, A., GREEN, J.M., BENNUN, L.A., BURGESS, N.D., FISHPOOL, L.D., GARNETT, S.T. and LEONARD, D.L. 2012. Financial costs of meeting global biodiversity conservation targets: current spending and unmet needs. *Science* **338**: 946–949.

MILES, L. and KAPOS, V. 2008. Reducing Greenhouse Gas Emissions from Deforestation and Forest Degradation: Global Land Use Implications. *Science* **320**: 1454–55.

OLDEKOP, J.A., HOLMES, G., HARRIS, W.E., and EVANS, K.L. 2016. A global assessment of the social and conservation outcomes of protected areas. *Conservation Biology* **30**: 133–141.

PAN, Y., BIRDSEY, R.A., FANG, J., HOUGHTON, R., KAUPPI, P.E., KURZ, W.A., PHILLIPS, O.L., SHVIDENKO, A., LEWIS, S.L., CANADELL, J.G. and CIAIS, P. 2011. A large and persistent carbon sink in the world's forests. *Science* **333**: 988–993.

RICKETTS, T.H., SOARES-FILHO, B., DA FONSECA G.A.B., NEPSTAD, D., PFAFF, A., PETSONK, A., ANDERSON, A., BOUCHER, D., CATTANEO, A., CONTE, M. and CREIGHTON, K. 2010. Indigenous Lands, Protected Areas, and Slowing Climate Change. *PLoS Biology* **8(3)**: e1000331.

RIPPLE, W.J., WOLF, C., NEWSOME, T.M., GALETTI, M., ALAMGIR, M., CRIST, E., MAHMOUD, M.I., LAURANCE, W.F. and 15,364 SCIENTIST SIGNATORIES FROM 184 COUNTRIES. 2017. World scientists' warning to humanity: a second notice. *BioScience* **67**: 1026–1028.

SCHARLEMANN, J.P., KAPOS, V., CAMPBELL, A., LYSENKO, I., BURGESS, N.D., HANSEN, M.C., GIBBS, H.K., DICKSON, B. and MILES, L. 2010. Securing tropical forest carbon: the contribution of protected areas to REDD. *Oryx* **44**: 352–357.

SMITH, R., GUEVARA, O., WENZEL, L., DUDLEY, N., PETRONE-MENDOZA, V., CADENA, M., and RHODES, A. 2019. Ensuring Co-benefits for Biodiversity, Climate Change and Sustainable Development. In: FILHO, W.L., BARBIR, J. and PREZIOSI, R. (eds.). *Handbook of Climate Change and Biodiversity.* Springer. pp151–166.

SOARES-FILHO, B., MOUTINHO, P., NEPSTAD, D., ANDERSON, A., RODRIGUES, H., GARCIA, R., DIETZSCH, L., MERRY, F., BOWMAN, M., HISSA, L. and SILVESTRINI, R. 2010. Role of Brazilian Amazon protected areas in climate change mitigation. *Proceedings of the National Academy of Sciences* **107**(24): 10821–10826.

STRASSBURG, B.B., KELLY, A., BALMFORD, A., DAVIES, R.G., GIBBS, H.K., LOVETT, A., MILES, L., ORME, C.D.L., PRICE, J., TURNER, R.K. and RODRIGUES, A.S. 2010. Global congruence of carbon storage and biodiversity in terrestrial ecosystems. *Conservation Letters* **3**: 98–105.

STOLTON, S. and DUDLEY, N. (eds). 2010. *Arguments for Protected Areas. Multiple Benefits for Conservation and Use.* Earthscan, Earthscan, London, U.K. 297 pp.

TALBERTH, J. 2013. Green versus Gray: Nature's Solutions to Infrastructure Demands. *Solutions* **1**: 4. http://thesolutionsjournal.anu.edu.au/node/1241

UNEP-WCMC, IUCN and NGS. 2018. *Protected Planet Report 2018*. UNEP-WCMC, IUCN and National Geographic Society: Cambridge UK; Gland, Switzerland; Washington, D.C. USA.

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC). 2015. Paris Agreement. unfccc.int/process/conferences/pastconferences/paris-climate-change-conference-november-2015/paris-agreement Accessed 11 July 2019.

UTOMO, A.B. and WALSH, T.A. 2018. Hutan Harapan ecosystem restoration concession, Sumatra, Indonesia: a potential OECM? *PARKS* **24** *Special Issue*: 61–68.

VARCOE, T., BETTS O'SHEA, H. and CONTRERAS, Z. 2015. *Valuing Victoria's Parks: Accounting for ecosystems and valuing their benefits.* Parks Victoria and Department of Environment, Land, Water and Planning, Victoria. Australia.

VIRKKALA, R., PÖYRY, J., HEIKKINEN, R.K., LEHIKOINEN, A., and VALKAMA, J. 2014. Protected areas alleviate climate change effects on northern bird species of conservation concern. *Ecology and Evolution* **4**: 2991–3003.

WALKER, W., BACCINI, A., SCHWARTZMAN, S., RÍOS, S., OLIVEIRA-MIRANDA, M.A., AUGUSTO, C., RUIZ, M.R., ARRASCO, C.S., RICARDO, B., SMITH, R. and MEYER, C. 2014. Forest carbon in Amazonia: the unrecognized contribution of indigenous territories and protected natural areas. *Carbon Management* **5**: 479–485.

WATSON, J.E., DUDLEY, N., SEGAN, D.B. and HOCKINGS, M. 2014. The performance and potential of protected areas. *Nature* **515**: 67–73.

WATSON, J.E., SEGAN, D.B. and TEWKSBURY, J. 2019. Tropical Forests in a Changing Climate In: LOVEJOY, T.E., and HANNAH, L. (eds.) *Biodiversity and Climate Change: Transforming the Biosphere*. Yale University Press, New Haven, USA. pp. 196–210.

WOODLEY, S., BERTZKY, B., CRAWHALL, N., DUDLEY, N., LONDOÑO, J.M., MACKINNON, K., REDFORD, K. and SANDWITH, T. 2012. Meeting Target 11: What does success look like for protected area systems? *PARKS* **18**: 23–36.

WOODLEY, S., LOCKE, H., LAFFOLEY, D., MACKINNON, K., SANDWITH, T. and SMART, J. 2019. A Review of Evidence for Area-based Conservation Targets for the Post-2020 Global Biodiversity Framework. *PARKS* **25**: 31–45.

WORBOYS, G.L., FRANCIS, W.L., and LOCKWOOD, M. (eds.). 2010. *Connectivity Conservation Management. A Global Guide*. Earthscan, London, U.K. 417 pp.

WORLD BANK. 2010. *Convenient Solutions to an Inconvenient Truth: Ecosystem-based approaches to Climate Change*. World Bank, Washington, USA. 210 pp.

Making the priceless valuable: forests and ecosystem services

M. JENKINS[a], J. SALZMAN[b], G. BENNETT[a] and J. GRANFORS[a]

[a]*Forest Trends, 1203 19th Street NW, Washington, DC 20036, USA*
[b]*Bren School of Environmental Science and Management, University of California, Santa Barbara, USA*

Email: mjenkins@forest-trends.org, salzman@bren.ucsb.edu, gbennett@forest-trends.org, jgranfors@forest-trends.org

SUMMARY

Historically, forest ecosystem services have been undervalued or not valued at all, thus encouraging the destruction and conversion of our global forest estate. Fortunately, these last decades have witnessed a real shift – the active and innovative development of markets and payments for the ecosystem values of forests and other ecosystems. Payments for Environmental Services programs are now in place around the globe. Schemes focused on forest carbon, such as the California Cap-and-Trade law, programs in China and Colombia, South Korea and Chile, coupled with new initiatives in the aviation sector, point to steady progress toward the carbon/climate value of forests. Innovative green infrastructure initiatives around water and watersheds in Peru, Costa Rica, Australia and South Africa provide another growing stream of value for forests. And sustainable commodity supply chains and conservation banking bring more large-scale private sector actors and new business sectors to the table. Here we provide a global status of PES around the world.

Keywords: ecosystem values, forest carbon, watersheds, conservation banking, trends

Estimer l'inestimable: les forêts et les services d'écosystèmes

M. JENKINS, J. SALZMAN, G. BENNETT et J. GRANFORS

Historiquement, les services d'écosystèmes forestiers ont été sous-évalués, sinon jugés sans valeur, encourageant ainsi la destruction et la conversion de notre domaine forestier global. Heureusement, ces trois dernières décennies ont été témoin d'un véritable revirement: le développement actif et innovateur des marchés et des paiements des valeurs de l'écosystème forestier et d'autres systèmes. Les paiements pour les programmes de services environnementaux sont maintenant établis tout autour du globe. Les projets se concentrent sur le carbone forestier, tel que la loi californienne Cape-and-Trade, les programmes en Chine, en Colombie, en Corée du sud et au Chili, allant de pair avec de nouvelles initiatives dans le secteur de l'aviation, révèlent un progrès solide vers une valorisation carbone/climat des forêts. Des initiatives innovantes d'infrastructure verte autour de l'eau et des bassins versants au Pérou, en Costa Rica, en Australie et en Afrique du Sud constituent un autre courant grandissant de valeur pour les forêts. Des chaînes d'approvisionnement durable en matières premières et la conservation bancaire attirent plus d'acteurs à grande échelle du secteur privé ainsi que de nouveaux secteurs de commerce sur le terrain. Nous présentons ici un statut global des PES autour du monde.

Cómo hacer valioso lo que no tiene precio: los bosques y los servicios ecosistémicos

M. JENKINS, J. SALZMAN, G. BENNETT y J. GRANFORS

Históricamente, los servicios ecosistémicos forestales han sido infravalorados, o no han sido valorados en absoluto, lo que ha fomentado la destrucción y la conversión de nuestra superficie forestal mundial. Afortunadamente, en las últimas décadas hemos sido testigos de un verdadero cambio: el desarrollo activo e innovador de los mercados y los pagos por los valores ecosistémicos de los bosques y otros ecosistemas. Los programas de Pagos por Servicios Ambientales (PSA) están ya en funcionamiento por todo el mundo. Los programas centrados en el carbono forestal, como la Ley de Límite y Comercio (*Cap-and-Trade*) de California, los programas de China y Colombia, Corea del Sur y Chile, junto con las nuevas iniciativas en el sector de la aviación, apuntan a un progreso constante hacia admitir el valor del carbono de los bosques y para el clima. Las innovadoras iniciativas de infraestructura ecológica en torno al agua y las cuencas hidrográficas en el Perú, Costa Rica, Australia y Sudáfrica constituyen otra corriente creciente de valor para los bosques. Además, las cadenas de suministro de materias primas sostenibles y el sector bancario involucrado en la conservación atraen cada vez más actores del sector privado de gran escala y a nuevos sectores empresariales. En este artículo se proporciona un resumen del estado global de los PSA en todo el mundo.

INTRODUCTION

The last several decades has seen dramatic changes in the way society views, values, and manages forests. This piece builds on the work at Forest Trends over the last 2 decades and articles recently published that capture the global trends and status of markets and market-like approaches to Environmental Services. I was fortunate to have some time with John over 30 years, and our work at Forest Trends reflects and honors his lifetime dedicated to making forests valuable as a pathway to preserving the global forest estate. The reframing of how to think about forests has been fundamental to this transformation of forests and society. Rather than simply viewed as landscapes for growing timber and fiber, forests have increasingly been viewed as *systems* that provide play central and interconnected roles in the water, climate and biodiversity infrastructure of the planet. These ecosystem services are worth far more than the market commodities of timber and fiber. Indeed they are fundamental to human society, ensuring protection of watersheds and water quality, habitat reservoirs for species and genes critical to our agricultural systems, and storm protection to our vulnerable coastline cities and populations. The significant economic and personal harms caused by intensifying storms and droughts, fires, and floods have increased recognition that nature-based approaches like forests must form critical pieces in any effective response to the looming climate impacts.

Historically, forest ecosystem services have been undervalued or not valued at all, thus encouraging the destruction and conversion of our global forest estate. Why forgo clearcutting if there is no obvious downside? Fortunately, these last decades have witnessed a real shift – the active and innovative development of markets and payments for the ecosystem values of forests and other ecosystems.

While one can find isolated examples of payments for ecosystem services (PES) from decades ago, the rise of activity dates from the late 1990s. The confluence of influential publications in scientific journals, books featuring case studies of PES, adoption of ecosystem services as the metric for the Millennium Ecosystem Assessment, and the networking and research activities of groups such as Forest Trends and its Katoomba Group raised the prospect of PES as a promising policy approach. The threats of increasing deforestation, rising greenhouse gases, and loss of biodiversity made starkly clear that traditional conservation measures were proving inadequate and that additional strategies were needed.

Payments for Ecosystem Services programs are now in place around the globe. Schemes focused on forest carbon, such as the California Cap-and-Trade law, programs in China and Colombia, South Korea and Chile, coupled with new initiatives in the aviation sector, point to steady progress toward the carbon/climate value of forests. Innovative green infrastructure initiatives around water and watersheds in Peru, Costa Rica, Australia and South Africa provide another growing stream of value for forests. And sustainable commodity supply chains and conservation banking bring more large-scale private sector actors and new business sectors to the table.

While Brazil, the United States, Australia and other countries are in a period of regulatory rollback around climate, forests and restoration, subnational, state and municipal actions are rising to fill the void. And a generational shift is taking place, as young people around the world are seeking to find their voice and young professionals increasingly seek to enter the environmental markets and finance to do meaningful work. The transformation to making the true values of our forest ecosystems recognized in markets is clearly underway. The question is whether it will happen quickly enough and at the scale required to address meaningfully the threats of development and global change.

There are numerous definitions of PES (Wunder *et al*. 2018, Vaissière *et al*. 2020). We define PES programmes in a broad, inclusive manner – as the exchange value for land management practices intended to provide or ensure ecosystem services. The most comprehensive assessment recorded over 500 active programmes around the globe and an estimated US$36–42 billion in annual transactions (Salzman *et al.* 2018a).

PES represent a recent policy instrument with often very different programmes operating at local, regional and national levels. Here we provide an assessment of the trends and current status of PES mechanisms – user-finance, government-finance and compliance – across the domains of water, biodiversity and forest/land-use carbon around the world.

In economic terms, PES seek to internalize the positive externalities (that is, the third-party benefits) generated by natural systems, creating incentives for landholder behaviour that ensure service provision. In some circumstances, PES can create additional revenue streams for conservation and has been described as "making trees worth more standing than cut down" (Salzman *et al.* 2018b). It is important to recognize, however, that PES captures only a fraction of the values provided by natural systems. Existence values, option values and many public goods benefits often remain outside the scope of PES mechanisms, but these market-like approaches are powerful.

Forest and Land Use Carbon

The forest and land-use carbon market has received the most attention of any PES sector. A policy instrument to combat climate change, US$2.8 billion has been spent since 2009 for forestry and land use practices that sequester carbon and quantify carbon benefits in the form of a standardized offset. (Salzman *et al.* 2018a). Over the past 20 years, markets and funding mechanisms for climate mitigation have emerged all over the globe – from purely voluntary exchanges (CCX) to international funding mechanisms (BioCarbon Fund), state mandates (California's AB-32) and international treaty flexibility mechanisms (CDM). The Paris Agreement endorsed continued market development, introducing the term "Internationally Transferred Mitigation Outcomes". The four main sources for forest and land-use carbon offsets include afforestation/reforestation, improved forest management (IFM), sustainable agricultural land management, and reduced emissions from land use and forest degradation

(REDD), which now termed as REDD+ may include afforestation/reforestation, IFM or agricultural interventions.

Voluntary Carbon Market

Forest Trends' Ecosystem Marketplace has benchmarked voluntary carbon markets every year since 2006. In doing so, this research has helped answer fundamental questions about the size, scope, and direction of voluntary offsets. These data are proving increasingly important for international financing institutions, governments, businesses, and private investors seeking to become "carbon neutral" or understand emerging investment opportunities.

New data from the United Nations shows that carbon emissions are still rising every year. Carbon offsets are one of the tools to reverse that trend. Offsets are a practical solution while the world undergoes necessary – but slower – structural transitions in its energy and transportation systems. Some emissions are also nearly impossible to totally eliminate (i.e., emissions from the airline industry). Offsets allow a way for those emitters to still be carbon-neutral, or even carbon-negative.

The number of voluntary projects marketing offsets to buyers motivated by corporate social responsibility (CSR) or in anticipation of future compliance obligations has continued to grow, with forest carbon the dominant project type on the voluntary market for the past two years, surpassing renewable energy-based project types in market value. Nonetheless, demand from philanthropy and private sector programmes has only satisfied a small fraction of the available supply for carbon offsets to date. This year's 2019 report, released at the climate negotiations in Madrid, finds voluntary carbon offsets growing exponentially. Major new sources of demand have materialized, including from airlines and the energy sector. And buyers are showing unprecedented enthusiasm for offsets that finance nature-based climate solutions, such as tree-planting and forest protection.

Limited impact to date of compliance carbon markets

Neither the Clean Development Mechanism nor the European Union Emissions Trading Scheme has directed large investment flows to forest conservation. California's Air Resources Board has been more receptive to these project types: 65% of all offsets issued by the Board as of 2017 were from forestry and land-use projects (Salzman *et al.* 2018a). However, volumes transacted in 2016 (4.1 million tonnes CO_2 equivalent) were still small compared with overall offsets markets activity, and the requirement that all offset projects must be based in the United States (excluding Hawaii and only for certain regions in Alaska) limits potential for scale. The Paris Agreement explicitly recognized the importance of forests in mitigating climate change, but subsequent negotiations have not yet resulted in agreement on the role for forest and land use carbon offsets in meeting emissions reduction targets.

The future of REDD+

Recently there is an important move towards jurisdictional programmes, efforts at the subnational/state level to ensure that credits at the landscape level, forests and land use are credible and can be accounted for at the national and global level. Funding for REDD+ and REDD Readiness (building

FIGURE 1 *Voluntary Carbon Offset Market Size by Project Region and Country, 2018 (Forest Trends' Ecosystem Marketplace 2019)*

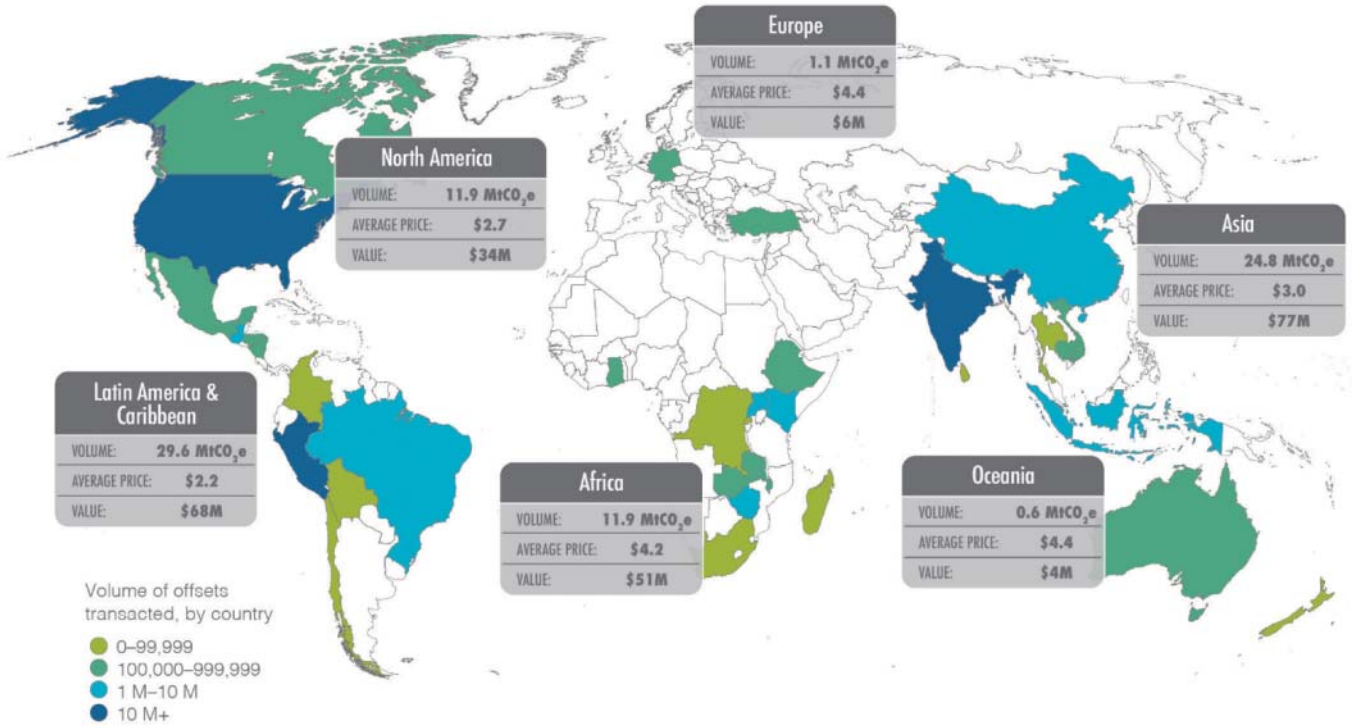


TABLE 1 *Watershed PES* (Salzman *et al.* 2018a)

PES Mechanism (Category)	Definition	Example	Market Size 2009 → '15	Programs 2005→ '15	Distribution (Countries)
Subsidy PWS (government-financed)	Public finance rewards land managers for enhancing or protecting ecosystem services. The funders do not directly benefit from the management activities.	Chinese government's Sloping Lands Conversion Program pays farmers to stop cultivating on steep slopes. Roughly 53 million farmers receive compensation to improve water quality and flood control.	$6.3 billion → $23.7 billion ($12.98 billion in China).	17 → 139, with 69 in China	39
Collective Action PWS (user and government-financed)	An institution pools resources from multiple water users (private parties, NGOs, government bodies) to pay upstream land owners for management actions that provide water quality and other benefits.	Quito's Water Conservation Fund relies on a 1% surcharge on monthly water bills and monies from local electrical utility and beer company directed to finance projects protecting forests and grasslands in the watershed.	$402 million → $564 million	16 → 86	22
Bilateral PWS (user and government-financed)	A single water user compensates one or more parties for activities that deliver hydrologic benefits to the payer or serves to mitigate impacts from their activities.	In the 1990s, New York City raised a bond to pay for land use changes in the Catskills and Delaware watersheds in order to ensure the quality of their drinking water at much cheaper than a treatment plant.	$13 million → $93 million	19 → 111	27
Instream Buybacks (user and government-financed)	Water rights are purchased or leased from historic rights holders and retired, which leaves the water in-stream to deliver water quality benefits and ensure healthy ecological flows.	In Australia, the Restoring the Balance program committed over $3 billion over a ten year period to purchase water entitlements from farmers to ensure instream flows in the Murray-Darling Basinfff.	$25 million → $60.7 million	15 → 20, with 18 in the USA	3
Quality trading and offsets (compliance)	Water service providers comply with regulations by paying landowners for activities that improve a measure of water quality (such as nutrients, salinity, temperature, etc.) in exchange for credits.	In the Hunter River Salinity Trading Scheme, salt credits are traded among mines and power stations based on river conditions to control the salinity.	$8.3 million → $22.2 million	10 → 31, with 29 in the USA	3

capacity to accept payments for performance) has, to date, dominated the PES carbon sector. Developed countries have pledged over US$8 billion in funds for REDD Readiness through 2020 (46% from Norway) to 67 tropical forest countries and almost US$3 billion for payments for actual emissions reductions. (Salzman *et al.* 2018a) Although $8.1 billion has been documented in Readiness funds disbursement, progress in making payments for actual performance has been slow: as of 2017, only US$218 million had been paid to countries for emissions reductions. Without REDD+, the prospects for forest carbon PES are much diminished (Salzman *et al.* 2018a). The Paris Agreement endorsed the REDD+ approach, but the focus on Nationally Determined Contributions creates considerable uncertainty over how many national and subnational programmes will accept REDD+ credits from other countries for compliance obligations.

Watershed Services and Natural Infrastructure Approaches

The watershed PES sector is the most mature in terms of transaction value and geographical distribution (US$24.7 billion in 62 countries in 2015) (Salzman *et al.* 2018a). While hydrology can be quite complicated, the seemingly obvious connection between land management in an upper watershed and threats of poor water quality and flooding to downstream users makes it easier to gain support for payments from beneficiaries to providers. Transaction costs can be low because existing institutions collect funds from diffuse beneficiaries, whether through water utilities or government taxation power. Compliance is easy to confirm because nearly all programmes pay for 'practice' (implementing a particular management activity on a specified area of land, such as installing fencing to keep livestock away from riparian areas) rather than 'performance' (such as measured improvements in water quality).

Chinese dominance

China dominates subsidy payments for watershed PES. A series of major floods and droughts in the late 1990s made it clear to the Chinese government that deforestation posed serious threats to water quality and flooding. China's unique political and centralized authority has allowed it to put in place PES strategies at a scale and speed simply not possible in other countries, reshaping the country's policy and ecological landscape in a very short period of time.

Water funds in South America have experienced the most rapid growth in number of watershed PES programmes. In a PES water fund, an institution combines resources from multiple water users (including private parties, NGOs or government bodies) to pay upstream landowners for management actions that provide water quality and other benefits. At least 57 funds have been created in the past decade, with a wide range of approaches in programme size, participants, funding strategies and forms of compensation (Salzman *et al.* 2018a).

Natural Infrastructure

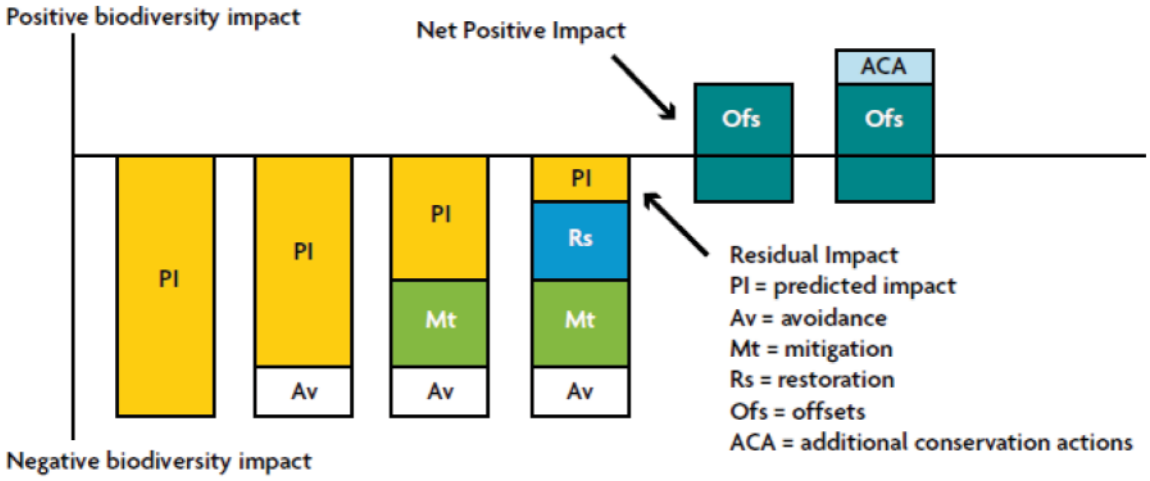
Lake Piuray supplies nearly half of Cusco's potable water, making it a critical resource for this growing city that is also one of Peru's most important tourism hubs. There's something else special about the lake: it is the focus of an innovative agreement between Cusco's water utility, SEDACUSCO, and rural communities located upstream around the lake. SEDACUSCO has committed a portion of water user tariffs to protecting water quality at its source, by expanding access to rural sanitation in upstream communities and compensating land managers who implement sustainable agriculture and conservation practices. While still a program in development, the agreement has increased water security for both rural residents and urban water users and provided a platform for ongoing dialogue and cooperation.

The example set in the Piuray-Corimarca watershed is a bellwether for the entire country of Peru. A series of regulatory reforms at the national level beginning in 2012 have recognized and promoted the role of water utilities in financing conservation projects. To date, 24 water utilities in Peru have approved tariffs similar to SEDACUSCO's, including Lima's water utility, SEDAPAL (Bennett 2018). Part of the work that we are undertaking at this moment is creating a streamlined mechanism that moves public funds from the "central bank" to local communities. We worked with the Ministry of Environment to create new guidelines for an IOARR (Investments for Optimization, Marginal Expansion, Replacement, that is widely applied to grey infrastructure) that can be applied for Natural Infrastructure. Approved December 31, 2019 by the Ministry, this regulation will help to accelerate investments in Natural Infrastructure by cutting through massive bureaucracy of State funding programs. As the country's capital and home to about one-third of its population, Lima is incredibly important for Peru in social, economic, and political terms. SEDAPAL's 2015–2020 master plan, formally approved in June 2015, includes a 1% tariff increase to be used for ecosystem services (about US $25 million). An additional 3.8% is allocated for climate change adaptation and disaster risk reduction (about US $105 million). These commitments are by far the greatest commitments for natural infrastructure by any water utility in Latin America.

The biodiversity PES sector remains the least developed in terms of geographical scope and is most challenging for countries to put in place. Unlike in water PES for which the beneficiaries of clean water and flood protection are straightforward and local, the beneficiaries of biodiversity are often widespread and the specific benefits indirect or non-material. Institutions comparable to water utilities that can collect fees on behalf of many beneficiaries do not exist, and common metrics are difficult to determine.

One can debate over which programs should qualify as PES. We do not include conservation easements or traditional conservation finance such as land purchase, because many of these are made to ensure open space or transit rather than provision of ecosystem services (Salzman *et al.* 2018a). Our primary focus on biodiversity PES is the use of offsets to ensure no net loss. By this measure, biodiversity PES programmes in the field remain limited to 36 countries, and the most successful initiatives rely on regulatory drivers. The very practice of offsets remains controversial, with strong opposition from NGOs worried about endorsing habitat destruction.

FIGURE 2 *The Mitigation Hierarchy (Business and Biodiversity Offsets Programme 2013)*



The compliance mitigation programmes that restore stream and wetland habitat benefit from strong regulations backed by credible enforcement and common agreement on currencies of exchange (such as wetland acreage). (Salzman and Ruhl 2001) This sector is the least transparent in terms of availability of data on transactions or project implementation. Global transactions are estimated to be US$2.5–8.4 billion per annum, a wide range indicative of the difficulties in tracking payments (Salzman *et al.* 2018a).

Mitigation credits. Mitigation credit banks are growing but primarily in developed countries. With transactions estimated at US$3.6 billion per annum, compensatory mitigation banking continues to grow (Salzman *et al.* 2018a). It has not spread geographically, however; almost all the growth has occurred in the United States, Australia, Canada and Germany (where wetlands are the largest habitat type offset). Mitigation banking has been introduced on a voluntary basis in Malaysia and for compliance purposes in the Northern Mariana Islands, and is in the process of being piloted in Colombia; otherwise, it is found only in developed countries. In developing countries, mitigation carried out directly by the party producing the impact or by a subcontractor, known as 'permittee-responsible mitigation', is the most commonly found option for compliance, although many countries (including Brazil, Cameroon, China, Colombia, Egypt, India, Mozambique and South Africa) allow developers to pay a compensation fee in lieu of an offset, which is generally used to fund conservation projects carried out by the public sector or an NGO.

Forest Trends Business and Biodiversity Offsets Programme (BBOP)

BBOP was designed to help developers, conservation groups, communities, governments and financial institutions who wish to consider and develop best practice related to achieving no net loss of biodiversity through the thorough application of the mitigation hierarchy (avoid, minimise, rehabilitate/restore, offset). The Principles and Standard have been developed and tested by members of the BBOP Secretariat and Advisory Group since 2004 and have benefited from contributions and suggestions from many people who registered on the BBOP consultation website and numerous others who have joined for discussions in meetings.

Certification and Standards

We regard product certification as one of the earliest form of PES or a market-like mechanisms, provided that the certification standard ensures some form of service provision. Large-scale agriculture and unsustainable forest practices are responsible for roughly two-thirds of tropical deforestation and significant biodiversity loss. Most of these impacts arise from the production of a small number of commodities – palm oil, soy, cattle, and timber and pulp – in developing countries (which account for 70% of the world's soy and all of its palm oil). These commodities were valued at $98 billion of agricultural exports in 2013 (Supply Change 2015). They provide ingredients for many consumer products, from candy bars to soaps, and account for a large part of supply chains' greenhouse gas emissions. Maintaining these trade flows is critical to sustain tropical countries' continued development.

An increasing number of actors throughout the supply chain have publicly committed to reduce the ecosystem impacts of the commodities that they produce or procure. These commitments vary enormously – by level of stringency, breadth of coverage, length of obligation, and many other sourcing characteristics. Established commodity groups such as the Forest Stewardship Council, Roundtable for Responsible Soy, and the Roundtable for Sustainable Palm Oil provide a forum for hundreds of companies to engage in stakeholder dialogues and develop reporting and certification standards. In sum, commitments have come from companies exceeding $4 trillion in market capitalization. Over 30% of these commitments were made in 2014 (Supply Change 2015).

Because there has been no effective standardization of definitions or performance verification, it is difficult to compare across commitments. Two-thirds of the parties work within certifications systems, with the remaining outside standardized verification frameworks. And some companies go above and beyond the certification requirements in their commitment.

TABLE 2 *Biodiversity/Habitat PES* (Salzman *et al.* 2018a)

PES Mechanism (Category)	Definition	Example	Market Size 2008→2016	Number of Programs	Distribution (Countries)
Wetlands and stream mitigation (Compliance)	To compensate for filling wetlands or streams, developers purchase credits for comparable wetlands and streams created offsite that have been certified by a government agency.	Under the U.S. Clean Water Act, a permit for development of wetlands can require the purchase of mitigation credits from an offsite bank of created wetlands.	$1.3–2.2 billion → $1.4–6.7 billion	5	1
Compliance biodiversity (Compliance)	To comply with regulatory requirements that mitigate impacts on biodiversity, developers can purchase credits for a specific habitat type that has already been created by a third party as an offset, purchase biodiversity credits created in a similar manner, or pay into a general offset fund.	The Biodiversity Offsets and Banking Scheme (BioBanking) was launched by the state of New South Wales in 2007 to offset habitat impacts from development. Developers can purchase credits from conservation management activities such as managing grazing, removing invasive species, habitat corridors, etc., for trades that match "like for like" credits and impact according to the habitat type.	$0.5 billion→$1.1–$1.7 billion	99	33
Voluntary biodiversity offsets (Government-financed)	Developers choose to mitigate the impacts of projects through measurable conservation outcomes intended to achieve no net loss, or preferably a net gain, of biodiversity with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity.	In Sabah, Malaysia, the Malua BioBank contains one of the world's highest concentrations of orangutans. The government of Saba worked with private parties to invest in the restoration and maintenance of 34,000 hectares of rainforest. The BioBank sells "biodiversity conservation certificates," with each certificate representing 100 square meters of forest restoration and protection for at least 50 years.	$20→$10.5 million	16 implemented project sites	11

The dramatic increase in the scale of certified commodities represents the most significant new opportunity for PES to address deforestation. This marks a major shift from ten and twenty years ago, when the push for certification primarily came from consumers. Now major retailers and suppliers are taking the lead. While a promising development, this poses significant challenges. Ensuring traceability requires mapping thousands of supply chains from farm to production to suppliers and retailers. Companies setting their own goals may be engaged in greenwashing, so how can credibility be ensured? Certification organizations have an incentive to ensure their standards are complied with, but they face significant conflicts of interest. Weak standards may encourage wide participation but lack credibility. Enforcing strict standards may lead to a drop in users and significant monitoring costs may prove too expensive. Competing organizations may also arise, as has occurred with eco-labeling. An independent institution may be needed to ensure certification systems' credibility.

But does it work?

The preceding sections described PES in terms of geographic coverage, number of programs, and value of transactions. These data cannot, however, measure whether PES actually has been effective in terms of service provision (a biophysical measure), efficiency (an economic measure), or improvement of social welfare (such as poverty reduction, gender equity, or securing property rights). Perhaps surprisingly, for the vast majority of programs we simply do not know. Reviews over the past decade have consistently lamented the lack of data on the effectiveness of PES (Börner *et al*. 2017, Miteva *et al*. 2012, Pattanayak *et al*. 2010).

Few PES schemes have been established with evaluation in mind. As a result, researchers studying them at a later date have lacked baseline data, control areas, or randomized design, making it difficult to evaluate counter-factuals – what would have happened without a PES program? (Ferraro *et al*. 2015)

Empirical studies on the effectiveness of forest PES have reported mixed results for reduced deforestation, depending on the time period and area (Snilsveit *et al*. 2019, Alix-García & Wolff 2014). Researchers have highlighted concerns over additionality – that PES contracts are often established on low-value lands unlikely to be converted to other uses – and leakage – that avoided deforestation in the PES area leads to increased logging in other areas (Sanchez-Azofeifa *et al*. 2007). At a local scale, there has been evidence of qualitative benefits such as clarification and security of land tenure, greater levels of compliance, and increased social capital (Richards 2013). Robust studies on the effectiveness of forest certification programs have also been lacking (Heilmayr and Lambin 2015).

There is a large literature on water PES schemes. A 2011 review of 47 schemes by Brouwer *et al*. found that 58 percent had been "classified as effective in reaching their environmental objectives, while 42 percent were not" (Brouwer *et al*. 2015) Reflecting the massive scale of recent Chinese watershed PES programs, an increasing number of studies have started to assess these initiatives (Zheng *et al*. 2013).

A small number of PES programs, such as South Africa's Work for Water Program, have explicit poverty alleviation goals. Some studies of PES watershed schemes have found positive welfare impacts for PES participants, with increased household income (Wunder 2008), but the overall record has not demonstrated strong positive or negative impacts on poverty (Richards 2013). A number of researchers have raised equity concerns created by PES programs. Rodriguez de Francisco *et al*. charged that PES reinforced existing social differences (Rodriguez de Francisco *et al*. 2013). The most critical literature has focused on REDD initiatives, though most of these articles have been predictive (Bottazzi P *et al*. 2014). Empirical research has typically found little or slightly positive social effects (Poudel *et al*. 2015, Maraseni *et al*. 2014). PES impacts on gender remain largely unstudied (Heilmayr and Lambin 2015).

Viewed overall, there has been scant impact evaluation of PES in the field. This prevents meaningful analysis of the program's effectiveness or efficiency; it hinders comparisons across programs; and it frustrates understanding the trade-offs between environmental, economic, and social/political goals, particularly important in PES programs that promote multiple benefits. If program critics challenge whether funds have been spent effectively, this information gap will prove problematic.

CONCLUSION

Despite this period of regulatory rollbacks, there still exist numerous opportunities around the globe to scale up investments in forests and other natural ecosystems through market instruments and payments for ecosystem services. This gives us great hope that we will arrive at the day when our global forested space will be fully valued for the supermarkets of goods and services it provides to humankind and our planet. The race is on to realize these critical benefits as our forests and natural ecosystems face increasing threats from population growth and climate change.

REFERENCES

BENNETT, G. 2018. For Cusco, Peru, an investment in the countryside is an investment in the city. Washington DC: Forest Trends.

BÖRNER, J., BAYLIS, K., CORBERA, E., EZZINE-DE-BLAS, D., HONEY-ROSÉS, J., PERSSON, U.M., and WUNDER, S. 2017. The effectiveness of payments for environmental services. *World Development* **96**: 359–374.

BOTTAZZI, P., CRESPO, D. SORIA, H., DAO, H., SERRUDO, M., BENAVIDES, J.P., SCHWARZER, S., RIST, and S. 2014. Carbon sequestration in community forests: trade-offs, multiple outcomes and Institutional Diversity in the Bolivian Amazon. *Development and Change* **45**(1): 105–131.

BROUWER, R., TESFAYE, A., and PAUW, W.P. 2011. Meta-analysis of institutional-economic factors explaining the environmental performance of payments for watershed services. *Environmental Conservation* **38**(04): 380–392.

BUSINESS AND BIODIVERSITY OFFSETS PROGRAMME. 2013. To no net loss and beyond: an overview of the business and biodiversity offsets programme (BBOP). Washington DC: Forest Trends.

FERRARO, P.J., HANAUER, M.M., MITEVA, D.A., NELSON, J.L., PATTANAYAK, S.K., NOLTE, C., and SIMS, K.R.E. 2015. Estimating the impacts of conservation on ecosystem services and poverty by integrating modeling and evaluation. *PNAS* **112**(24): 7420–7425.

FOREST TRENDS' ECOSYSTEM MARKETPLACE. 2019. Financing emission Reductions for the future: state of voluntary carbon markets 2019. Washington DC: Forest Trends.

HEILMAYER, R. and LAMBIN, E.F. 2016. Impacts of non-state, market-driven governance on Chilean forests. *PNAS* **113**(11): 2910–2915.

MARASENI, T.N., NEUPANE, P.R., LOPEZ-CASERO, F., and CADMAN, T. 2014. An assessment of the impacts of the REDD+ pilot project on community forest user groups (CFUGs) and their community forests in Nepal. *Journal of Environmental Management* **136**: 37–46.

PATTANAYAK, S.K., WUNDER, S., and FERRARO, P.J. 2010. Show me the money: do payments supply environmental services in developing countries? *Review of Environmental Economics and Policy* **4**(2): 254–274.

POUDEL, M., THWAITES, R., RACE, D., and DAHAL, G.R. 2015. Social equity and livelihood implications of REDD+ in rural communities – a case study from Nepal. *International Journal of the Commons* **9**(1): 177–208.

RICHARDS, M. 2013. What do we know about Gender and other social impacts of IWS projects? Washington DC: Forest Trends.

RODRÍGUEZ DE FRANCISCO, J.C., BUDDS, J., and BOELENS, R. 2013. Payment for environmental services and unequal resource control in Pimampiro, Ecuador. *Society and Natural Resources* **26**(10): 1217–1233.

SALZMAN, J. and RUHL, J.B. 2001. Currencies and the commodification of environmental law. *Stanford Law Review* **53**: 607.

SALZMAN, J., BENNETT, G., CARROLL, N., GOLSTEIN, A. and JENKINS, M. 2018a. The global status and trends of payments for ecosystem services. *Nature Sustainability* **1**(March): 136–144.

SALZMAN, J. BENNETT, G., CARROLL, N., GOLSTEIN, A. and JENKINS, M. 2018b. Payments for Ecosystem Services: Past, Present and Future, Texas A&M Law Review **6**: 602.

SNILSVEIT, B., STEVENSON, J., LANGER, L., TANNOUS, N., RAVAT, Z., NDUKU, P., POLANIN, J., SHEMILT, I., EYERS, J., and FERRARO, P.J. 2019. Incentives for climate mitigation in the land use sector – the effects of payment for environmental services on environmental and socioeconomic outcomes in low- and middle-income countries: a mixed-methods systematic review. *Campbell Systematic Reviews* **15**(3): 1045.

SUPPLY CHANGE. 2015. Corporations, commodities, and commitments that count. Washington DC: Forest Trends.

VAISSIÈRE, A.-C., QUÉTIER, F., CALVET, C., LEVREL, H., and WUNDER, S. 2020. Biodiversity offsets and payments for environmental services: clarifying the family ties. *Ecological Economics* **169**: 106428.

WUNDER, S., BROUWER, R., ENGEL, S., EZZINE-DE-BLAS, D., MURADIAN, R., PASCUAL, U., and PINTO, R. 2018. From principles to practice in paying for nature's services. *Nature sustainability* **1**(3): 145–150.

ZHENG, H., ROBINSON, B.E., LIANG, Y.-C., POLASKY, S., MA, D.-C., WANG, F.-C., RUCKELSHAUS, M., OUYANG, Z.-Y., and DAILY, G.C. 2013. Benefits, costs, and livelihood implications of a regional payment for ecosystem service program. *PNAS* **110**(41): 16681–16686.

Multilateral forestry research and tertiary forestry education for development: reflections on progress since the 1970s

P.J. KANOWSKI

Fenner School of Environment and Society, The Australian National University, Canberra, ACT 2601, Australia

Email: peter.kanowski@anu.edu.au

SUMMARY

The contemporary institutional landscapes for multilateral forestry research and tertiary forestry education for development were shaped largely in the last three decades of the 20th century. Some limitations of largely post-colonial arrangements in the 1970s for forestry research for development were addressed by the establishment of CIFOR and incorporation of ICRAF into the CGIAR system in the early 1990s, following international processes in which FAO, IUFRO and the World Bank played central roles. Contemporaneously, tertiary forestry education evolved and internationalised in conjunction with that sector more generally. Institutional arrangements for multilateral forestry research are now undergoing another phase of change, as key actors seek more impact without more investment. Traditional models of tertiary forestry education for development are similarly challenged by ongoing changes in higher education systems. Both forestry research and education need now to address the profound challenges and potential opportunities associated with major forces such as ongoing forest loss and degradation, climate change, economic globalisation, and social and demographic change. In parallel, the value of evidence-based policy and practice, and of multilateralism, are being challenged by resurgent political populism and nationalism. Together, these contexts suggest that those engaged in forestry research and education for development will need to be politically and institutionally astute, and proactive and strategic, in catalysing and pursuing opportunities; and that various collaborative models, both nationally and internationally, will remain important vehicles for sharing resources, commanding the attention of decision-makers, and realising development impacts.

Keywords: forestry education, forestry research, global South, research for development, sustainable development

Recherche forestière multilatérale et éducation forestière supérieure pour le développement: réflexions sur les progrès effectués depuis les années 70

P.J. KANOWSKI

Les paysages institutionnels contemporains pour la recherche forestière multilatérale et la recherche forestière en éducation supérieure pour le développement ont été principalement ébauchés au cours des trois dernières décennies du XXème siècle. Certaines limites des arrangements, largement post-coloniaux dans les années 70, pour la recherche forestière en développement ont été visées par l'établissement du CIFOR et l'incorporation de l'ICRAF au système du GCRAI au début des années 90, à la suite des processus internationaux dans lesquels la FAO, l'IUFRO et la Banque Mondiale ont joué des rôles capitaux. Dans la même période, l'éducation forestière supérieure évolua et s'internationalisa plus généralement en conjonction avec ce secteur. Les arrangements institutionnels pour la recherche forestière multilatérale connaissent actuellement une autre phase de changement, alors que les acteurs-clé recherchent davantage d'impact sans investissement additionnel. Les modèles traditionnels d'éducation forestière supérieure pour le développement sont eux aussi ébranlés par les changements en cours dans les systèmes d'enseignement supérieur. La recherche et l'éducation forestières doivent à présent faire face aux profonds défis et aux opportunités potentielles associés à des forces majeures, telles que la perte et la dégradation forestières en cours, le changement climatique, la globalisation économique et les changements démographiques et sociaux. Parallèlement, la valeur des politiques et des pratiques basées sur des preuves et celle du multilatéralisme sont secouées par un populisme et un nationalisme politique résurgents. Mis ensemble, ces contextes suggèrent que les personnes engagées dans la recherche et l'éducation forestières pour le développement devront faire preuve de finesse politique et institutionnelle et être stratèges et proactives pour catalyser et poursuivre les opportunités. De même, les modèles collaboratifs variés, nationaux et internationaux, resteront des véhicules importants pour le partage des ressources, afin d'attirer l'attention des preneurs de décision et de réaliser les impacts de développement.

Investigación forestal multilateral y educación forestal terciaria para el desarrollo: reflexiones sobre los progresos realizados desde la década de 1970

P.J. KANOWSKI

El panorama institucional contemporáneo de la investigación forestal multilateral y de la educación forestal terciaria para el desarrollo se configuró en gran medida en las tres últimas décadas del siglo XX. Algunas limitaciones de las disposiciones, principalmente postcoloniales, de la década de 1970 para la investigación forestal para el desarrollo se abordaron con el establecimiento del CIFOR y la incorporación del ICRAF al sistema de CGIAR a principios de la década de 1990, tras los procesos internacionales en los que la FAO, IUFRO y el Banco Mundial desempeñaron un papel fundamental. Al mismo tiempo, la enseñanza forestal terciaria evolucionó y se internacionalizó a la par que ese sector de manera más general. Las disposiciones institucionales para la investigación forestal multilateral están atravesando ahora otra fase de cambio, en la que los principales agentes buscan más impacto sin más inversión. Los modelos tradicionales de educación forestal terciaria para el desarrollo se han visto cuestionados igualmente por los cambios que se están produciendo en los sistemas de educación superior. Tanto la investigación como la educación forestal deben abordar ahora los profundos desafíos y las posibles oportunidades asociadas a las principales fuerzas de cambio como la pérdida y degradación continua de los bosques, el cambio climático, la globalización económica y los cambios sociales y demográficos. Al mismo tiempo, el valor de las políticas y las prácticas basadas en evidencia, así como el del multilateralismo, se ven cuestionados por el resurgimiento del populismo político y el nacionalismo. En conjunto, estos contextos sugieren que las personas dedicadas a la investigación y la educación forestal para el desarrollo tendrán que ser astutas en lo político y lo institucional, así como ser proactivas y estratégicas, para catalizar y aprovechar las oportunidades; y que los diversos modelos de colaboración, tanto a nivel nacional como internacional, seguirán siendo importantes vehículos para compartir recursos, atraer la atención de quienes adoptan las decisiones y lograr impactos en el desarrollo.

INTRODUCTION

The case for the centrality of forests, and the ecosystem goods and services they provide, to what is now characterised as 'sustainable development' (World Commission on Environment and Development 1987) has been made by foresters since the 19th Century (Westoby 1989), by forest-related development institutions since the 1960s (e.g. Westoby 1987, World Bank 1978), and since the 1980s by multilateral initiatives and processes focused on forests that now characterise the international forests regime (Fernández-Blanco *et al*. 2019, Rayner *et al*. 2010). The scope of forest ecosystem goods and services recognised has broadened progressively, from an early emphasis on wood products and forest industry-based development, to the contemporary understanding of forests being foundational to much of the United Nations Sustainable Development Agenda (Katila *et al.* 2019) and to planetary health (e.g. Griscom *et al*. 2017, Rosenstock *et al*. 2019).

Key elements of the contemporary international institutional landscape of forestry[1] 'research for development' (*sensu* Bartlett 2016, Clark *et al.* 2016 – viz. research conducted in support of sustainable development) were shaped during the last three decades of the 20th century. Over the same period, tertiary forestry education also evolved substantially, reflecting an intersection of a broadening understanding of "the purpose of forests" (*sensu* Westoby 1987), the expansion of tertiary ('higher') education globally (UNESCO 2017), and institutional changes in tertiary education systems (Kanowski 2000). During these three decades, John Spears worked successively for FAO and the World Bank, and on related international initiatives such as the World Commission for Forests and Sustainable Development (Krishnaswamy and Hanson 1999; see Lele *et al*. 2019). This paper is part of a Special Issue acknowledging his contributions to forestry for development.

These research and education trends from the 1970 have generally accelerated this century. Research and development (R&D) investment has both internationalised and grown since the 1980s (Dehmer *et al.* 2019), with global R&D expenditure more than doubling in real terms since 1996, to USD$1,400 Billion (2013 value; UNESCO 2019). Similarly, tertiary education has globalised and internationalised (Altbach *et al.* 2009, Zajda 2015); access to both education generally and higher education specifically has improved dramatically, although remaining limited, inequitable and of poor quality in some regions and countries (UNESCO 2016, UNESCO 2017, World Bank 2018). Multilateral forest-related research and tertiary forestry education have evolved in these broader systemic contexts as well those more specific to forests and forestry (*e.g.* Katila *et al.* 2019, van Noordwijk 2019, Westoby 1987, Chapters 7 and 12; other papers in this Special Issue).

The genesis of this paper, as part of a series in honour of John Spears' many contributions to forestry internationally, shapes its scope and focus. The paper describes the institutional

[1] The term 'forestry' is used here in a broad sense, building on established definitions (*e.g.* Helms 1998), to describe purposeful activities related to the conservation, sustainable management and restoration of forests and trees, and the realisation of their values, services and products; including in 'agroforestry' contexts (van Noordwijk *et al*. 2019) Such activities may draw on both traditional and modern knowledge, applied in particular societal and landscape contexts. The term does not privilege any particular interpretation, emphasis or outcomes of those activities.

gaps identified in the 1970s through processes led by international agencies or entities for whom Spears worked or with whom he interacted; the international institutional arrangements for multilateral forestry research for development that emerged; how tertiary forestry education relevant to development has evolved; the relationship between contemporary multilateral forestry research and forestry education for development and the ambitions articulated in the 1970s and 1980s; and future opportunities and challenges suggested by these reflections.

FORESTRY RESEARCH FOR DEVELOPMENT IN THE 1970S

Forestry research in the 1970s was dominated by institutions in the global North, addressing primarily topics of relevance to those industrialised economies. Some form of forestry research institution existed in most countries of the global South, but – with some notable exceptions – many were poorly funded and staffed, with inadequate facilities, and questionable research priorities (World Bank and FAO 1981). Their priorities largely reflected the post-World War II paradigm of industrial forestry-based development (*e.g.* Westoby 1962), and largely neglected the interface between agriculture and forestry (King 1987). A 1980 global survey identified some 600 forestry research institutions worldwide, of which 90 were engaged on what were them seen as priority topics for forestry in developing countries; 51 of these were in the global North, and four others were multilateral (CGIAR[2]) centres (World Bank and FAO 1981). Many of the Northern institutions were already engaged in bilateral or multilateral research and capacity development partnerships with those in the South. These arrangements reflected, variously, post-colonial bilateral relationships and multilateral initiatives facilitated by the UN FAO and by IUFRO, which had expanded from its pre-1950 solely-European membership to 267 institutional members from 68 countries by the mid-1970s (Johann *et al*. 2017).

One example amongst many is the international collaboration in forest genetic resources coordinated by FAO's Panel of Experts on Forest Gene Resources, established in 1968 (FAO 2012). The Panel facilitated and coordinated activities led by nominated (usually Northern) institutions, supported by both FAO and national development assistance agencies. For example, Australia's CSIRO took responsibility for collecting and distributing the genetic resources of eucalypts from Australia and neighbouring countries (FAO 2002); the UK's Commonwealth Forestry Institute coordinated collection and distribution of the genetic resources of tropical and subtropical American pines and legumes (Burley *et al*. 2009); Denmark's Forest Tree Seed Centre led teak germplasm collection, conservation and improvement in partnership with Thailand (Hedegard 1971); France's Centre Technique Forestier Tropical (CTFT) led work on the genetic resources of many African hardwood species (FAO 1969). This cooperation often extended to related research on these species, such as that on plantation management and products (*e.g.* Burley *et al*. 2009, Turnbull 2003). Tropical forest management and forest products research followed broadly similar institutional arrangements, with – for example – partnerships between European institutions and those of their former colonies, and multilateral facilitation by FAO, in many cases building on long-established work. While there were some strong established or emerging institutions in the global South – for examples, various CTFTs in Francophone Africa, India's and Malaysia's Forest Research Institutes, or the precursors of Brazil's Embrapa – these were in the minority. Attempts to facilitate the establishment and work of 'regional'-level forest research institutions had generally not been successful (World Bank and FAO 1981).

MULTILATERAL FORESTRY RESEARCH FOR DEVELOPMENT – NEXT STEPS FROM THE LATE 1970S

A series of initiatives led by the World Bank and FAO, with the collaboration of IUFRO, from the late 1970s argued the case and progressively developed options for strengthening multilateral forestry research for development. Key stages in this process are summarised below.

The 1978 World Bank *Forest Sector Policy Paper* and World Forestry Congress

The 1978 World Bank *Forest Sector Policy Paper* (World Bank 1978), shaped in large part by John Spears as the then Forestry Adviser, characterised the situation of forests and their potential role in development in terms which are now familiar. It was concerned primarily with the loss of tropical forests to agriculture; the impacts of industrial logging, fuelwood consumption and shifting cultivation; recognising the high levels of reliance on forests and trees by the world's rural poor; the underinvestment in forestry for rural development and environmental services compared to that for industrial development; and the lack of institutional capacity in governance, research and education. The key messages of the *Paper* were complemented by those of the 8th World Forestry Congress, convened by FAO in the same year, the theme of which – *Forests for people* – built on FAO work subsequently published as *Forestry and rural development* (FAO 1981), which similarly signalled a reorientation of thinking away from a focus on forestry for industrial development to the broader roles and potential of forests and trees in livelihoods and development (Westoby 1978).

The World Bank *Paper* identified research priorities to support more sustainable transformation of tropical landscapes.

[2] Consultative Group for International Agricultural Research (see www.cgiar.org).

These included agroforestry systems, intensified forest management, fast-growing fuelwood plantations, alternatives to and more efficient fuelwood use, environmental research focused on forest catchment management and restoration, and research on smaller scale processing and pulp and paper technologies and on value-adding. It also identified training as an integral part of forestry development and of Bank support (World Bank 1978: 48–49).

Exploration and refinement of research priorities and institutional options in the 1980s

The research-related content of the World Bank *Paper* was amplified and refined with information from a global survey of developing country research needs, conducted by the World Bank and FAO in 1981, and presented at the 17th IUFRO World Congress later that year (World Bank and FAO 1981). Its conclusions, developing those outlined in the *Paper*, are succinctly summarised in the Abstract:

> "... new priorities for research are ... directed towards the contribution of trees and forests to increased agricultural productivity and rural development, to the increased production and more efficient use of wood-based energy, and to the conservation and management of existing forest resources. Strategies advocated for ensuring more intensive research in these areas and for meeting technical and physical research needs include strengthening national research institutions in the developing countries themselves and more effective 'twinning' of national agencies with some 90 existing research agencies identified in the paper which are already carrying out research in these priority areas."

The 1981 IUFRO Congress paper noted an almost universal preference for strengthening national institutions, but that other options were not mutually exclusive. It also suggested a third option not aired previously, that of new institutions and the possible role of a "small International Forestry Research Secretariat" (p 24), with a coordination and facilitation role complementing those of FAO and IUFRO.

The survey was considered and its recommendations endorsed by FAO's Committee on Forestry at its 6th session in 1982 (FAO 1982), and the Secretariat suggestion subsequently evolved into IUFRO's Special Program for Developing Countries, established in 1983 (Buckman 1986). Both the World Bank and FAO (1981) and Buckman (1986) outlined the role of the multilateral CGIAR system's then 13 International Agricultural Research Centers in addressing the challenges facing agriculture in the developing world, noted their strengths compared to national centres and their research priority-setting process, and commented on the value of well-developed global and regional research networks, which they observed to be less well-developed in forestry than agriculture. Both noted in the latter context the respective roles of the Nairobi-based International Council for Research in Agroforestry (ICRAF), the establishment of which was catalysed by Canada's International Development Research Centre in 1977 (King 1987); and that of the Costa Rica-based regional Tropical Agricultural Research and Higher Education Centre (CATIE), established in its present form in 1973 with integrated research, education and extension objectives (CATIE 2015).

IUFRO's President Robert Buckman (1986: 447) and his colleagues built on a suggestion first aired in the 1981 World Bank and FAO paper to propose an "International Council for Forestry Research and Extension" (INCOFORE), as "a small secretariat and advisory mechanism to focus on global and regional problems of forestry research and extension", and reported on preliminary discussions about its structure and funding. Over the next few years, that proposal intersected with others emerging from the World Commission on Environment and Development (1987) and the CGIAR system itself, which identified the need for research that better integrated agriculture with its environment, natural resource and sustainability contexts and dimensions; that addressed the research constraints identified in the context of the recently-initiated Tropical Forests Action Plan (TFAP); and connected with the momentum then building towards the 1992 UN Conference on Environment and Development and its Agenda 21 (Sayer 1994).

The establishment of multilateral forestry research institutions within the CGIAR

In early 1988, an International Task Force on Forestry Research (ITFFR) established by the Rockefeller Foundation, the World Bank, UNDP and FAO identified the global research priorities listed in Box 1, and explored institutional options to address these constraints, including: "creating an independent world centre for the direction, execution and coordination of tropical forestry research; expanding the mandate of the CGIAR to include forestry research; and establishing a new consultative group or similar body with a specific mandate for forestry research" (Sayer 1994).

Box 1 Research priorities identified by the International Task Force on Forestry Research, 1988
(source: Sayer 1994)

- forestry's role in agroforestry, watershed and arid zone land-use management;
- natural resource conservation and management;
- tree breeding and tree improvement;
- utilization and market research;
- policy and socio-economic research

Proposals to expand the CGIAR mandate into forestry were not uncontroversial: for example, ICRAF's Director-General had noted in 1987 that the strong disciplinary focus of the existing CGIAR centers was not compatible with the inherently interdisciplinary research needs that characterised agroforestry (Lundgren 1987). Nevertheless, in 1989, the core group of actors who had initiated TFAP and ITFFR reconvened and eventually endorsed the incorporation of forestry research into the CGIAR system (Sayer 1994). The CGIAR's Technical Advisory Committee subsequently recommended

that ICRAF join the CGIAR, as the International Center for Research in Agroforestry, with a global mandate for strategic agroforestry research; and the establishment of new CGIAR centre, the Centre for International Forestry Research (CIFOR), with a global mandate for strategic and applied research on forestry, and lead responsibility for coordination of forestry research within the CGIAR system. Consequently, ICRAF joined the CGIAR in 1991, with its headquarters remaining in Nairobi; and CIFOR was established in 1993 in Bogor, Indonesia, after more than two years of preparatory work led by the Australian Centre for International Agricultural Research (ACIAR) (Sayer 1994).

A series of consultative research priority-setting processes followed for both ICRAF and CIFOR. These drew from the ITFFR work (Box 1), ICRAF's established research program (ICRAF 1992a), ACIAR's developmental work for CIFOR, and consultations for policy research at both centers (Gregersen *et al.* 1992, Spears *et al.* 1994). A new ICRAF strategic plan was approved by the CGIAR in 1991 (ICRAF 1992b), and CIFOR's research agenda was formalised in 1994 (Sayer 1994) and incorporated into its first Strategic Plan (CIFOR 1996). CIFOR's focus emerged strongly as policy-oriented research and development, informed by and catalysing research on topics emerging from the ITFFR and subsequent processes (Sayer 1994; see e.g. Byron and Arnold 1997). These priorities are reflected in the initial research program areas summarised in Box 2.

The establishment of CIFOR and incorporation of ICRAF as international forestry and agroforestry research centres within the CGIAR system, and the research priorities they pursued, thus represented outcomes of ideas first proposed in the 1978 World Bank *Forest Sector Policy Paper*, and nurtured through the subsequent decade by FAO, IUFRO and the World Bank, in particular. This expansion of the CGIAR coincided with IUFRO's centenary, and the UN Conference on Environment and Development, in 1992 in Rio de Janiero.

MULTILATERAL FORESTRY RESEARCH FOR DEVELOPMENT IN 2020

In the c. 30 years since multilateral forestry research for development institutions were established in the terms summarised above, the institutional landscape for such research has taken the shape characterised in Table 1, in the broader context of the international arrangements for forestry overviewed by Dargavel (2010) and Fernández-Blanco *et al*. (2019), and detailed by Rayner *et al.* (2010). The role that each of these categories of institution plays is discussed below.

Global research centres: Since the establishment of CIFOR and the incorporation of the World Agroforestry Centre (formerly ICRAF) into the CGIAR system, the two centres have progressively worked more closely together: initially, mostly informally; since 2011, formally under the

Box 2 CIFOR and ICRAF research programs, early 1990s

CIFOR (Sayer 1994)	**ICRAF** (ICRAF 1992b)
• Policy development • Management and conservation of natural forests • Reforestation of degraded lands • Products and markets • Research support and information	• Environmental characterisation and analysis • Multipurpose tree improvement and management • Component interactions • Systems improvement • Policy, adoption and impact analysis

TABLE 1 *International institutional landscape for forestry research for development*

Institutional character	Mode	Examples
International multilateral – global scope; broad agenda	Global research priorities and programs; usually conducted in partnership with national entities.	FAO, CIFOR, CIRAD, ICRAF, INBAR
International – global scope; more-focused agenda	Specific research and advocacy foci	Chatham House, EFI, ETFRN, IIED, ODI, RRI, WRI; some IGOs and NGOs
International – global scope; network	Network facilitating research collaborations	IUFRO
International – regional scope	Regional research priorities and programs	APFnet, CATIE, RECOFTC
International research for development funding agencies	Bilateral and multilateral funding of research	ACIAR, DfID, EU, GIZ, IDRC, PROFOR, USAID
National or subnational research centres and universities	National and subnational organisation focus on priorities at those levels; universities' foci are more shaped by staff expertise and funding. Both are likely to engage in international collaboration.	National or subnational research organisations (e.g. EMBRAPA, Chinese Academy of Forestry, CIRAD, Kenya Forestry Research Institute); universities
Corporate	Focus on corporate business/operational priorities	Many large forestry sector businesses

framework of the CGIAR *Forests, Trees and Agroforestry* (FTA) research program (FTA 2017a); and since 2019, as a merged entity (CIFOR 2018, CIFOR-ICRAF 2020). Other CGIAR centres, notably Bioversity International, also play specific roles in FTA. Outside the CGIAR, INBAR's exclusive focus on bamboo and rattan (INBAR 2019) both complements and intersects with elements of CIFOR's and World Agroforestry's work. Knowledge syntheses commissioned by FAO Forestry Department (*e.g.* those published as its *Forestry Paper* series) continue their longstanding role in communicating research outcomes.

Research institutes with a global focus in specific topic areas: A small number of research institutes, typically drawing on a mix of philanthropic and official development assistance (ODA) funding, play leading roles in particular topic areas. Examples include the UK-based Chatham House (Royal Institute for International Affairs), International Institute for Environment and Development (IIED), and Overseas Development Institute (ODI); other European centres or networks, such as the European Forest Institute (EFI) and European Tropical Forest Research Network (EFTRN); and the USA-based Rights and Resources Institute (RRI) and World Resources Institute (WRI). In a few cases, of which France's CIRAD[3] is a preeminent example, nationally-funded research organisations play substantive and wide-ranging forestry research roles internationally. International intergovernmental organisations, such as the International Tropical Timber Organisation and some other members of the Collaborative Partnership on Forests (CPF 2020), may also fund limited research in their areas of responsbility.

Global networks: IUFRO continues its leading role as the global network for cooperation in forest science, including as a facilitator of international meetings and collborations. Some 42% of its global membership of 625 organisations is now in countries of the global South; of these, around a quarter are located in each of Africa and Latin America, and half in Asia (IUFRO 2019a; p28). In addition to its discipline-focused Divisions, IUFRO organises activities through a series of Special Programs, including that on Development of Capacities[4], with a strong focus on the global South (IUFRO 2019a, p25–26).

International centres with a regional focus: Although long-foreshadowed (World Bank 1978), few regional forestry research centres have succeeded as stand-alone entities. A number of well-established regional institutions, such as Central America's CATIE (CATIE 2015), or the Bangkok-based Center for People and Forests (RECOFTC) (RECOFTC 2018), are predominantly education, training and extension centres with associated research functions. In some cases, regional networks (*e.g.* the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation; APFnet 2019), support research and tertiary education as part of their activities.

International research for development funding agencies: ODA agencies continued to play a key role in supporting forestry research for development, through both bilateral and multilateral programs and projects. It is difficult to characterise aggregate levels and trends of forestry development assistance and subsidiary research funding, which is typically reported as part of agricultural and/ or rural development funding. Expenditure on 'agriculture' as a whole represents a reasonably steady c. 4% of total ODA investment (c. US$11b in 2017; FAO 2019a), but is generally expected to decline in the future (Arkin 2016).

The share of CGIAR funding for forestry research offers one measure of the proportion of 'agriculture' research funding directed to forestry. CGIAR forestry research (FTA, CIFOR, ICRAF) represented 9.6% of total funding committed in the period 2017–2021 to the CGIAR's specifically-targeted program and project investments ('Windows 2 and 3', respectively; total US$2.23b; CGIAR 2019). In conjunction with ODA-specific data[5], this suggests that the overall proportion of agriculture and rural development research funding spent on forestry is unlikely to more than 10%, and – as for agriculture and rural development generally – is similarly unlikely to increase significantly in real terms.

National or subnational research centres: National forestry research agencies, subnational agencies in countries with federal structures, and topic-specific research centres are (variously) well-established in countries of the global South. They frequently work with international partners in both multilateral and bilateral research activities. In general, however, their funding is following similar trends to that internationally. Relative levels of public expenditure on agriculture, including in research and development, were less in 2010 than in the 1980s, despite increases in developing countries (Yu *et al*. 2016). Hickey (2013) notes that many global research funding trends are reflected in forestry: amongst these, levels of public sector investment in research and development have been declining since 1981, although some of this reflects a shift to co-investment with the private sector; and there has generally been a shift in funding away from government institutions to universities. This has resulted – with some exceptions, where there are effective coordinating mechanisms – in a more fragmented and disjunct and, often, less strategically-directed research effort (e.g. for Australia: Turner and Lambert 2016; for the USA: McGinley *et al.* 2019).

Corporate: As in other arenas, the relative contribution of the private sector to forest research has been increasing over the past three decades (Hickey 2013), often in response to financial incentives for research and development investment, and for various forms of public-private partnership. Corporate investment in research is typically focused almost exclusively on supporting firms' specific interests; in forestry, this usually means research focused on forest products and on production

[3] www.cirad.fr
[4] the successor to the original IUFRO Special Program for Developing Countries
[5] For example, the approximate proportion of the ACIAR budget spent on forestry is 10% (AG Bartlett, pers. comm.)

and processing systems, with investment on environmental and social issues limited to that necessary to meet sustainability commitments and regulatory compliance.

Current foci of multilateral forestry research for development institutions

Thirty years after the incorporation of forestry research into the CGIAR was agreed, the multilateral forestry research for development institutional landscape looks much like that envisaged in the 1980s. The two preeminent multilateral forestry research centres, albeit now merging under the maxim of 'two heads are better than one', have an annual budget of $USD100m and a staff of 700 across 20 countries in the global South (CIFOR 2019a). Their research priorities, as articulated in the themes listed in Box 3, reflect both continuity and evolution over the three decades since those listed in Boxes 1 and 2 were identified. Sustainable management of landscapes and the livelihoods this supports, value chains and trade, and effective policy and governance mirror the early priorities; landscape restoration, climate change mitigation and adaptation, and gender, equity and rights have each assumed a greater significance over time.

Box 3 CIFOR-ICRAF Research Themes 2020
(source: CIFOR-ICRAF 2020)

- Restoration of landscapes and dependent livelihood systems
- Value chains and trade
- Sustainable and resilient landscapes
- Climate change mitigation and adaptation
- Supporting policies and governance that work
- Gender, equity and rights

Other, more specifically-focused research and advocacy institutes – such as Chatham House or WRI – play key policy-informing roles in their areas of focus. Their research foci are complemented by those of international environmental and social organisations – *e.g.*, the Forest Peoples' Programme, the World Conservation Union (IUCN) or WWF. IUFRO's Task Forces and Special Programmes continue to coordinate research efforts and enabling resources on topics of contemporary importance, and their topics[6] and those of related publications[7] illustrate the evolution of these internationally-agreed research priorities.

Regional (*e.g.* APFnet) or thematic (*e.g.* the Poverty Environment Network; CIFOR 2019) research networks are more common than institutions with a regional mandate, such as CATIE or RECOFTC. This reflects, at least in part, the advantages of the former in the context of what is often relatively transient and project-oriented funding. It also emphasises the commitment required to foster and sustain the success of the latter, a challenge already evident in the 1970s (World Bank and FAO 1981).

The expansion of North-South and South-South research networks between institutions, beyond those of largely colonial or FAO-mandated origin in the 1970s, both reflects and has contributed to the emergence of greater forestry research capacity in the global South, including in its universities. As noted by Pardy (2016) and Yu *et al.* (2016) for agriculture, and Denham *et al.* (2019) for R&D generally, by much of the growth in public R&D expenditure has been in the developing economies, particularly those of the BRIC countries and others that have developed rapidly, such as Vietnam. In forestry research, as in other domains, the rise of China is particularly noteworthy (Hickey 2013). However, where economic development has been slower, and where public resources are most limited – for example in many African countries, or in the poorer countries of Asia-Pacific and Latin America – funding for research in general (Pardy 2016), and for national and sub-national forestry research institutions and programs within that context, remain very constrained and limiting. In many of these cases, international research project funding may be the only means by which these constraints can be addressed, at least for topics that are tractable within project timeframes (e.g. for PNG, Bartlett 2018).

The resource constraints familiar to most forestry researchers in the global South are also becoming more common in the global North, impacting on the capacity of Northern institutions to collaborate with multilateral and Southern partners. For example, Australian forestry research investment and capacity have declined substantially over the past 30 years (Turner and Lambert 2016); similar trends are evident in the USA this century (McGinley *et al.* 2019). As McGinley *et al*. (2019) note, such a trend demands greater collaboration between forestry research institutions and research and development stakeholders, including those in the private sector – but also constrains the topics and terms of collaboration, and limits the scope and continuity of research efforts.

Enhancing research quality and impact has become a central concern of research funders and institutions. An explicit, *a priori*, focus on articulating theories of change (e.g. FTA 2017b, Mayne 2015), identifying and refining pathways to impact (e.g. Douthwaite *et al.* 2007), and ensuring quality (e.g. Belcher *et al.* 2016) now characterise much forestry research planning, prioritisation and implementation. The challenges of evaluating impacts of research on complex, real-world problems have been addressed by conceptual and methodological advances, such as in 'theory-based' methods (e.g. contribution analysis, Riley *et al.* 2018). The utility of these approaches has been demonstrated in various 'forestry research for development' contexts (e.g. Halimanjaya *et al*. 2018, Young and Bird 2015).

[6] see iufro.org > Science in IUFRO
[7] see iufro.org > Publications > Series

FORESTRY EDUCATION FOR DEVELOPMENT IN THE 1970S

In 1970, FAO foreshadowed a "World Consultation on Education for Forestry and Forest Industries at which it is planned to discuss with reason rather than fervour the content of forestry education" (FAO 1970). That Consultation took place in Stockholm in 1971, with participants representing 75 countries and relevant international agencies. There were then[8] some 354 forestry education and training institutions globally, 119 of which were in the global North and 135 in the global South (FAO 1977). Discussion focused largely but not exclusively on education and training in the developing world, the challenges of which were summarised as (Sisam 1972: 129):

> ". . . the problem is to create a meaningful program and maintain high academic standards where there is no tradition of indigenous forestry education, no local teaching staff, no textbooks relevant to the local situation, a public unaware of the need for trained forestry personnel, and limited resources to devote to forestry education."

The outcomes of the Consultation were summarised by its Chair (Sisam 1972). It:

- agreed that professional forestry education should be integrated into universities rather than offered by independent forestry schools, as had been the case in many countries; that the image of forestry and forestry students in universities needed to be improved; that education needed to recognise both the environmental and production dimensions of forestry, and should address its global context; and that continuing education was a necessary complement to degree programs;
- recognised the importance of technical and vocational education and training (TVET), noting that technical staff were usually responsible for the quality of operational activities; and the need for TVET programs to recognise the typically poor levels of prior education of those pursuing such training;
- identified poor extension and communication as major constraints to advancing the cause and delivering the benefits of forests and forestry in all countries;
- recommended strengthening international collaboration, bilaterally and multilaterally, between forestry education institutions, to capitalise on the strengths and resources of established universities in support of institutions in developing countries.

TERTIARY FORESTRY EDUCATION FOR DEVELOPMENT IN 2020

The 2030 Agenda for Sustainable Development conceives education in broad terms, encompassing formal, non-formal and informal elements over a person's lifetime (UNESCO 2016), and 'at the heart' of sustainable development (UNESCO *et al.* 2016: 24). Access to all levels of education has continued to expand in most countries (UNESCO 2017, World Bank 2018); tertiary education, the primary vehicle for 'forestry' education, has internationalised dramatically in the past few decades (Kanowski 2015, UNESCO 2017). Environment and sustainability education were championed by the *UN Decade of Education for Sustainable Development 2005–2014* (UNESCO 2016), providing a platform for linking SDG4 *Quality education for all* with forests (Kanowski *et al.* 2019). These trends provide the context for contemporary tertiary forestry education.

The outcomes of the 1971 FAO Consultation on Education for Forestry and Forest Industries (Sisam 1972) offer a starting point for reviewing progress in tertiary forestry education for development over the past c. 50 years. Its major recommendations and a commentary on their current status (author's precis in both cases) are presented in Table 2, and discussed below.

Professional and technical forestry education

Institutionally, professional forestry education is now almost universally offered within university systems, as the 1971 Consultation recommended; the (incomplete) Global Forests Information Service (GFIS) listing of tertiary forestry programs identifies 290 universities in 84 countries offering tertiary education for forestry or the forest industries (GFIS 2019). TVET training is offered both by specialist forestry-focused (*e.g.* for Cameroon, Rekola 2019) and more generalist institutions; however, there is no semi-comprehensive global listing of these institutions comparable to that available for universities.

The image of forestry and forestry students

Historically, stand-alone institutions for forestry education fostered a mutually-reinforcing image of forestry and forestry students that might be characterised stereotypically as either – as seen from within – elite and heroic, or – as seen from the outside – marginal and technocratic (see, e.g., Burley *et al.* 2009, Roche and Dargavel 2008). These perceptions were amplified by the almost universally male character of forestry student cohorts until the 1970s (e.g. Coutinho-Sledge 2015). The incorporation of professional forestry education into more comprehensive universities has largely addressed the issue of an educational identity separate from that of others, and forestry curricula have also typically been more integrated with cognate curricula, primarily those in environment, natural resources and sustainability. Student cohorts are now largely gender-balanced (see e.g. Rekola *et al.* 2017), and diverse (see e.g. Gilless 2015), and so both more representative and inclusive. These changes are both welcome and

[8] Data drawn from FAO 1977, which updated a 1974 FAO list compiled following the Stockholm Consultation (FAO 1977).

TABLE 2 *Status of tertiary forestry education and training in relation to recommendations of 1971 FAO Consultation*

1971 FAO Consultation – recommendations (drawn from Sisam 1972)	**Current status – commentary** (author's interpretation; elaborations in text)
Professional forestry education should be integrated into universities rather than offered by independent forestry schools.	Now almost universal; some technical forestry schools remain independent.
The image of forestry and forestry students in universities needed to be improved.	Usually now not an issue, as forestry programs and students are now integrated with those of universities more generally.
Forestry education needs to recognise both the environmental and production dimensions of forestry, and should address its global context.	Curricula have broadened to address these and other dimensions of forestry.
Technical and vocational education is important, and needs to recognise the typically poor levels of prior education of those pursuing vocational training.	Progress in TVET has often been more limited than that in professional education.
Address poor extension and communication as major constraints to advancing the cause and delivering the benefits of forests and forestry.	Traditional extension capacity has generally diminished, but new approaches have emerged. Improving communication and outreach have been a major focus of many forestry institutions and curricula, but remain challenging.
Strengthen international collaboration, bilaterally and multilaterally, between forestry education institutions.	Various global, regional and multi- or bi-lateral programs exist; some are more durable than others.

necessary to enable truly-inclusive sustainable forest management and sustainable development (Arora-Jonsson *et al*. 2019). However, in parallel, diminishing numbers of 'forestry' students, and a diminution of the strong sense of common identity and purpose that characterised earlier eras of professional forestry (for both better and worse), have impacted on the capacity and viability of forestry-focused professional and student associations, and the roles they can play in enabling professional development.

In 2020, challenges to the standing of forestry as a discipline and profession remain both profound and significant, reflecting various complex interactions of economic, institutional and societal forces (see, *e.g*. Katila *et al.* 2019 for an overview). Hull's (2011) reflection on these issues, "Forestry's conundrum: high value, low relevance", whilst set in the specific context of the USA, is much more widely applicable. Forestry educators, professionals and institutions in most countries continue to grapple with this conundrum.

Forestry curricula

Forestry curricula have broadened, both in the terms suggested by the 1971 Consultation, and in other dimensions, notably in the incorporation of the social sciences and interdisciplinarity (e.g. Gilless 2015). The curriculum challenges of balancing breadth and depth, and of specialist technical content and practical experience with more generic knowledge and skills, remain as real now as they were when professional forestry education became widespread from the early 20th century (see, *e.g.*, recent reviews: globally, Rekola *et al.* 2017; for Africa – Rekola 2019, Ramcilovic-Suominen *et al.* 2016; for USA – Gilless 2015). The Joint IUFRO-IFSA Task Force on Forest Education found, in its survey of forestry education and professional competency needs in nine countries across five continents (Rekola *et al*. 2017: 5):

> "Generally speaking, forest education curricula in all studied countries should emphasize more generic competencies, such as leadership and management skills, social relations, and communication. However, many differences between countries are especially related to subject specific competencies. The most widely observed need was to increase the role of entrepreneurship, economics, and management."

These results echo those reported two decades earlier by Sample *et al*. (1999), in their study of USA employers' assessment of the 'skills needed by graduates for long term success in forestry', and which have a wider currency beyond the USA. Employers identified a suite of 'soft' and generic skills – abilities to work in a team, to listen and address public concerns, to take an innovative approach to working with the public, and to synthesise information from diverse sources – as generally being of greater or comparable importance to the more technical skills of understanding forest ecosystems, planning at landscape level, and developing and implementing innovative approaches to forest management.

The emergence, however tentative and tenuous thus far, of a green economy (*sensu* UNEP 2011) and the bioeconomy (e.g. Winkel 2017) presages the need for a wider knowledge and skill base for the sustainable management of forests and trees, including those on farms and in cities, for the breath of potential ecosystem goods and services (Lawrence *et al*. 2017); and to support the development of a diversity of innovative, sustainable forest industries at a range of scales (Macqueen *et al*. 2018, Panwar *et al*. 2016, Sanchez Badini *et al.* 2017). Similar challenges and opportunities will apply in managing forests in the context of climate change, which is likely to require strengthening a range of forest and land management knowledge and skills (Kelly and Brown 2019); and in the expansion of urban forestry, paralleling the ongoing

global demographic shift to cities (Dümpelmann 2020, Salbitano *et al.* 2016).

Forestry curricula and programs have become much more internationalised, as the 1971 Consultation recommended. Globalisation and the rise of information and communication technologies (ICT) and social media have enabled this, as well as underlining the importance of ICT competencies for future professionals (Kanowski *et al*. 2019). The internationalisation of forestry education is manifest in a range of complementary ways: within individual courses and programs; through specific international, including joint and mobility, programs; in the internationalisation of both undergraduate and graduate student communities at many institutions; through the development of international student networks (notably IFSA); and through the engagement of forestry 'youth' in international processes (for reviews, see Kanowski 2015, Kanowski *et al*. 2019).

The importance of technical and vocational education

Technical and vocational education (TVET) is generally poorly developed in many countries, especially those of the South, and for the natural resource sectors (Robinson-Pant 2016, UNEP 2017). TVET for rurally-oriented knowledge and skills suffers from perceptions, particularly among youth in many countries, that rural-based occupations and work are those of last resort (Robinson-Pant 2016). However, there are significant opportunities to improve household livelihoods, rural communities' resilience, and environmental outcomes from more effective technical and vocational education that is also more inclusive of women, the proportion of whom identifying as farmers and in rural employment has increased greatly (Lawrence *et al.* 2017, Robinson-Pant 2016). The 'green' knowledge and skills elements of TVET also need to be strengthened and embedded more widely in VET curricula (INRULED 2012, UNESCO-UNEVOC 2017). Regional forestry institutions such as CATIE and RECOFTC are amongst those who have addressed this need in their domains.

Extension and communication

Publicly-funded extension services for farmers, including small-scale tree growers, have declined in most countries (Mogues *et al*. 2015), catalysing new approaches, including those capitalising on the rapid development and reach of ICT (Sagor *et al*. 2014), and a greater emphasis on community-based capacity building (*e.g*. Bloomfield *et al.* 2018, Catacutan *et al.* 2015, Reid 2017), often facilitated by non-governmental and community-based organisations. Examples include the UK Sylva Foundation's *myForest* initiative (Sylva Foundation 2018), which facilitates forest information and knowledge exchange for landowners, and the community-based focus of international partnerships and initiatives such as the Global Evergreening Alliance (Global Evergreening Alliance 2020) or Forest and Landscape Restoration (Chazdon *et al*. 2017).

Communication about the value of forests and their sustainable management remains challenging (see Hull 2011, as noted above), in part because the message is typically more complex than simple (*e.g.* for the case of large-scale tree planting to mitigate climate change: Chazdon and Brancalion 2019 *cf*. Bastin *et al*. 2019). The emergence of climate change as a dominant environmental and social issue globally, and the current and prospective role of forests in climate change mitigation and adaption (*e.g.* IPCC 2019), illustrate both how forest-related communication can benefit from being embedded in a larger topic of strong public interest, but also how it can be submerged or distorted in such contexts. The rise of social media and concurrent decline of traditional media offer new opportunities for communicating about forests and forestry, as well as a myriad of new challenges (Kanowski *et al.* 2019). Examples of forest-related communications campaigns by government (*e.g.* Pollinate 2018, for Australia), NGOs (*e.g.* WWF 2019), the forest industries (WBSCD 2019), research organisations (*e.g*. Palahí *et al*. 2019), and of learning resources (*e.g.* APFnet 2019) or toolkits (*e.g.* FAO 2019b), illustrate both the diversity of approaches to effective communication and the resources and skills usually required to achieve outcomes.

Strengthened international collaboration between education institutions

Professional forestry education has followed the wider trend of increasing internationalisation in higher education (Kanowski 2015). Common collaborative arrangements include:

- global or regional networks fostering knowledge sharing and partnership in forestry education, such as the Joint IUFRO-IFSA Task Force on Forest Education (IUFRO 2019), the European SILVA Network (SILVA Network 2019), the African Network for Agriculture, Agroforestry and Natural Resources Education (Yayé *et al.* 2017), and the Asia-Pacific Forestry Education Coordination Mechanism (APFnet and AP-FECM 2018);
- international joint degree programs, such as those under the EU's Erasmus Mundus framework (*e.g.* SUTROFOR; SUTROFOR 2019), or the TRANSFORM program between European and Canadian universities (Leblon *et al*. 2013);
- international joint bilateral or multilateral courses, such as those facilitated by APFECM (AP-FECM 2019), or various partnership and student mobility programs (see Kanowski 2015);
- partnerships which focus on research students, typically in conjunction with capacity development and research collaborations, such as those facilitated by many national development assistance agencies or specific partnership research agencies (*e.g.* Australia's ACIAR);
- less formal international learning opportunities, such as the field visits or specialist training associated with most international meetings, many of which make specific funded provision for students (*e.g.* IUFRO 2019a; IFSA 2019).

However, resource and institutional constraints, and sometimes curriculum requirements, remain barriers to realising the potential of international collaboration between education institutions in forest-related topics (Kanowski 2015).

CONCLUSIONS

The emergence since the 1970s of institutions and networks to strengthen multilateral forestry research and tertiary forestry education for development was catalysed primarily by accelerating tropical forest loss and degradation, and the adverse consequences for the livelihoods of those most dependent on forests and for environmental services. These pressures have continued, only little abated, over the intervening five decades. Their underlying drivers have changed little since they were first formally addressed in an international multilateral context by the UN Conference on Humans and the Environment (the 'Stockholm Conference') in 1972 (O'Neill 2009), reviewed by the World Commission on Environment and Development (WCED 1987), or by the World Commission on Forests and Sustainable Development (WCFSD 1999) a decade later. New or resurgent economic, social and political, and environmental factors have variously exacerbated these pressures: examples of each include the increasing globalisation of supply chains (*e.g.* Kröger 2013, Rousseau *et al*. 2019), populist nationalism (*e.g.* Brazil–de Area Leão Pereira *et al*. 2019, Hope 2019) and conflicts at a range of scales and durations (*e.g.* de Jong *et al*. 2007, Harwell 2010), and climate change and the multiple challenges that it presents for both mitigation and adaptation (e.g. Angelsen *et al*. 2018, Rosenstock *et al.* 2019). These underlying drivers and exacerbating factors show little sign of abating.

The ambitions of those who worked through the 1980s to strengthen multilateral forestry research institutions have largely been realised, although both the character of the CGIAR 'forestry' institutions and of the CGIAR system itself are now changing substantially (see e.g. CIFOR 2018, Bioversity International 2019, CGIAR System Council 2019). It remains to be seen whether the intent of these changes, primarily to realise greater impact more efficiently, will be realised; but it seems unlikely that the share of 'agricultural' research and development funding directed to forestry is likely to increase above its current level of c. 10%. The focus of multilateral forestry research, as conceived four decades ago, is likely to continue to consolidate under a limited number of global themes approximating those of CIFOR-ICRAF (2020): those of the environmental services, and value chains and industries, associated with sustainable management of forests and trees in their landscape contexts; of food and livelihood security and human health for communities at different scales; of forest and landscape restoration; of good policy and governance, respectful of rights and attentive to inequity; and of each of these in the contexts of climate change mitigation and adaptation. To respond most effectively these challenges, multilateral forestry research needs, on the one hand, to maintain the critical mass and focus necessary to advance knowledge and its application in forest- and forestry-specific arenas; and on the other, to integrate effectively with other fields of research and practice, and with multiple interests and stakeholders. Experience in many contexts, such as asserting of the role and value of agroforestry research in the context of increasingly-industrialising agriculture (e.g. Leakey 2014), or of gender research in forestry (e.g. Asher and Varley 2018), suggests this is a continually challenging task.

Similar trends are evident in tertiary forest-related education, which has over the past five decades become more integrated with other tertiary education programs, more encompassing of the humanities and social sciences, more gender-balanced, and more internationalised. These positive trends have interacted with the institutional challenges of generally diminishing undergraduate student numbers and so of maintaining a critical mass of forest-focused academic staff, of often-declining public sector graduate employment opportunities that are not yet balanced by growth in private and non-government sectors, and of constraints on funding for international educational collaboration and student mobility. These constraints are often greatest for institutions in the global South. Conversely, the greater flexibility of many curricula, the emergence of graduate degrees as important professional pathways, and the enhanced connectedness and mobility of students act to counteract these constraints.

The contemporary institutional landscape for multilateral forest research and tertiary forestry education for development shares characteristics with the broader 'international forests regime' (see, *e.g*., Fernández-Blanco *et al.* 2019, Singer and Giessen 2017), with elements of both coordination and fragmentation, marginality to dominant political discourses and agendas, and the consequent limitations for sustainable development outcomes. Enhancing the impacts of multilateral forestry research and tertiary forestry education for development – on societal understanding and demands of forests, their expression in forest and landscape governance and management, and on development trajectories – remain as much of concern to key actors and stakeholders now as in the 1970s. Advances in understanding of theories of change and of impact pathways offers the prospect of better directing investments and adapting institutional arrangements for multilateral forestry research, to make a greater difference to forest-based and -related sustainable development. Similarly, conceiving of tertiary forestry education in the broad sense encapsulated by SDG4 (Kanowski *et al*. 2019) can help inform prioritisation and targeting of investments in education.

Forty years ago, those who sought to advance multilateral forestry research and tertiary forestry education for development – such as John Spears – pursued opportunities to persuade governments, international agencies, and other key actors of the urgent need to strengthen research and education to better address the challenges facing forests and people in the global South; and developed strategies and institutions to

do so. In the contemporary world, with both the global South and North now more connected by global supply chains and information and communication technologies, similarly threatened by climate change and the other environmental impacts of unsustainable resource use, and experiencing major demographic and social transitions, the challenges for forests and people are even more global, and more pressing, than previously. However, in parallel, more populist politics are shaping policy priorities and responses that are less evidence-based and less multilateral (e.g. Hetemäki 2019, Pereira and Viola 2019).

Those of us who advocate for forests and trees and the benefits they deliver, and for the research and education required to harness these benefits for forest-based and -related sustainable development, will need to rise to the contemporary challenges and opportunities identified above, amongst others. To do so, we will need to continue to make the case for evidence-based action, and the role of research and education in enabling it (e.g. Hetemäki 2019, Kelly and Brown 2019); and to build on current forestry research and educational platforms, including those established over the past thirty years. Whilst the scale of forest-related challenges globally suggests there is a case for 'more of everything' (*sensu* Lindahl *et al*. 2017), in reality, resources for both forestry research and education are likely to remain limited relative to need. In conjunction with the diversity of national and sub-national institutional and social circumstances, this suggests that there is unlikely to be any single best strategy or institutional form to address these challenges, and that researchers and educators will need to continue to be politically and institutionally astute, and proactive and strategic, in catalysing and pursuing opportunities in their respective realms of endeavour and influence. It also suggests that various collaborative models, both nationally and internationally, will remain important vehicles for sharing resources, capturing the attention of decision-makers, and realising development impact. In these contexts, the coevolution of the major multilateral forestry research for development institutions and their commitment to partnerships (CIFOR-ICRAF 2020), and the continuing internationalisation of tertiary forestry education and collaboration between institutions (e.g. Rekola *et al*. 2017), are as important now as the steps taken internationally in the 1970s in each of the forestry research and education arenas.

ACKNOWLEDGEMENTS AND DEDICATION

I thank the editors for the invitation to write for this Special Issue, and many former Oxford Forestry Institute colleagues for introducing me to forestry research and education for development. In that context, I thank particularly Jeff Burley and Mike Arnold; and for their comments on an earlier version of this paper. I also acknowledge the late Peter Savill, who epitomised commitment to the topic of this paper, and to whom I dedicate it. I have also learned from many colleagues engaged in forestry research for development, especially those associated with ACIAR, CIFOR, ICRAF and the CGIAR; and similarly from many colleagues working in tertiary forestry education globally. My thanks to them all, and to the four reviewers whose critiques greatly improved the paper. The reflections here, and the associated biases and limitations, remain my own.

REFERENCES

ALTBACH, P.G., REISBERG, L. and RUMBLEY, L.E. 2009. *Trends in global higher education: Tracking an academic revolution*. UNESCO, Paris. 278 p.

ANGELSEN, A., MARTIUS, C., DE SY, V., DUCHELLE, A.E., LARSON, A.M., and PHAM, T.T. 2018. *Transforming REDD+: lessons and new directions*. CIFOR, Bogor. 275 p.

APFnet. 2019. *Asia-Pacific Network for Sustainable Forest Management and Rehabilitation*. www.apfnet.cn/en/index.php (Accessed 10 December 2019).

APFnet and AP-FECM. 2018. *Growing higher forestry education in a changing world*. APFnet and AP-FECM, Beijing. www.apfnet.cn/en/single-159.html (Accessed 10 December 2019).

AP-FECM. 2019. *SFM online courses*. apfecm.forestry.ubc.ca/sfm-online-courses/ (Accessed 10 December 2019).

ARKIN, F. 2016. *Are donors pulling back on agriculture research funding*? www.devex.com/news/are-donors-pulling-back-on-agriculture-research-funding-88276 (Accessed 10 December 2019).

ARORA-JONSSON, S., AGARWAL, S., PIERCE COLFER, C.J., KEENE, S., KURIAN, P. and LARSON, A.M. 2019. SDG5 Gender Equality – a precondition for sustainable forestry. Chapter 5 in KATILA, P., PIERCE COLFER, C., DE JONG, W., GALLOWAY, G., PACHECO, P. and WINKEL, G. (eds.). *Sustainable Development Goals: their impacts on forests and people*. Cambridge University Press. 146–177.

ASHER, K. and VARLEY, G. 2018. Gender in the jungle: a critical assessment of women and gender in current (2014–2016) forestry research. *International Forestry Review* **20**: 149–159.

BARTLETT, A.G. 2016. Evaluating relative success of donor-funded collaborative research projects. *Research Evaluation* **25**: 405–415.

BARTLETT, A.G. 2018. Understanding and evaluating success in international forestry research projects: experience from ACIAR projects in Vietnam, Indonesia and Papua New Guinea. *International Forestry Review* **20**: 274–295.

BASTIN, J.-F., FINEGOLD, Y., GARCIA, C., MOLLICONE, D., REZENDE, M., ROUTH, D., ZOHNER, C.M. and CROWTHER, T.M. 2019. The global tree restoration potential. *Science* **365**(6448): 76–79.

BELCHER, B.M. RASMUSSEN, K.E., KEMSHAW, M.R. and ZORNES, D.R. 2016. Defining and assessing research quality in a transdisciplinary context. *Research Evaluation* **25**: 1–17.

BIOVERSITY INTERNATIONAL. 2019. *The alliance of Bioversity International and CIAT*. www.bioversityinternational.org/alliance/ (Accessed 10 December 2019).

BLOOMFIELD, G., BUCHT, K., MARTÍNEZ-HERNÁNDEZ, J.C., RAMÍREZ-SOTO, A.F, SHESEÑA-HERNÁNDEZ, I., LUCIO-PALACIO, C.R. and INZUNZA, E.R. 2018. Capacity building to advance the United Nations sustainable development goals: An overview of tools and approaches related to sustainable land management. *Journal of Sustainable Forestry* **37**: 157–77.

BURLEY, J., MILLS, R.A., PLUMPTRE, R.A, SAVILL, P.S., WOOD, P.J. and WRIGHT, H.L. 2009. Witness to history. A history of forestry at Oxford University. *British Scholar* **1**: 236–261.

BYRON, N. and ARNOLD, M. 1997. *What futures for the peoples of the tropical forests?* Working Paper 19, CIFOR, Bogor. 19 p.

CATACUTAN, D., MULLER, C., JOHNSSON, M. and GARRITY, D. 2015. Landcare – a landscape approach at scale. In: MINANG, P., VAN NOORDWIJK, M., FREEMAN, E.O., MBOW, C., DE LEEUW, J. and CATACUTAN, D. (eds.) *Climate-smart landscapes: multifunctionality in practice*. World Agroforestry, Nairobi. 151–162.

CATIE. 2015. *Strategic Plan 2013–2020*. Tropical Agricultural Research and Higher Education Center (CATIE), Turrialba, Costa Rica. www.catie.ac.cr/en/what-is-catie/from-words-to-deeds.html (Accessed 10 December 2019).

CGIAR. 2019. *CGIAR Trust Funds Dashboard*. www.cgiar.org/funders/trust-fund/trust-fund-contributions-dashboard/ (Accessed 10 December 2019).

CGIAR System Council. 2019. *9th CGIAR System Council Meeting, 13–14 November 2019, Chengdu, China*. www.cgiar.org/meeting-document/9th-cgiar-system-council-meeting/ (Accessed 10 December 2019).

CHAZDON, R. and BRANCALION, P. 2019. Restoring forests as a means to many ends. *Science* **365**(6448): 24–25.

CHAZDON, R.L., BRANCALION, P.H.S., LAMB, D., LAESTADIUS, L., CALMON, M. and KUMAR, C. 2017. A policy-driven knowledge agenda for global forest and landscape restoration. *Conservation Letters* **10**: 125–132.

CIFOR. 1996. *CIFOR's strategy for collaborative forestry research*. www.cifor.org/library/109/ (Accessed 10 December 2019).

CIFOR. 2018. *World's leading forestry and agroforestry organizations merge for accelerated impact against climate change*. www.cifor.org/press-releases/worlds-leading-forestry-and-agroforestry-organizations-merge-for-accelerated-impact-against-climate-change (Accessed 10 December 2019).

CIFOR. 2019a. *Two heads are better than one*. www.cifor.org/newsletter/2019/January.html (Accessed 10 December 2019).

CIFOR. 2019b. *Poverty Environment Network*. www.cifor.org/pen/ (Accessed 10 December 2019).

CIFOR. 2020. *CIFOR-ICRAF merger FAQ*. www.cifor.org/our-work/cifor-icraf-merger-faq/ (Accessed 10 May 2020).

CIFOR-ICRAF. 2020. *2020–2030 Strategy*. CIFOR-ICRAF, Bogor and Nairobi. 8 p. www.cifor.org/our-work/cifor-icraf-merger-faq/ (Accessed 10 May 2020).

COLLABORATIVE PARTNERSHIP ON FORESTS. 2020. *CPF strategic vision towards 2030*. 3 p. www.cpfweb.org (Accessed 10 May 2020).

COUTINHO-SLEDGE, P. 2015. Feminized forestry: the promises and pitfalls of change in a masculine organization. *Gender, Work & Organization* **22**: 375–389.

DARGAVEL, J. 2010. Netting the global forest: attempts at influence. *Global Environment* **5**: 127–158.

DE JONG, W., DONOVAN, D. and ABE, K. (eds.). *Extreme conflict and tropical forests.* Springer, Dordrecht. 184 p.

DEHMER, S.P., PARDEY, P.G., BEDDOW, J.M. and CHAI, Y. 2019. Reshuffling the global R&D deck, 1980–2050. *PLoS One* **14**(3): e0213801. 12 p.

DE AREA LEÃO PEREIRA, E.J., SILVEIRA FERREIRA, P.J., DE SANTANA RIBEIRO, L.C., SABADINI CARVALHO, T. and DE BARROS PEREIRA, H.B. 2019. Policy in Brazil (2016–2019) threaten[s] conservation of the Amazon rainforest. *Environmental Science and Policy* **100**: 8–12.

DOUTHWAITE, B., ALVAREZ, S., COOK, S, DAVIES, R., GEORGE, P., HOWELL, J., MACKAY, R. and RUBIANO, J. 2007. The impact pathways approach: a practical application of program theory in research-for-development. *Canadian Journal of Program Evaluation* **22**(2): 127–159.

DÜMPELMANN, S. 2020. Urban trees in times of crisis: palliatives, mitigators, and resources. *One Earth* **2**: 402–404.

FAO. 1969. *FAO Panel of Experts on Forest Gene Resources: Report of the First Session (Rome, 21–25 October 1968)*. FAO, Rome. www.fao.org/3/85704E/85704E00.htm

FAO. 1970. Forestry education and training. *Unasylva* **24**(1). www.fao.org/3/98085e/98085e01.htm#forestry%20education%20and%20training (Accessed 10 December 2019).

FAO. 1977. *World list of forestry schools*. FAO Forestry Paper 3. FAO, Rome. 88 p.

FAO. 1981. *Forestry and rural development*. FAO Forestry Paper 26. FAO, Rome. 35 p.

FAO. 1982. *Report of the Sixth Session of the Committee on Forestry (Rome, 3–7 May 1982)*. FAO, Rome. 70p + appendices. www.fao.org/forestry/events/all-cofo-sessions/en/ (Accessed 10 December 2019).

FAO. 2002. *Forest Genetic Resources: international and Australian perspectives*. Forest Genetic Resources Working Paper FGR/36E (September 2002). Forest Resources Development Service, Forest Resources Division. FAO, Rome (*unpublished*). www.fao.org/3/AC547E/ac547e00.htm#Contents (Accessed 10 December 2019).

FAO. 2010. *Panel of Experts on Forest Gene Resources*. www.fao.org/forestry/genepanel/en/ (Accessed 10 May 2020).

FAO. 2019a. *Development flows to agriculture*. www.fao.org/economic/ess/investment/flows/en/ (Accessed 10 December 2019).

FAO. 2019b. *Forestry Communication Toolkit*. www.fao.org/forestry/communication-toolkit/en/ (Accessed 10 December 2019).

FERNÁNDEZ-BLANCO, C.R., BURNS, S.L. and GIESSEN, L. 2019. Mapping the fragmentation of the international

forest regime complex: institutional elements, conflicts and synergies. *International Environmental Agreements: Politics, Law and Economics* **19**: 187–205.

FTA (CGIAR Research Program on Forests, Trees and Agroforestry). 2017a. *Program overview.* FTA, Bogor. www.cifor.org/publications/pdf_files/brochures/6606-FTAbrochure.pdf (Accessed 10 December 2019).

FTA (CGIAR Research Program on Forests, Trees and Agroforestry). 2017b. *Ensuring quality of research for development: the MELIA system.* www.foreststreesagroforestry.org/publications/ (Accessed 10 December 2019).

GFIS (Global Forest Information Service). 2019. *Education programmes*. www.gfis.net/content/education_programmes (Accessed 10 December 2019).

GILLESS, J.K. 2015. The Berkeley Summit – Looking to the future for forestry education. *Journal of Forestry* **113**(6): 587–591.

GLOBAL EVERGREENING ALLIANCE. 2020. *About us*. www.evergreening.org/alliance-overview/ (Accessed 10 May 2020).

GREGERSEN, H., ORAM, P. and SPEARS, J. 1992. *Priorities for forestry and agroforestry policy research: report of an international workshop.* International Food Policy Research Institute, Washington, DC. 95 p.

GRISCOM, B.W., ADAMS, J., ELLIS, P.W. *et al*. 2017. Natural climate solutions. *PNAS* **114**: 11645–11650.

HALIMANJAYA, A., BELCHER, B. and SURYADARMA, D. 2018. Getting forest science to policy discourse: a theory-based outcome assessment of a global research programme. *International Forestry Review* **20**: 469–487.

HARWELL, E. 2010. *Forests in fragile and conflict-affected states.* Program on Forests (PROFOR), Washington, DC. 71 p.

HEDEGART, T. 1971. The Thai-Danish teak improvement centre five years after initiation. *Unasylva* **25**(100). www.fao.org/3/b3350e00.htm#Contents (Accessed 10 May 2020).

HELMS, J.A. (ed.). *The dictionary of forestry*. SAF/CABI, Wallingford. 210 p.

HETEMÄKI, L. 2019. The role of science in forest policy – experiences by EFI. *Forest Policy and Economics* **105**: 10–16.

HICKEY, G.M. 2013. International developments in the administration of publicly-funded forest research: a review. *Forest Policy and Economics* **37**: 1–8.

HOPE, M. 2019. The Brazilian development agenda driving Amazon devastation. *Lancet Planet Health* **3**(10): e409–e411.

HULL, R.B. 2011. Forestry's conundrum: high value, low relevance. *Journal of Forestry* **109**(1): 50–56.

IFSA. 2019. *About IFSA*. ifsa.net (Accessed 10 December 2019).

INBAR. 2019. *About INBAR*. www.inbar.int/about-inbar/ (Accessed 10 December 2019).

INRULED. 2012. *Education and training for rural transformation: skills, jobs, food and green future to combat poverty.* INRULED, Beijing. 322 p.

ICRAF. 1992a. *Annual Report 1991*. ICRAF, Nairobi. 148 p.

ICRAF. 1992b. *The way ahead: Strategic Plan*. ICRAF, Nairobi. 35 p.

IPCC. 2019. *Climate change and land.* www.ipcc.ch/srccl/ (Accessed 10 December 2019).

IUFRO. 2019a. *IUFRO Annual Report 2018*. IUFRO, Vienna. 32 p.

IUFRO. 2019b. *Joint IUFRO-IFSA Task Force on Forestry Education*. www.iufro.org/science/task-forces/forest-education/ (Accessed 10 December 2019).

JOHANN, E., BUCK, A., BURGER, B, KLEINE, M., PRÜLLER, R. and WOLFRUM, G. 2017. *125 Years of IUFRO. History of the International Union of Forest Research Organizations 1892–2017*. IUFRO, Vienna. 128 p.

KATILA, P., PIERCE COLFER, C., DE JONG, W., GALLOWAY, G., PACHECO, P. and WINKEL, G. (eds.). 2019. *Sustainable Development Goals: their impacts on forests and people*. Cambridge University Press. 617 p.

KANOWSKI, P., YAO, D. and WYATT, S. 2019. SDG 4: Quality education and forests – 'The Golden Thread'. Chapter 4 in KATILA, P., PIERCE COLFER, C., DE JONG, W., GALLOWAY, G., PACHECO, P. and WINKEL, G. (eds.). *Sustainable Development Goals: their impacts on forests and people*. Cambridge University Press. 108–145.

KELLY, E.C. and BROWN, G. 2019. Who are we educating and what should they know? An assessment of forestry education in California. *Journal of Forestry* **117**(2): 95–103.

KING, K.F.S. 1987. The role of agroforestry. Chapter 1 in: STEPPLER, H.A. and NAIR, P.K.R (eds). *Agroforestry: a decade of development*. ICRAF, Nairobi. 3–12.

KRISHNASWAMY, A. and HANSON, A. 1999. *Our forests, our future. Summary report of the World Commission on Forests and Sustainable Development*. WCFSD, Winnipeg, Canada. 37 p.

KRÖGER, M. 2013. Globalization as the "Pulping" of landscapes: forestry capitalism's North–South territorial accumulation. *Globalizations* **10**: 837–853.

LAWRENCE, A., SPINELLI, R., TOPPINEN, A. and SALO, E. 2017. What are the implications of the bioeconomy for forest-related jobs? In: WINKEL, G. (ed.) *Towards a sustainable European forest-based bioeconomy: assessment and the way forward. What Science Can Tell Us 8.* European Forest Institute, Joensuu, Finland. 108–117.

LEAKEY, R.R.B. 2014. The role of trees in agroecology and sustainable agriculture in the tropics. *Annual Review of Phytopathology* **52**: 113–133.

LEBLON, B., SPIEKER, H., NEUVONEN, J., MOT-TONEN, M., HAMANN, A., KARLSSON, A., CA-HALAN, C., STADLER, M. DRUMMOND, A. and VALINGER, E. 2013. TRANSFOR-M: A unique transatlantic forestry master program leading to a dual European and Canadian degree. *Forestry Chronicle* **89**: 205–210.

LELE, U., LJUNGMAN, L., KISHOR, N., DEWEES, P., ROWE, C., ROBERTS, R., EL LAKANY, H. and GREGERSEN, H. 2019. Obituary – John Spears. *International Forestry Review* **21**: 128–129.

LINDAHL, K.B., STÉNS, A., SANDSTRÖM, C., JOHANSSON, J., LIDSKOG, R., RANIUS, T. and ROBERGE, J.-M. 2017. The Swedish forestry model: more of everything? *Forest Policy and Economics* **77**: 44–55.

LUNDGREN, B.O. 1987. Institutional aspects of agroforestry research and development. Chapter 4 in: STEPPLER, H.A. and NAIR, P.K.R (Eds). *Agroforestry: a decade of development*. ICRAF, Nairobi. 43–51.

MCGINLEY, K.A., GULDIN, R.W. and CUBBAGE, F.W. 2019. Forest sector research and development capacity. *Journal of Forestry* **117**(5): 443–461.

MACQUEEN, D., BOLIN, A., GREIJMANS, M. and GROUWELS, S. 2020. Innovations towards prosperity emerging in locally controlled forest business models and prospects for scaling up. *World Development* **125**: 104382.

MAYNE, J. 2015. Useful theory of change models. *Canadian Journal of Program Evaluation* **30**(2): 119–142.

MOGUES, T., FAN, S. and BENIN, S. 2015. Public investments in and for agriculture. *European Journal of Development Research* **27**: 337–52.

O'NEILL, K. 2009. *The environment and international relations*. Cambridge University Press. 250 p.

PALAHÍ, M., NASI, R. and SIMONS, T. 2019. *Open letter: An urgent need to put forests on the global agenda*. www.cifor.org/corporate-news/an-urgent-need-to-put-forests-on-the-global-agenda/ (Accessed 10 December 2019).

PANWAR, R., KOZAK, R.A. and HANSEN, E. (eds.) 2016. *Forests, business and sustainability*. Routledge. 214 p.

PARDEY, P.G. 2016. Agricultural R&D is on the move. *Nature* **537**: 301–303.

PEREIRA, J.C. and VIOLA, E. 2019. Catastrophic climate risk and Brazilian Amazonian politics and policies: a new research agenda. *Global Environmental Politics* **19**: 93–103.

POLLINATE. 2018. *Project positive forestry frame*. Australian Department of Agriculture and Water Resources, Canberra. 16 p. www.agriculture.g.ov.au/forestry/publications/project-positive-forestry-frame (Accessed 10 December 2019).

RAYNER, J., BUCK, A. and KATILA, P. (eds). 2010. *Embracing complexity: meeting the challenges of international forest governance*. IUFRO World Series Volume 28. IUFRO, Vienna. 172 p.

RECOFTC. 2018. *Our vision and mission*. Available at: www.recoftc.org/about/our-vision-and-mission (Accessed 10 December 2019).

RAMCILOVIC-SUOMINEN, S. PUENTES RODRIGUEZ, Y., KIRONGO, B. and PITKÄNEN, S. 2016. Higher forestry education in Kenya: bridging the gap between educational training and job market competencies. *International Forestry Review* **18**: 56–67.

REID, R. 2017. Developing farmer and community capacity in Agroforestry: is the Australian Master Tree Grower program transferable to other countries? *Agroforestry Systems* **91**: 847–65.

REKOLA, M. (Ed). 2019. *Global Outlook on Forest Education (GOFE). A Special Report*: *Forest Education in Africa.* IUFRO, Vienna. 26 p. foresteducation.wordpress.com/ (Accessed 10 December 2019).

REKOLA, M., ABBAS, D., BAL, T., BURNS, J., LACKNER, M., RODRIGUEZ, S. and SHARIK, T. (eds.). 2017. *Global Outlook on Forest Education (GOFE): A pilot study report.* IUFRO, Vienna. 141 p. foresteducation.wordpress.com/ (Accessed 10 December 2019).

RILEY, B.L., KERNOGHAN, A., STOCKTON, L., MONTAGUE, S., YESSIS, J. and WILLIS, C.D. 2017. Using contribution analysis to evaluate the impacts of research on policy: Getting to "good enough." *Research Evaluation* **27**: 16–27.

ROBINSON-PANT, A. 2016. *Learning knowledge and skills for agriculture to improve rural livelihoods.* UNESCO, Paris. 149 p.

ROCHE, M.M. and DARGAVEL, J. 2008. Imperial Ethos, Dominions Reality: Forestry Education in New Zealand and Australia, 1910–1965. *Environment and History* **14**: 523–543.

ROUSSEAU, K., GAUTIER, D. and WARDELL, D.A. 2019. Socio-economic differentiation and shea globalization in western Burkina Faso: integrating gender politics and agrarian change. *Journal of Peasant Studies* **46**: 747–766.

SALBAITANO, F., BORELLI, S., CONIGLIARO, M, AND CHEN, Y. 2016. *Guidelines on urban and periurban forestry*, FAO Forestry Paper 178. FAO, Rome. 158 p.

SAGOR, E.S., KUEPER, A.M., BLINN, C.R. and BECKER, D.R. 2014. Extension forestry in the United States: A national review of state-level programs. *Journal of Forestry* **112**(1): 15–22.

SAMPLE, V.A., RINGGOLD, P.C., BLOCK, N.E. and GILTMIER, J.W. 1999. Forestry education: adapting to changing demands. *Journal of Forestry* **97**(9): 4–10.

SANCHEZ BADINI, O., HAJJAR, R. and KOZAK, R. 2018. Critical success factors for small and medium forest enterprises: a review. *Forest Policy and Economics* **94**: 35–45.

SAYER, J. 1994. Forestry research within the Consultative Group for International Agricultural Research. *Unasylva* **45**(2). www.fao.org/forestry/unasylva/8708/en/ (Accessed 10 December 2019).

SILVA Network. 2019. *SILVA Network*. www.silva-network.eu (Accessed 10 December 2019).

SINGER, B. and GIESSEN, L. 2017. Towards a donut regime? Domestic actors, climatization, and the hollowing-out of the international forests regime in the Anthropocene. *Forest Policy and Economics* **79**: 69–79.

SISAM, J.W.B. 1972. World consultation on forestry education and training. *Forestry Chronicle* **48**(3): 129–132.

SPEARS, J. ORAM, P., BYRON, N., SCHERR, S. and IZAC, A.M. 1994. *A review of tropical forestry and agroforestry problem areas and policy research needs and the planned response of the CGIAR System.* Working Paper 5. CIFOR, Bogor. 42 p.

SUTROFOR. 2019. *SUTROFOR – MSc in Sustainable Tropical Forestry*. sutrofor.eu (Accessed 10 December 2019).

SYLVA FOUNDATION. 2019. *Sylva Foundation*. Available at: sylva.org.uk/about (Accessed 10 December 2019).

ROSENSTOCK, T.R., DAWSON, I.K., AYNEKULU, E. *et al*. 2019. A planetary health perspective on agroforestry in Sub-Saharan Africa. *One Earth* **1**: 330–344.

TURNBULL, J.W. (ed.) *Eucalypts in Asia*. ACIAR Proceedings No. 111. ACIAR, Canberra. 267 p.

TURNER, J. and LAMBERT, M. 2016. Changes in Australian forestry and forest products research for 1985–2013. *Australian Forestry* **79**: 53–58.

UNEP 2011. *Forests in a green economy: a synthesis.* UNEP, Nairobi. 23 p.

UNESCO 2016. *Education for people and planet: creating sustainable futures for all*. UNESCO, Paris. 620 p.

UNESCO, UNDP, UNPFA, UNHCR, UNICEF and UN WOMEN. 2016. *Incheon Declaration and Framework for Action for the implementation of Sustainable Development Goal 4*. uis.unesco.org/sites/default/files/documents/education-2030-incheon-framework-for-action-implementation-of-sdg4-2016-en_2.pdf (Accessed 10 December 2019).

UNESCO. 2017. *Six ways to ensure higher education leaves no one behind*. Policy Paper 30. UNESCO, Paris. 10 p.

UNESCO. 2019. *How much does your country invest in R&D?* uis.unesco.org/apps/visualisations/research-and-development-spending/ (Accessed 10 December 2019).

UNESCO-UNEVOC. 2017. *Greening technical and vocational education and training: a practical guide for institutions.* UNESCO, Paris. 95 pp.

VAN NOORDWIJK, M., COE, R. and SINCLAIR, F.L. 2019. Agroforestry paradigms. Ch. 1 in: VAN NOORWIJK, M. (ed.). *Sustainable development through trees on farms: agroforestry in its fifth decade*. World Agroforestry (ICRAF), Bogor. 1–14.

WBCSD (World Business Council for Sustainable Development). 2019. *Forest sector SDG roadmap*. WBCSD, Geneva. 47 p.

WESTOBY, J.C. 1962. The role of forest industries in the attack on economic underdevelopment. Chapter 1 in: WESTOBY, J.C. *The purpose of forests: follies of development*. Basil Blackwell, Oxford. 3–70.

WESTOBY, J.C. 1978. Forest industries for socio-economic development. Chapter 11 in: WESTOBY, J.C. *The purpose of forests: follies of development*. Basil Blackwell, Oxford. 241–254.

WESTOBY, J.C. 1987. *The purpose of forests: follies of development*. Basil Blackwell, Oxford. 343 p.

WESTOBY, J.C. 1989. *Introduction to world forestry*. Basil Blackwell, Oxford. 228 p.

WINKEL, G. (ed.) 2017. *Towards a sustainable European forest-based bioeconomy – assessment and the way forward*. What Science Can Tell Us **8**. European Forest Institute, Joensuu, Finland. 160 p.

WORLD BANK. 1978. *Forestry: Sector Policy Paper*. The World Bank, Washington DC. 65 p.

WORLD BANK. 2018. *World Development Report 2018: learning to realize education's promise.* World Bank, Washington, DC. 216 p.

WORLD BANK and FAO. 1981. *Forestry research needs in developing countries – time for a reappraisal?* Paper for 17th IUFRO Congress, Kyoto, Japan. 6–17 September 1981. 56 p. documents.worldbank.org/curated/en/124641492710409733/Forestry-research-needs-in-developing-countries-time-for-a-reappraisal (Accessed 10 December 2019).

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT. 1987. *Our common future*. Oxford University Press. 416 p.

WWF INTERNATIONAL. 2019. *Living Forests Report*. wwf.panda.org/our_work/forests/forest_publications_news_and_reports/living_forests_report/ (Accessed 10 December 2019).

YAYÉ, A.D., OCHOLA, A.O., CHAKEREDZA, S. and AUCHA, J. 2015. Strengthening capacity for agribusiness in agroforestry and natural resources in tertiary agricultural education in Africa: African Network for Agriculture, Agroforestry and Natural Resources Education (ANAFE). *Agroforestry Systems* **91**: 835–45.

YOUNG, J. and BIRD, N. 2015. *Informing REDD+ policy: an assessment of CIFOR's Global Comparative Study.* ODI, London. 93 p.

YU, B., FAN, S. and MAGALHÃES, E.M.A. 2015. Trends and composition of public expenditures: a global and regional perspective. *European Journal of Development Research* **27**: 353–370.

ZAJDA, J. (ed). 2015. *Second International Handbook on Globalisation, Education and Policy Research.* Springer, Dordrecht. 854 p.

The rise of big data and supporting technologies in keeping watch on the world's forests

R. TAYLOR, C. DAVIS, J. BRANDT, M. PARKER, T. STÄUBLE and Z. SAID

World Resources Institute, 10 G St. NE #800, Washington, DC 20002

Email: rod.taylor@wri.org, crystal.davis@wri.org, john.brandt@wri.org, meaghan.parker@wri.org, ts@heimatstudio.net, zuraidah.said@wri.org

SUMMARY

Technology-driven advances in the gathering, processing and delivery of big data are making it easier to monitor forests and make informed decisions over their use and management. This paper first describes how innovations in remote sensing and cloud computing are enabling generation of geospatial data more often, at lower cost and in more user-friendly formats. Second, it describes the evolution of systems and technologies to trace forest products, and agricultural commodities linked to deforestation, from source to final use. Third, it reviews the potential for emerging data mining technologies such as natural language processing, web scraping and computer vision to support forest policy analysis and augment geospatial data gathered through remote sensing. The paper gives examples of how these technologies are being used and may be used in the future to monitor and respond to deforestation, fire and natural disasters, improve governance by enabling faster and more comprehensive analysis of social networks, policies and regulations, and increase traceability and transparency within supply chains.

Keywords: forests, deforestation, geospatial, traceability, data-mining

L'essor des grandes données et des technologies les soutenant dans la surveillance des forêts du monde

R. TAYLOR, C. DAVIS, J. BRANDT, M. PARKER, T. STÄUBLE et Z. SAID

Les avancées poussées par la technologie dans le rassemblement, le traitement et la distribution des grandes données rendent la surveillance des forêts plus aisée, tout comme les prises de décision averties sur leur utilisation et leur gestion. Ce papier décrit tout d'abord comment les innovations dans le sensoriel à distance et dans l'informatique en nuage aident à créer des données géo-spatiales plus fréquemment, à moindre coût et dans des formats plus confortables à l'usage. De plus, il décrit l'évolution des systèmes et des technologies pouvant tracer les produits forestiers et les matières premières agricoles associées à la déforestation, de la source à leur utilisation finale. Il analyse ensuite le potentiel que détiennent les technologies émergeantes prospectrices de données telles que le traitement du langage naturel, le grattage web et la vision par ordinateur pour soutenir l'analyse de la politique forestière et augmenter les données géo-spatiales recueillies par télédétection. Ce papier donne des exemples de la manière dont ces technologies sont utilisées et comment elles pourraient être utilisées dans le futur pour gérer et répondre à la déforestation, les incendies et les catastrophes naturelles, pour améliorer la gestion en facilitant une analyse plus rapide et complète des réseaux sociaux, des politiques et des règles, et pour augmenter le traçage et la transparence au sein des chaînes d'approvisionnement.

El auge de los macrodatos y las tecnologías de apoyo para la vigilancia de los bosques del mundo

R. TAYLOR, C. DAVIS, J. BRANDT, M. PARKER, T. STÄUBLE y Z. SAID

Los avances tecnológicos en la recolección, el procesamiento y la transmisión de macrodatos están facilitando el monitoreo de los bosques y la adopción de decisiones informadas sobre su utilización y gestión. En este artículo se describe, en primer lugar, cómo las innovaciones en materia de teledetección y computación en la nube facilitan la generación de datos geoespaciales con mayor frecuencia, a menor costo y en formatos más fáciles de utilizar. En segundo lugar, se describe la evolución de los sistemas y tecnologías con los que dar seguimiento a los productos forestales y los productos agrícolas vinculados a la deforestación, desde su origen hasta su uso final. En tercer lugar, se examina el potencial de las nuevas tecnologías de minería de datos, como el procesamiento de lenguajes naturales, la extracción de datos de sitios web (*web scraping*) y la visión artificial, para apoyar el análisis de las políticas forestales y aumentar los datos geoespaciales recolectados por teledetección. El artículo proporciona ejemplos de la forma en que se están utilizando estas tecnologías y como podrían utilizarse en el futuro para monitorear y enfrentarse a la deforestación, los incendios y los desastres de amenazas naturales, mejorar la gobernanza mediante un análisis más rápido y completo de las redes sociales, las políticas y los reglamentos, y aumentar la transparencia y la capacidad de dar seguimiento en las cadenas de suministro.

INTRODUCTION

Big data, which involves computational methods that rely on the computing scale of cloud resources, and supporting technologies are increasingly being used to keep watch on the world's forests and enable better decision-making over their use and governance(Chen, Mao, & Liu, 2014). These technologies are being used to monitor the biophysical structure of forests, to ensure traceability and transparency within supply chains, and to analyze and improve forest policy and governance.

Within the field of forest monitoring, advances in remote sensing and cloud computing (the use of networks of remote servers hosted on the Internet to store, manage, and process data) are making it possible to monitor changes in forest cover and condition, as well as the extent of fires and the impacts of natural disasters more cost-effectively and more frequently than forest patrols and surveys are able to. In addition to remote sensing, drones and mobile technology are increasingly being used to monitor forests at local scales, often in combination with satellite and remote sensing data. Big data is also transforming traceability and transparency efforts within supply chains through sensor networks, genetic analysis, and smart labels. These technologies are used to track the chain of custody along the supply chain and to identify the taxonomy or geographic provenance of raw or processed materials in a product. Improved traceability in supply chains provides a means for business and other stakeholders to verify if the wood or agricultural ingredients in a product are responsibly sourced. Finally, big data methods are enabling researchers to analyze legislative and policy texts and social and news media data to improve policies and governance systems. This paper provides examples of how the latest technology is being used in these three application fields, the impact it is having, and what might be possible with further technological development on the horizon.

FOREST MONITORING

Historically, researchers documented the extent of and condition of forests – canopy cover, tree size, species, biodiversity, soil carbon content or seedling density – by boots-on-the ground surveys. At the national level, countries monitored their forests through site-based sample plots as part of a national forest inventory. These field-based efforts were resource-intensive and best suited to the scale of individual forest management units, protected areas, or a limited sample of plots across a country. Consequently, national inventories tended to be done infrequently, often with patchy coverage of remote forests that are not easily accessed by road or river. At a global scale, the FAO has conducted the Global Forest Resources Assessment at five-yearly intervals since 1948 to provide national statistics on forest cover extent and change (FAO 2015).These efforts rely primarily on statistics reported by countries and are thus dependent on the frequency and accuracy with which individual countries conduct their forest inventories or update forest-relevant statistics.

In recent years, advances in remote sensing and cloud computing have created a whole new array of options for large-scale forest monitoring and field work. These technologies have enabled better detection of forest change, more frequently, over larger areas, at less cost and with easier communication channels, such as the presentation of data in the form of geospatially-explicit maps that can be accessed online. At the same time, the advent of geographic positioning systems (GPS), and technology-enabled ground patrols and forest inventories, has allowed field staff to record more detailed coordinate points for their observations and upload those data into geographic information systems (GIS). This generates richer data in support of local forest management, as well as providing means to ground-truth and refine automated systems for interpretation, visualization and analysis of satellite data at global, continental or national scales.

Remote sensing first emerged with the use of cameras mounted on planes to take aerial photographs as early as World War I and has transitioned to a mix of airborne and satellite-borne imagery in recent decades. Airborne instruments – sensors attached to planes, or cameras mounted on drones – are still used today to capture detailed information about a specific forest area at higher resolution than can be achieved from space. Airborne light detection and ranging (LiDAR) sensors can capture detailed information about the physical structure of forests (Asner, 2009) at a resolution of one meter 1 m to up to ten meters, which is detailed enough to see individual tree crowns and map tree species distribution (Baldeck *et al*. 2015).

For satellite-based remote sensing, a major breakthrough occurred in 2008, when the U.S. Geological Survey opened all data from its Landsat satellite to the public for free (Wulder & Coops, 2014). permitting large-scale analyses through time back to 1972. Many previous mapping efforts had utilized freely available coarse resolution MODIS satellite data, which ranges from 250 to 1000 meters in resolution. Suddenly, Landsat offered 30-meter resolution data—almost 70 times better than MODIS—permitting much finer-scale monitoring, systematically and at global scale. Landsat became the "go-to" source of imagery for mapping forest extent and change.

Satellite imagery spatial resolution and availability continue to improve. In 2013, the European Commission and European Space Agency (ESA) decided to openly license data from the Sentinel satellites (European Space Agency, 2013), complementing Landsat with freely available, 10-meter data, as well as radar satellites that can see through cloud cover, smoke, and haze (Reiche *et al*. 2016). An increasing number of commercial satellite companies (e.g., Planet, TerraSar) offer high spatial resolution data (under 3 meters) that—while costly for large-scale systematic analyses—can be valuable for validation, calibration, and verification.

In the early days of satellite imagery analysis (starting in the 1980s), experts visually interpreted the images and delineated forest extent and deforestation by hand. For example, the annual deforestation monitoring system in Brazil (known as PRODES) still heavily relies on expert interpreters to

manually inspect imagery to identify forest changes. By contrast, machine learning technologies rely on learning algorithms within computers that build mathematical models based on sample data, known as training data, and use this to interpret imagery without humans having to write explicit programs on how they perform such tasks (Bishop 2006). Since the early 2000s, innovative machine learning algorithms have facilitated automatic mapping of forest extent, changes, and values, producing results faster and more consistently than what can be done by human interpreters. Cloud computing platforms (e.g., FAO SEPAL, Google Earth Engine, Amazon Web Services) enable these algorithms to process large volumes of imagery cheaply. Google Earth Engine, for example, combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities.

These advances mean forests can be consistently characterized and systematically monitored over large geographic areas. The University of Maryland's ground-breaking high-resolution maps of annual tree cover change were the hallmark of a new era of global monitoring of forests from space (M.C. Hansen *et al*. 2013). Other pioneer products include the global and pantropical maps of above-ground woody biomass density from (Saatchi *et al*. 2011) and (Baccini *et al.* 2012). They also enable detection of change in near-real time (see Table 1).

As forest monitoring technology has evolved, so too has the demand to make the resulting information public. Once accessible only through paper maps (or not at all), forest monitoring data has become widely available through online geoportals and databases that are simple for non-experts to use. The launch of the Global Forest Watch platform in 2014 was notable in making the University of Maryland's global spatial forest monitoring data accessible to the public for free in easy-to-understand and dynamic maps, charts, and graphs.

Corporations and academics increasingly work in collaboration to improve forest monitoring methods and transfer expertise to government institutions. This has resulted in a dramatic improvement in national forest management capacity over the last decade. For example, the MapBiomas effort in Brazil involves leading researchers and technology companies working together to produce annual land use and land cover maps. Official government data produced via the TerraClass program of the Brazilian Space Agency and Agricultural Ministry only covers the Legal Amazon and is not published every year. MapBiomas uses an automated algorithm processed in the cloud to process satellite imagery and publish land cover maps each year for the entire country. The MapBiomas team includes members of the Brazilian government as expert reviewers and strives to transfer lessons learned to government institutions. Beyond Brazil, five other Latin American countries now operate near real time alerting systems, and globally, a dozen countries have adapted the global University of Maryland annual tree cover loss product to their national context. Many more countries, such as Suriname, through its National Forest Monitoring System, are using some form of satellite imagery analysis as part of their periodic national forest inventories and/or forest reference emission levels.

Many prospects for remote sensing monitoring systems with increased accuracy, spatial resolution, and temporal frequency are on the horizon. Higher resolution optical images will enable detection of fine-scale changes indicative of forest degradation rather than outright loss of tree cover (Fagan & DeFries 2009). Operational radar data from Sentinel-1 will enable detection of forest disturbances even through cloud cover. NASA's new spaceborne lidar instrument (GEDI), mounted on the International Space Station in early 2019, will map biomass and forest structure from space, enabling more sophisticated approaches for quantifying forest carbon. Expansion in cloud computing capacity will enable more imagery to be processed more quickly. More advanced machine learning algorithms, (e.g., neural networks) should enable more accurate monitoring, and possibly prediction, of forest change, though the applications of these methods have thus far been primarily limited to high-resolution imagery,

TABLE 1 *systems detecting near-real time forest change*

System	geographic coverage	spatial resolution	Update frequency
University of Maryland GLAD alerts – (Matthew C Hansen *et al*., 2016; Reiche, Hamunyela, Verbesselt, Hoekman, & Herold, 2018; Reiche, Verhoeven, *et al*., 2018).	30 degrees North to 30 degrees South	30x30 meters	Weekly
Real-Time System for Detection of Deforestation (DETER) (Shimabukuro, dos Santos, Formaggio, Duarte, & Rudorff, 2016).	Brazilian Amazon	250x250 meters	Monthly
Terra-I (Reymondin *et al*., 2012)	Whole of Latin America + tropics	250x250 meters	Weekly
Sistema de Alerta de Desmatamento (SAD) (De Souza, Hayashi, & Veríssimo, 2008).	Brazilian Amazon	250x250 meters	Monthly
Fire Information for Resource Management System (FIRMS) (Davies, Ilavajhala, Min Minnie Wong, & Justice, 2009).	Global	375x375 meters	Daily

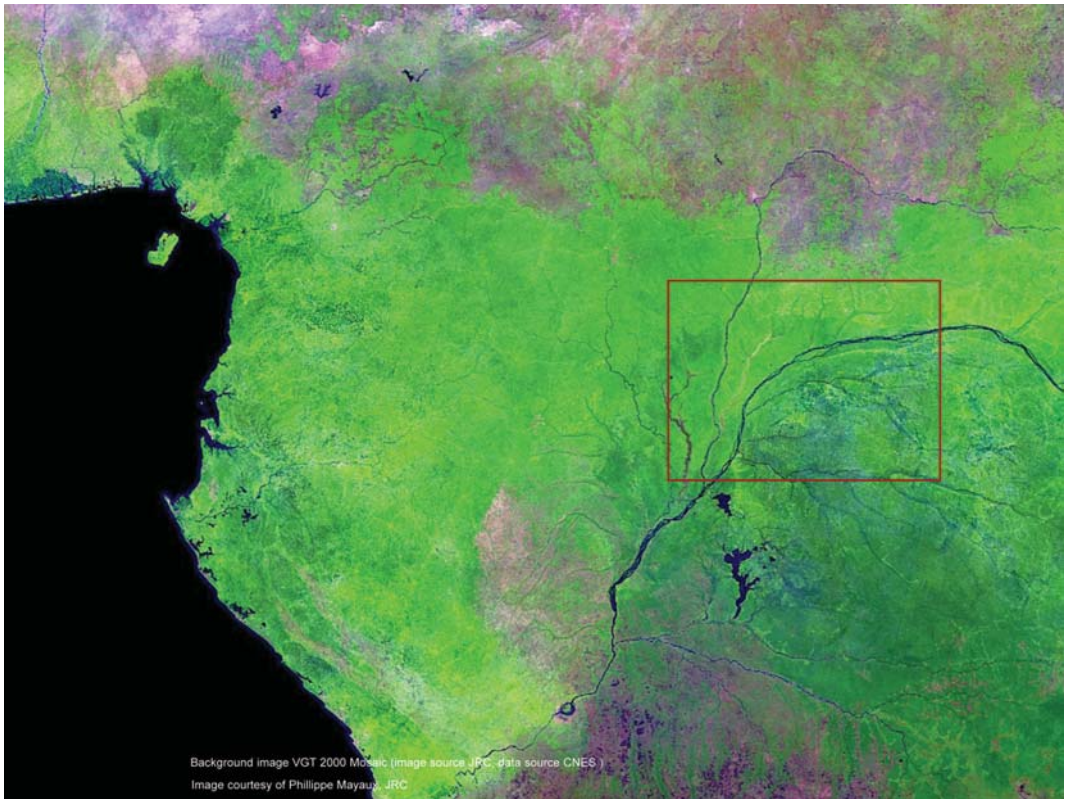


Image 1 - This cloud free mosaic of the Central African Forest Basin was assembled by the Joint Research Centre from daily images acquired by the European VGT sensor on board the SPOT satellite processed and distributed by the Flemish Technological Research Institute VITO.
The image shows the vast size of Central Africa's forests. It covers 2 million km^2 accounts for 22% of the World's humid tropical forests and contains the World's only habitats for the great apes. It is also home to around 40 million people.

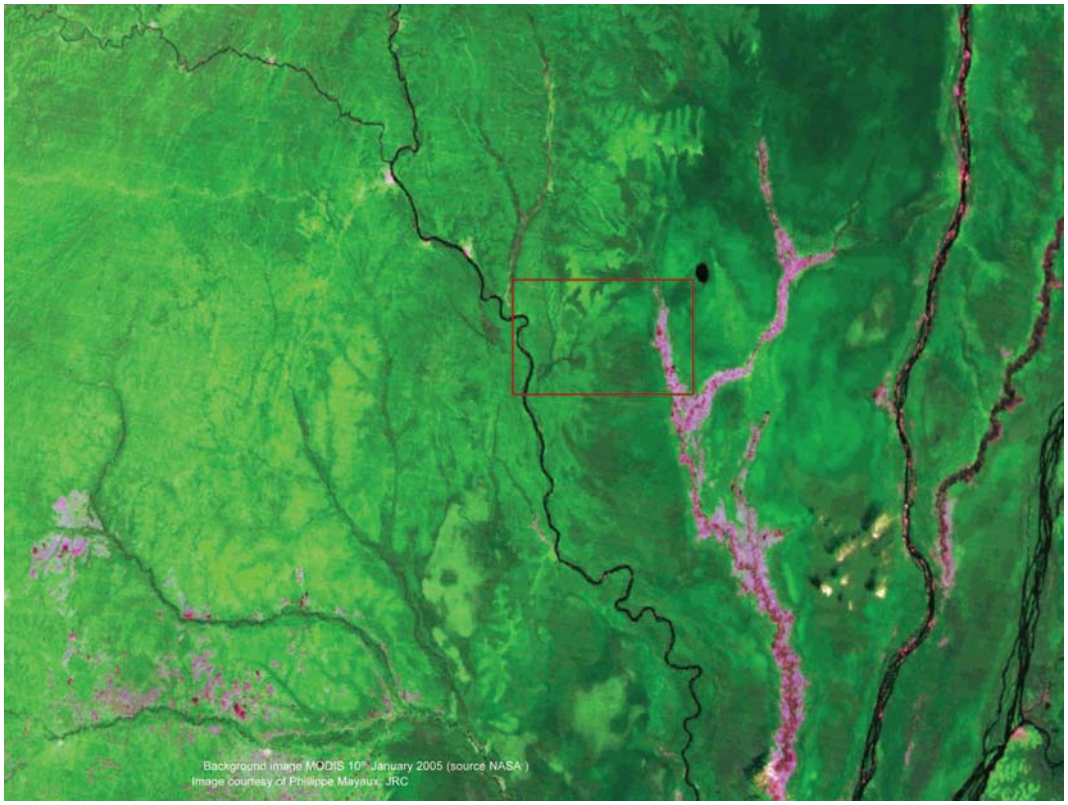


Image 2 - This detailed image (250 meter resolution) of the Central African Basin was acquired by the MODIS sensor on the US Terra satellite. The image shows the Sangha river (centre) and the Ubangi and Congo rivers to the right. The pink "river" is seasonally flooded grassland along the smaller Likouala river. There are clear signs of forest clearance and degradation around the towns such as Ouesso on the Sangha river and Mbandaka on the Congo. The impact of major roads such as the highway linking Ouesso with the coast can also begin to be seen at this resolution.

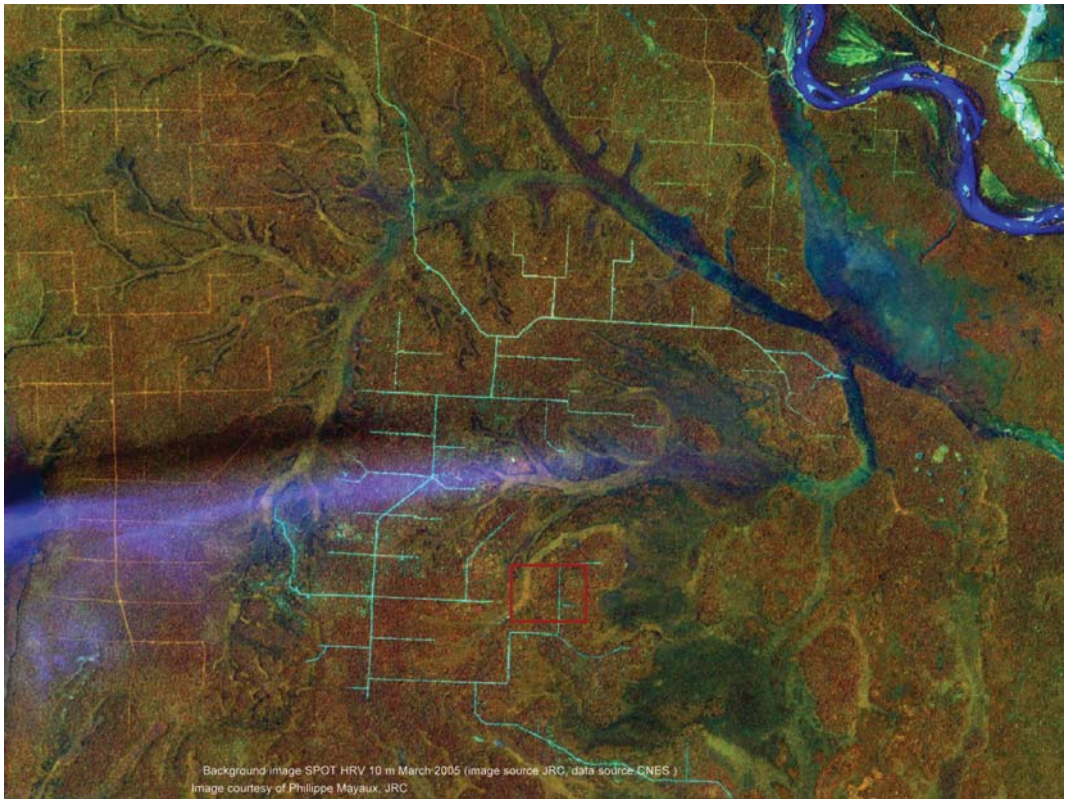


Image 3 - At resolutions of 10 meters, as with this image acquired by the European SPOT satellite, the true nature of the "undisturbed" forest begins to emerge. Both abandoned logging roads (orange) and new logging roads (blue) can be accurately mapped. Although no longer used for commercial timber exploitation the abandoned logging roads do provide access for poachers hunting for bush-meat including the great apes. The roads also provide access for less intensive, but no less destructive, timber extraction by illegal loggers.

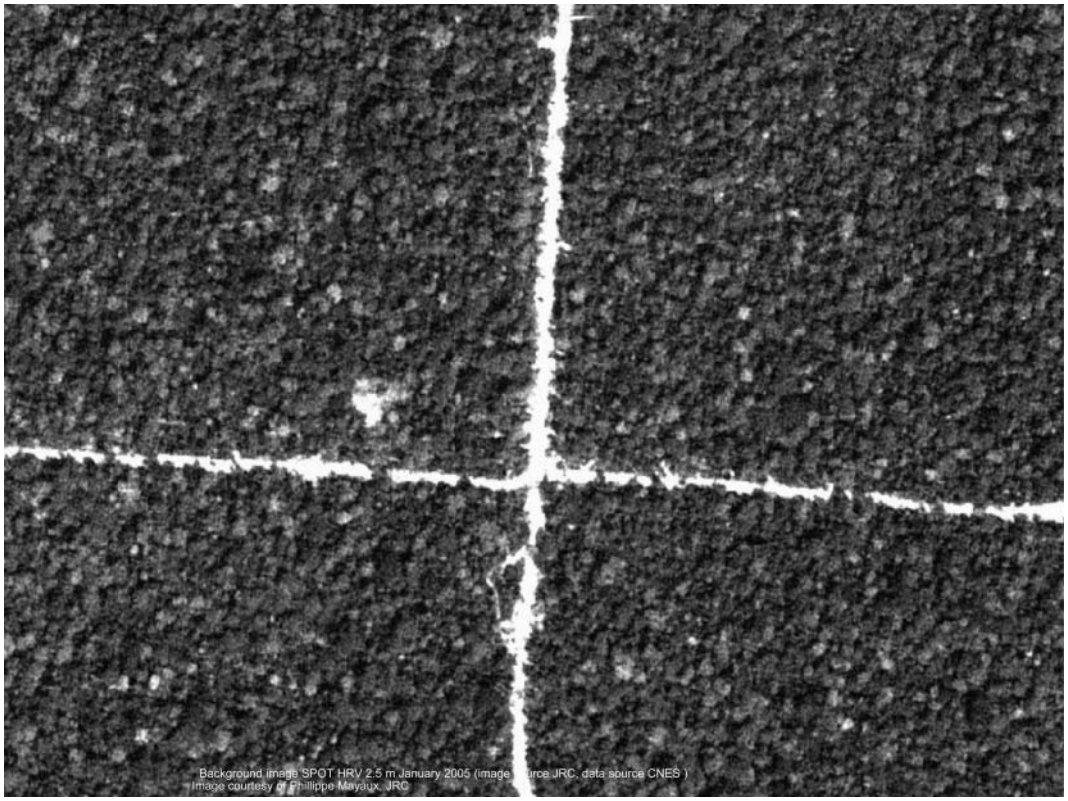


Image 4 - Using fine resolution imagery – in this case 2.5 metre resolution from the SPOT satellite, this image from the European Commission's Joint Research Facility enables measurement of the width of logging roads, and identifies the extraction of even individual trees (the white holes in the grey intact forest canopy).

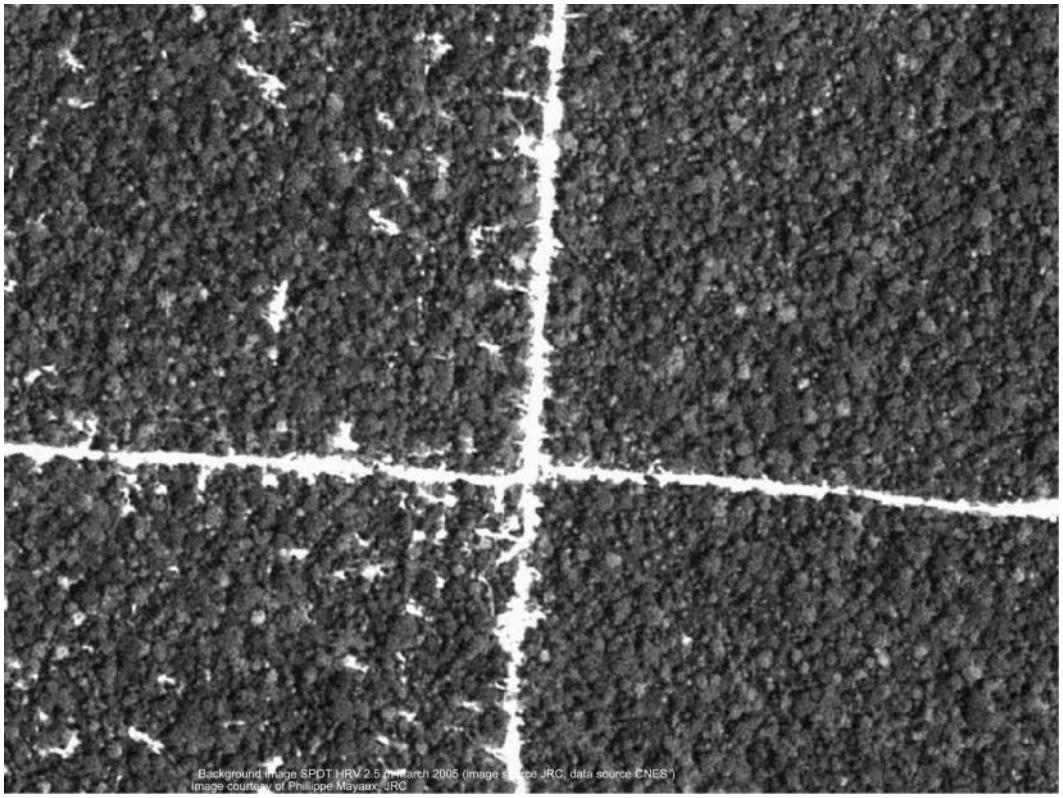


Image 5 - By using different images over time (this image was taken two months after the previous) an observer can determine overall rates of timber extraction, as well as locations – information which can help determine compliance with the terms under which any logging company has been granted a permit to work a given timber concession.

which is computationally infeasible at large geographic scales (Ma *et al*. 2019). Mobile data collection systems, such as Open Data Kit and CyberTracker, will help to unite ground-based perspectives with remote sensing data.

New data mining technologies also have huge potential to augment and automate the analyses of data collected through remote sensing, sensor networks or field measurements. Historically, analysis of such data depended on supervised techniques. These involved manual classification of geographic regions and plots to "train" algorithms to replicate human classification, or the prior formulation of hypotheses about what characteristics of a satellite image are indicative of a specific type of vegetation or disturbance. For example, identifying forest fires with remote sensing would typically require manual delineation of fire extent in thousands of images and empirical research to formulate the relationship between spectral signatures, rainfall patterns, slope, and other biophysical variables and fire disturbance. Data mining techniques can reduce the need for prior classification of data sets or prediction of causal relationships. For instance, one academic study applied the "fuzzy C-means clustering algorithm" to identify forested regions impacted by natural disasters or fires with 98.8% accuracy across varied geographic contexts without human-labelled training data (Singh & Singh 2018). Other academic studies have demonstrated the accuracy of data mining methods in modelling biomass and carbon storage relative to methods based on allometric equations (Carlos R Sanquetta *et al*. 2015, Carlos Roberto Sanquetta, Wojciechowski, Paula, Corte, & Rodrigues, 2013). Advances in clustering methodology may allow for faster and more accurate unsupervised classifications of remote sensing, sensor network, and biometric data. One such advancement is spectral clustering, which groups observations into clusters based on similarity metrics between low-dimensional mathematical representations of variability known as principal components. While spectral clustering consistently outperforms previous clustering approaches, it was not until 2018 that spectral clustering was computationally efficient enough to handle remote sensing data (Dhanachandra, Manglem, & Chanu, 2015; Shaham *et al*. 2018; Tung, Wong, & Clausi, 2010; Zhang & You, 2017). Spectral clustering is likely to replace traditional clustering methods in forest monitoring applications soon, increasing the accuracy of unsupervised approaches and further reducing data needs.

New data mining methods can also help reduce bias from seasonal, biometric, and cultural differences between geographic regions in remote sensing models, which are typically trained in geographies where training data is available and may then be applied to different geographies (Xie, Jean, Burke, Lobell, & Ermon, 2016). Conditional generative adversarial networks (cGANs) are a type of neural network that learns how to transform between domains of images, such as those taken in different seasons or regions. These have been used to generate ground-level views from satellite imagery (Deng, Zhu, & Newsam, 2018), identify road networks (Q. Shi, Liu, & Li, 2018), generate building footprint information from satellite imagery (Y. Shi, Li, & Zhu, 2019), and learn transformations between geographies (Kniaz, 2018). Unsupervised approaches to learning generalizable features from satellite imagery have also shown promise in mitigating geographic biases (Jean *et al*. 2018). Taken together, these advances in machine learning and data mining

have significant potential to improve accuracy in forest monitoring tasks where training data is expensive to generate or where such data exists only in specific geographies.

In addition to satellites, wireless sensor networks are increasingly deployed in forests to record sounds, temperature or movement for purposes such as fire control, prevention of illegal logging and biodiversity monitoring. Integrated data mining techniques, where data mining methods such as clustering or anomaly detection are built into the sensors themselves, can improve efficiency, reduce energy use, and lower data throughput requirements in such networks (Czúni & Varga, 2014; Saoudi, Euler, Bounceur, & Kechadi, 2016). Geolocation and social media data within individual electronic devices such as mobile phones also have huge future potential to support accurate real time detection of wildfires, floods, earthquakes, wildlife migrations and the spread of invasive species (Daume, 2016; Middleton, Middleton, & Modafferi, 2014; Tanev, Zavarella, & Steinberger, 2017). Social media activity on wildfires, for example, is highly corelated to where and when fires occur, and can thus be used to provide early warnings of fire outbreaks (Boulton, Shotton, & Williams, 2015).

Applying forest safeguards in supply chains

Tracking the movement of materials through supply chains is often critical for quality control, safety and financial discipline along the chain. It is also useful in distinguishing products sourced illegally or implicated in deforestation from those that come from well-managed forests or farms. Governments can help promote the application of good chain of custody practice by integrating requirements for adequate product flow controls in regulations and compliance monitoring.

Supply chain traceability requires careful documentation of the path that product ingredients take as they move from the farm or forest to the end customer, including any mixing or transformation along the way. A traditional chain of custody system is literally a "paper trail" documenting the flow of a specific batch of materials along a supply chain. However, advances in information technology, internet access and connectivity, GPS tracking systems and product scanning devices, mean a modern chain of custody system can live mostly online.

Labeling technologies in chain of custody systems facilitate rapid collection of large amounts of data that can be electronically time-stamped and cross-checked against records made at other checkpoints to detect and deter tampering (ITTO 2012). Labels containing nano-molecules or imprinted with bar codes can be scanned electronically. Others, such as RIFID labels, can be accessed using radio signals. Increasingly, data logging devices support data capture in the field for immediate or subsequent transfer to online databases. These devices can be handheld devices or integrated in existing machinery such as trucks and harvesting machines. Such technologies are more efficient than manual methods because they reduce the need for error-prone manual information transfer. Validation is also supported through the metadata automatically collected with each reporting event (e.g. who reported via the user-account, when the information was collected via the time-stamp, and where the information was collected via the GPS module in the device) (Baldwin, Markowitz, Koparova, Gerardu, & Zaelke, 2015).

Satellite-based GPS support traceability by enabling precise delineation of boundaries of forest management units and farms from which materials are sourced and tracking their transport to ports, processing and manufacturing facilities, and to final point of sale.

Increasingly, governments are deploying traceability technologies to augment regulation of the forest products trade. Countries currently operating or introducing mandatory public timber traceability systems with centralized reporting platforms include Indonesia, Brazil, Peru, Guatemala, Honduras, Colombia, Ecuador, Panama, Liberia and Ghana. However, while governments have the political power to make reporting to a traceability system a legal requirement, the scope of these systems is by default limited to the national border. Without an overarching, international system to cover the complex material flows from producer, via processing to consumer countries, the development of country by country mandatory traceability systems is unlikely to succeed in preventing products associated with illegal logging or

The Indonesian Timber Legality Assurance System, locally known as SVLK (*Sistem Verifikasi Legalitas Kayu*), is illustrative of recent developments in public sector supply chain control. Long before a tree is harvested, concession holders enter information in an online system on tree species, location and estimated timber volume. This generates a barcode that is attached to the tree. After felling, the same bar code is attached to its stump and logs. The barcode enables the logs to be tracked to the point of primary processing. Additional entries are made in the online system to track the timber through processing and to connect batches of processed products to export licenses. The system requires timber concession holders to directly enter tree harvesting data in the system with minimal government supervision. However, if the system detects excess harvesting it will lock the concession holder's account. Authorities can also monitor the system and take action if they find irregularities. Private conformity assessment bodies, authorized by the National Accreditation Agency, reconcile the data provided and, where necessary conducting a field visit, to verify the concession holder's legality certificate or issue a non-compliance report. While the system is currently focused on verifying the legal supply of timber, the Indonesian government has announced its intention to expand the scope to included performance assessment of concession holders and payment of non-tax revenues (MOEF 2018).

forest clearing from entering global markets. While the technology is available today, the institutionalization of a comprehensive global traceability system remains a transnational governance challenge for the future.

While mandatory traceability systems are intended to impede illegal logging and timber trade, they are vulnerable to manipulation through input of false data. They have even been described as "laundering machines" (EIA 2012, Greenpeace 2013, Kleinschmidt 2016, Nellemann 2012). If flawed documents, such as permits obtained fraudulently or allowable cuts not based on genuine forest inventories, can be registered in a traceability system, they effectively create "phantom" timber volumes that can be used to launder illegal wood. This problem is compounded when the traceability systems lack transparency and independent forest monitors cannot access the data in them. (JPIK 2018).

Where civil society can get access to data in government-run traceability systems, it can use the information to expose inconvenient truths, by cross referencing the information in the system with other sources. For example, in 2016 the BVRio Institute launched a due diligence and risk assessment system for Brazilian tropical timber trade. The system has a big data approach, drawing from public traceability systems, public registries of infractions and convictions, publicly available data on distribution and density of commercial species and spatial data from Global Forest Watch, the Brazilian Government and other NGOs. BVRio found that around 30% of 3,500 logging permits issued since 2006 from Para and Mato Grosso had questionable or unrealistic volumes (BVRio 2016).

Similar big data approaches are being used at international level to identify risk of deforestation in agricultural commodity supply chains. The Transparency for Sustainable Economies (TRASE) tool draws on production, trade, and customs data and modeling to trace commodity flows back to production landscapes while identifying the actors involved. It identifies individual companies that export, ship and import a given commodity and applies an enhanced form of material flow analysis to link them to specific production localities ("TRASE," n.d.). Initiatives like Chain Reaction Research also combine multiple data-types (deforestation alerts, chain-of-custody and trade data, corporate financial and governance data) to assess the exposure of individual companies to material financial risks within agricultural commodity chains (Graham, Thoumi, Drazen, & Seymour, 2018). The "Global Forest Watch Pro" application combines remote sensing data and cloud computing to help companies asses risk of tree cover loss occurring in the farms or supply sheds of the mills, silos, or slaughterhouses from which they source (Amaral & Lloyd, 2019).

The Open Timber Portal is another example of a transparency platform enabled by technology. The portal provides information about forest management practices and legal compliance in participating countries. It compiles information from three different sources: official concession boundaries and registered timber producers from the government; documents uploaded voluntarily by timber producers to demonstrate compliance; and observations by third party forest monitors ("Open Timber Portal," n.d.). The portal enables geospatial data, legal documents, and allegations of non-compliance from these diverse sources to be consolidated and presented in user-friendly formats. This transparent information sharing means all parties can upload data to challenge, verify or refute information claims made by others.

New forensic methodologies are being used to query claims around the origins or contents of agricultural, forest and wildlife products. For example, stable isotope analysis is commonly used to determine origin and subsequent legality of food products and more recently, timber (Camin *et al*. 2017, Dormontt *et al*. 2015). Likewise, genetic analyses have been successfully used to bolster prosecutions in illicit wildlife and timber court cases(Janjua, Fakhar-I-Abbas, William, Malik, & Mehr, 2017, Wasser *et al*. 2018). Newly applied wood identification tools are being scaled for use by both inspectors to screen suspect material in ports of entry and by scientists in the laboratory to generate prosecutorial evidence against entities accused of sourcing wood illegally.

Within the forest products industry, techniques such as chemical and genetic analysis can identify a timber species and its origin from elements present in a wood product (UNODC 2016). When a robust collection of physical reference samples has been gathered – coming from the natural range of a timber species – these techniques can validate or invalidate the declared species and origin claims on documentation. This provides authorities, buyers of the products, or activists with a means of testing suspect claims about the content of a product or its source. Wood identification technologies include:

- *Visual methods* – visual observation and analysis of the anatomical patterns in a wood product are used to identify the species. This ranges from simple visual inspections by a frontline official with the aid of a hand-held magnification lens, through to the use of sophisticated image capture devices and processing algorithms. The main constraint on these tools is human capital and the lack of developed image-based reference databases depicting the natural variations in wood structure within and across species.
- *Chemical methods* – Mass spectrometry is used to analyze the phytochemicals laid down in heartwood to distinguish between different species that look similar. Stable isotope ratio analysis probes variations in the presence of non-radioactive isotopes such as oxygen, hydrogen and nitrogen. The ratios between these isotopes in trees differ across landscapes depending on geology and weather patterns. Radiocarbon dating can be used to determine the age of timber samples and whether harvesting occurred after regulations protecting the species came into effect or after the species was listed under the Convention on international Trade in Endangered Species.
- *Genetic methods* – Genetic analysis through the use of techniques such as DNA barcoding, DNA fingerprinting and phylogenetics can be used to accurately

determine the species and/or harvest origin of wood products, with caveats. To date, genetic analysis of wood products is hindered by challenges in obtaining consistent, high-quality DNA from processed wood products. An additional barrier is the lack of genetic reference databases for commercial timber species and their harvest origins along with the high cost of developing such databases (Galpern, Manseau, & Wilson, 2012).

Some examples of how wood identification technologies are used include:

- If a log is falsely labelled as coming from country "a", these techniques can be used to prove the log was smuggled from country "b" which has a log export ban.
- To identify tropical hardwoods in charcoal; a WWF study found 61 percent of barbecues in Germany at risk with 42 percent of charcoal samples containing tropical woods (WWF Deutschland, 2018),
- To identify pulp from tropical hardwoods in books; a WWF study found 19 out of 51 German children's books produced in south east Asia contained pulp from tropical hardwoods (Peter Hirschberger, Jokiel, Plaep, & Zahnen, 2010).
- During the hunt for the people who illegally chopped down big leaf maple in Gifford Pinchot National Forest in Washington in 2015, investigators used genetic fingerprinting to match planks seized at a sawmill to the exact stumps in the forest from which the timber had come (Irwin, 2019).
- Stable isotope ratio analysis was used to show that Mongolian Oak purchased by a US hardwood-floor retailer was illegally sourced from the Russian Far East rather than legal stocks in China (Irwin, 2019).

POLICY AND GOVERNANCE

Big data technologies can also be deployed to augment efforts to strengthen forest policies and governance. Policy reforms are usually complicated by: procedural challenges in ensuring that all stakeholder perspectives are voiced; the lack of ready means to detect social wrongs and impacts relative to biophysical conditions; the tendency for relevant regulations and functions to be spread across multiple line agencies or levels of government; and related potential for conflicts between laws or discrepancies between the letter of the law and administrative procedures as practiced. Text mining and natural language processing computational methods bring promises of scalable, fast-paced monitoring and analysis of such complexity within policy implementation and governance systems.

Text mining involves extracting underlying statistics from text such as word count and broad topics, while natural language processing details methods for analyzing the latent meaning and structure of text, such as actions, events, moods, and sentiment (Grimmer & Stewart, 2013). Text mining is currently applied in several sectors to prioritize policy agenda and streamline regulatory compliance. For instance, the World Bank applies text mining techniques to identifying policy priorities in presidential speeches to establish country-level drivers of long-term growth (Calvo-González, Eizmendi, & Reyes, 2018). Organizations such as the World Anti-Doping Agency also apply text mining algorithms to identify athletes who may be breaching doping regulations (Hong Bui 2018). The Oak Ridge National Laboratory uses text mining to identify drivers of clean energy innovation by analyzing investments and project finance documents (Lin *et al*. 2016). Text mining is also used to identify wildlife and environmental threats in oil and gas permits (Nasdaq, n.d.). With broad success across a variety of government and sectoral applications, these methodologies may also allow for faster, more efficient policy analysis and feedback during agenda setting, policy creation, and evaluation in the forestry sector.

Data mining methodologies have significant potential to improve monitoring and evaluation of the political and social economy around forests, which is an important but understudied aspect of forest monitoring (Mclain, Guariguata, Lawry, & Reed, 2019). They have similar potential to support forest governance monitoring, which encompasses the accountability, effectiveness, efficiency and fairness of policy and legal frameworks, decision making processes, and their implementation (FAO, 2011). Monitoring of indicators relevant to these issues has primarily relied on traditional survey methods, with researchers gathering data directly from field interviews and surveys (Jackson *et al.* 2004). However, advances in natural language processing and data mining are beginning to enable real-time, quantitative assessments of the impact of policy reforms and better understanding of contextual issues such as land tenure conflicts. Global news media coverage databases, such as the Global Database of Events, Languages, and Tone (GDELT) and the Integrated Crisis Early Warning System (ICEWS) provide detailed information about news events happening globally in real time. These data sources have recently been used to map social conflict (Sehgal, 2018), natural resource conflict (Wayland & Kuniholm, 2016), and political movements (Gao, Leetaru, Hu, Cioffi-Revilla, & Schrodt 2013). These data sources and methodologies bring significant potential to understand land driven conflict, social opinions in forest policy reforms, and shifts in government agenda through automated analysis of news media.

Data mining technologies can also be deployed to support social network analysis, to produce insights on the relationships that organizations and individuals have with each other, including the most powerful and important actors in a given social network. These "champions" can support the long-term success of forest conservation or restoration initiatives by facilitating information and knowledge transfer, influencing policy, and encouraging action (Paletto, Balest, Demeo, Giacovelli, & Grilli, 2016). Policy and legislative documents, including national and subnational plans and environmental policies, contain vast amounts of information relevant to forest monitoring that have yet to be tapped into. Data mining

approaches can strengthen comparative policy analyses to inform policy-makers. (Cannon, Nakayama, Sasaki, & Rossiter, 2018) analyzed the rapid shifts of Turkey's Syria policies with text mining, finding reliable, valid, and generalizable results that greatly reduced the timeframe of policy analysis. (Ash, Chen, Delgado, Fierro, & Lin, 2018) found that machine learning models of judicial documents can accurately classify the impact of individual cases on policy. (Gilardi & Wüest, 2018) developed an end-to-end methodology for comparative policy analysis, finding that automated approaches to policy analyses increase transparency, facilitate replication, and allow for retroactive adjustments to and the scaling of existing analyses.

CONCLUSIONS

Forest stakeholders of all stripes are benefitting from faster computation of evermore data from earth observation, value chains and the data mining of texts and media. New technologies are enabling the transformation of this data into information that is more accessible, actionable and timely, making it harder to hide activities that harm forests or people living in and around them. Big data is shining a light on a diverse array of problems – illegal logging in remote frontiers, the willing purchase of commodities associated with deforestation, corrupt allocation of permits to log or clear forests, encroachment on the land of indigenous peoples without their consent, and official endorsement of implausible statistics.

Generation of data-driven insights is a necessary but insufficient condition for sound management of the Earth's forest assets. Quality information may fall on deaf ears because political will is lacking. It may not motivate remedial action due to fundamental flaws in governance. It may stay hidden in "black-box" government and corporate systems, denying access to civil-society watch-dogs or marginalized communities that it would otherwise benefit. These challenges are compounded by a confusing plethora of competing methodologies and data sources. This provides cover for lack of action and prevents comprehensive, transparent monitoring of progress towards global forest goals and corporate commitments.

That said, the diversity of forest data can also make forest sector actor more accountable. The multiple ways forest data can be generated – from high resolution satellite images, to mining of the "twittersphere", and genetic fingerprinting in a laboratory – ultimately make it harder to keep information hidden. This can manifest in a virtuous cycle that drives transparency. For example, the incentive for corrupt officials to obscure data on who is taking what volume of timber from a place will diminish if this can be discerned independently from satellite data and the mining of customs data. Similarly, the ability of an inspector or auditor to extract a kick-back by turning a bind-eye to a human rights violation, will diminish if that same violation is likely to be pinpointed through mining social media activity. If politicians are repeatedly queried on why their forests statistics tell a different story to data derived from independent geospatial data platforms, they may be motivated to upgrade their own forest monitoring systems. If companies that disclose very little about the sustainability of their supply chains are constantly facing down accusations of poor practice by campaigners, they might be moved to set ambitious sustainability targets and report openly and accurately on progress towards them.

While capacities and tools for forest monitoring will continue to improve, trade-offs will persist between the extent, resolution, precision, accuracy, and frequency of update of geospatial data (Fagan & DeFries, 2009). In developing forest monitoring systems, the key questions to ask are: what is the intended purpose of the system and what information is needed to fulfill that purpose? For example, a system to monitor national-level forest carbon changes for REDD+ will have different technical requirements than a system for quickly detecting illegal clearing within a national park. The purpose determines minimum requirements for: spatial resolution (what is the smallest object that can be distinguished): temporal resolution (how often does the data refresh); repeatability (can the methods be reproduced and compared across time to create a longitudinal record of changes); and affordability – lower cost systems are more likely to remain operational for large areas into the future (Davis & Peterson, 2016).

REFERENCES

AMARAL, L., and LLOYD, J. 2019. A new tool can help root out deforestation from complex supply chains. Retrieved July 15, 2019, from https://blog.globalforestwatch.org/commodities/a-new-tool-can-help-root-out-deforestation-from-complex-supply-chains

ASNER, G.P. 2009. Tropical forest carbon assessment: integrating satellite and airborne mapping approaches. *Environmental Research Letters* **4**(3): 034009. https://doi.org/10.1088/1748-9326/4/3/034009

BACCINI, A., GOETZ, S.J., WALKER, W.S., LAPORTE, N.T., SUN, M., SULLA-MENASHE, D., … HOUGHTON, R.A. 2012. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. *Nature Climate Change* **2**(3): 182–185. https://doi.org/10.1038/nclimate1354

BALDECK, C.A., ASNER, G.P., MARTIN, R.E., ANDERSON, C.B., KNAPP, D.E., KELLNER, J.R., and WRIGHT, S.J. 2015. Operational Tree Species Mapping in a Diverse Tropical Forest with Airborne Imaging Spectroscopy. *PLOS ONE* **10**(7): e0118403. https://doi.org/10.1371/journal.pone.0118403

BALDWIN, G., MARKOWITZ, K., KOPAROVA, M., GERARDU, J., and ZAELKE, D. 2015. *Special Report on Next Generation Compliance*. Retrieved from http://inece.org/topics/next-gen-compliance/.

BISHOP, C.M. 2006. *Pattern Recognition and Machine Learning*. Berlin, Heidelberg: Springer-Verlag.

BOULTON, C.A., SHOTTON, H., and WILLIAMS, H.T.P. 2015. Using Social Media to Detect and Locate Wildfires. *Tenth International AAAI Conference on Web and Social Media*, 178–186.

BVRIO. (2016). *Using Big Data to Detect Illegality in the Tropical Timber Sector A Case Study of BVRio Due Diligence and Risk Assessment System*. Retrieved from https://docspublicos.s3.amazonaws.com/madeira/BVRio-Big-data-to-detect-timber-illegality.pdf

CALVO-GONZÁLEZ, O., EIZMENDI, A., and REYES, G. (2018). *Winners Never Quit, Quitters Never Grow Using Text Mining to Measure Policy Volatility and Its Link with Long-Term Growth in Latin America*. Retrieved from http://econ.worldbank.org.

CAMIN, F., BONER, M., BONTEMPO, L., FAUHL-HASSEK, C., KELLY, S.D., RIEDL, J., AND ROSS-MANN, A. 2017. Stable isotope techniques for verifying the declared geographical origin of food in legal cases. *Trends in Food Science & Technology 61*: 176–187. https://doi.org/https://doi.org/10.1016/j.tifs.2016.12.007

CHEN, M., MAO, S., and LIU, Y. 2014. Big Data: A Survey. *Mobile Networks and Applications* **19**(2): 171–209. https://doi.org/10.1007/s11036-013-0489-0

CZÚNI, L., and VARGA, P.Z. 2014. *Lightweight Acoustic Detection of Logging in Wireless Sensor Networks*. 120–125.

DAUME, S. 2016. Mining Twitter to monitor invasive alien species – An analytical framework and sample information topologies. *Ecological Informatics* **31**: 70–82. https://doi.org/10.1016/j.ecoinf.2015.11.014

DAVIES, D.K., ILAVAJHALA, S., MIN MINNIE WONG, and JUSTICE, C.O. 2009. Fire Information for Resource Management System: Archiving and Distributing MODIS Active Fire Data. *IEEE Transactions on Geoscience and Remote Sensing* **47**(1): 72–79. https://doi.org/10.1109/TGRS.2008.2002076

DAVIS, C., and PETERSON, R. 2016. Tools for Monitoring Global Deforestation, Reference Module in Earth Systems and Environmental Sciences. *Elsevier*.

DE SOUZA, C.M., HAYASHI, S., and VERÍSSIMO, A. 2008. *Near real-time deforestation detection for enforcement of forest reserves in Mato Grosso Instituto do Homem e Meio Ambiente da Amazônia-Imazon*. Retrieved from http://www.obt.inpe.br/prodes/

DENG, X., ZHU, Y., and NEWSAM, S. 2018. What Is It Like Down There? Generating Dense Ground-Level Views and Image Features From Overhead Imagery Using Conditional Generative Adversarial Networks. *SIGSPATIAL*.

DHANACHANDRA, N., MANGLEM, K., and CHANU, Y.J. 2015. Image Segmentation Using K-means Clustering Algorithm and Subtractive Clustering Algorithm. *Procedia Computer Science* **54**: 764–771. https://doi.org/10.1016/j.procs.2015.06.090

DORMONTT, E.E., BONER, M., BRAUN, B., BREULMANN, G., DEGEN, B., ESPINOZA, E., … LOWE, A.J. 2015. Forensic timber identification: It's time to integrate disciplines to combat illegal logging. *Biological Conservation* **191**: 790–798. https://doi.org/https://doi.org/10.1016/j.biocon.2015.06.038

EIA.(2012. *The Laundering Machine: How Fraud and Corruption in Peru's Concession System are Destroying the Future of its Forests*. Retrieved from https://content.eia-global.org/posts/documents/000/000/501/original/The_Laundering_Machine_ENG.pdf?1475785276

EUROPEAN SPACE AGENCY. 2013. Free access to Copernicus Sentinel satellite data. Retrieved July 15, 2019, from https://earth.esa.int/web/guest/content/-/article/free-access-to-copernicus-sentinel-satellite-data

FAGAN, M., and DEFRIES, R. 2009. *Measurement and Monitoring of the World's Forests: A Review and Summary of Remote Sensing Technical Capability, 2009–2015*. Retrieved from https://media.rff.org/archive/files/sharepoint/WorkImages/Download/RFF-Rpt-Measurement and Monitoring_Final.pdf

FAO. 2011. *Framework for Assessing and Monitoring Forest Governance*. Retrieved from http://www.fao.org/climatechange/27526-0cc61ecc084048c7a9425f64942df70a8.pdf

FAO. 2015. *Forest Resources Assessment*.

GALPERN, P., MANSEAU, M., and WILSON, P. 2012. Grains of connectivity: analysis at multiple spatial scales in landscape genetics. *Molecular Ecology* **21**(16): 3996–4009. https://doi.org/10.1111/j.1365-294X.2012.05677.x

GAO, J., LEETARU, K.H., HU, J., CIOFFI-REVILLA, C., and SCHRODT, P. 2013. *Massive Media Event Data Analysis to Assess World-Wide Political Conflict and Instability*. https://doi.org/10.1007/978-3-642-37210-0_31

GRAHAM, P., THOUMI, G., DRAZEN, E., and SEYMOUR, F. 2018. *Mining Global Financial Data to Increase Transparency and Reduce Drivers of Deforestation*. Retrieved from https://wriorg.s3.amazonaws.com/s3fs-public/ending-tropical-deforestation-mining-global-financial-data.pdf

GREENPEACE. 2013. *The Amazon's Silent Crisis*. Retrieved from https://www.greenpeace.org/usa/wp-content/uploads/legacy/Global/usa/planet3/PDFs/Amazon5Ways.pdf

GRIMMER, J., and STEWART, B.M. 2013. Text as Data: The Promise and Pitfalls of Automatic Content Analysis Methods for Political Texts. *Political Analysis* **21**(3): 267–297. https://doi.org/DOI: 10.1093/pan/mps028

HANSEN, M.C., POTAPOV, P.V., MOORE, R., HANCHER, M., TURUBANOVA, S.A., TYUKAVINA, A., … TOWNSHEND, J.R.G. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. *Science* **342**(6160): 850–853. https://doi.org/10.1126/science.1244693

HANSEN, MATTHEW, C., KRYLOV, A., TYUKAVINA, A., POTAPOV, P.V, TURUBANOVA, S., ZUTTA, B., … MOORE, R. 2016. Humid tropical forest disturbance alerts using Landsat data. *Environmental Research Letters* **11**(3): 034008. https://doi.org/10.1088/1748-9326/11/3/034008

HONG BUI. 2018. Artificial intelligence takes on doping. Retrieved July 11, 2019, from https://www.veritone.com/blog/artificial-intelligence-takes-doping/

IRWIN, A. 2019. Tree sleuths are using DNA tests and machine vision to crack timber crimes. *Nature* **568**(7750): 19–21. https://doi.org/10.1038/d41586-019-01035-7

ITTO. 2012. *Tracking Sustainability: Review of Electronic and Semi-Electronic Timber Tracking Technologies*. Retrieved from http://www.itto.int/direct/topics/topics_pdf_download/topics_id=3145&no=0&disp=inline

JACKSON, J.E., LEE, R.G., SOMMERS, P., JACKSON, J.E., LEE, R.G., SOMMERS, P., … LEE, R.G. 2004. Monitoring the Community Impacts of the Northwest

Forest Plan: An Alternativeto Social Indicators Insights and Applications Monitoring the Community Impacts of the Northwest Forest Plan: An Alternative to Social Indicators. *Society and Natural Resources* **17**: 223–233. https://doi.org/10.1080/08941920490270258

JANJUA, S., FAKHAR-I-ABBAS, WILLIAM, K., MALIK, I.U., and MEHR, J. 2017. DNA Mini-barcoding for wildlife trade control: a case study on identification of highly processed animal materials. *Mitochondrial DNA Part A* **28**(4): 544–546. https://doi.org/10.3109/24701394.2016.1155051

JEAN, N., AZZARI, G., WANG, S., LOBELL, D., SAMAR, A., and ERMON, S. 2018. *Tile2Vec: Unsupervised representation learning for spatially distributed data arXiv: 1805. 02855v2 [cs . CV] 30 May 2018*.

JPIK. 2018. *SVLK: A Process toward Accountable Governance*. Retrieved from www.jpik.or.id

KLEINSCHMIDT, D. 2016. No TitleIllegal Logging and Related Trade: Dimensions, Drivers, Impacts, and Responses. In *Global Scientific Rapid Response Assessment Report*.

KNIAZ, V.V. 2018. Conditional GANs for semantic segmentation of multispectral satellite images. *Proc. SPIE 10789*, (October 2018). https://doi.org/10.1117/12.2325601

LIN, J., CHINTHAVALI, S., STAHL, C.D., STAHL, C., LEE, S., and SHANKAR, M. 2016. Ecosystem discovery: Measuring clean energy innovation ecosystems through knowledge discovery and mapping techniques. *The Electricity Journal* **29**(8): 64–75. https://doi.org/10.1016/j.tej.2016.09.012

MA, L., LIU, Y., ZHANG, X., YE, Y., YIN, G., and JOHNSON, B.A. 2019. Deep learning in remote sensing applications: A meta-analysis and review. *ISPRS Journal of Photogrammetry and Remote Sensing* **152**: 166–177. https://doi.org/https://doi.org/10.1016/j.isprsjprs.2019.04.015

MCLAIN, R., GUARIGUATA, M., LAWRY, S., and REED, J. 2019. Integrating tenure and governance into assessments of forest landscape restoration opportunities. In *CIFOR Infobrief*. https://doi.org/10.17528/cifor/007132

MIDDLETON, S.E., MIDDLETON, L., and MODAFFERI, S. 2014. Real-Time Crisis Mapping of Natural Disasters Using Social Media. *IEEE Intelligent Systems* **29**(April): 9–17. https://doi.org/10.1109/MIS.2013.126

MOEF. 2018. *The State of Indonesias Forests 2018* (S. Nurbaya and S. Awang, Eds.). Retrieved from http://perpustakaan.bappenas.go.id/lontar/file?file=digital/191959-%5B_Konten_%5D-Konten E2337.pdf

NASDAQ. (n.d.). How Artificial Intelligence Is Taking Over Oil And Gas – Nasdaq.com. Retrieved July 11, 2019, from https://www.nasdaq.com/article/how-artificial-intelligence-is-taking-over-oil-and-gas-cm1005575

NELLEMANN, C. 2012. *Green carbon, black trade: Illegal logging, tax fraud, and laundering in the worlds tropical forests: A rapid response assessment*. Retrieved from www.grida.no

OPEN TIMBER PORTAL. (n.d.). Retrieved July 15, 2019, from https://opentimberportal.org/

PALETTO, A., BALEST, J., DEMEO, I., GIACOVELLI, G., and GRILLI, G. 2016. Power of Forest Stakeholders in the Participatory Decision Making Process: A Case Study in Northern Italy. *Acta Silvatica et Lignaria Hungarica*, **12**(1): 9–22. https://doi.org/10.1515/aslh-2016-0002

PETER HIRSCHBERGER, JOKIEL, D., PLAEP, C., and ZAHNEN, J. 2010. *Tropical Forest Destruction for Children's Books*.

REICHE, J., HAMUNYELA, E., VERBESSELT, J., HOEKMAN, D., and HEROLD, M. 2018. Improving near-real time deforestation monitoring in tropical dry forests by combining dense Sentinel-1 time series with Landsat and ALOS-2 PALSAR-2. *Remote Sensing of Environment* **204**: 147–161. https://doi.org/10.1016/J.RSE.2017.10.034

REICHE, J., LUCAS, R., MITCHELL, A.L., VERBESSELT, J., HOEKMAN, D.H., HAARPAINTNER, J., … HEROLD, M. 2016. Combining satellite data for better tropical forest monitoring. *Nature Climate Change* **6**(2): 120–122. https://doi.org/10.1038/nclimate2919

REICHE, J., VERHOEVEN, R., VERBESSELT, J., HAMUNYELA, E., WIELAARD, N., HEROLD, M., … HEROLD, M. 2018. Characterizing Tropical Forest Cover Loss Using Dense Sentinel-1 Data and Active Fire Alerts. *Remote Sensing* **10**(5): 777. https://doi.org/10.3390/rs10050777

REYMONDIN, L., JARVIS, A., PEREZ-URIBE, A., TOUVAL, J., ARGOTE, K., REBETEZ, J., … MULLIGAN, M. 2012. *Terra-i: A methodology for near real-time monitoring of habitat change at continental scales using MODIS-NDVI and TRMM*.

SAATCHI, S.S., HARRIS, N.L., BROWN, S., LEFSKY, M., MITCHARD, E.T.A., SALAS, W., … MOREL, A. 2011. Benchmark map of forest carbon stocks in tropical regions across three continents. *Proceedings of the National Academy of Sciences of the United States of America* **108**(24): 9899–9904. https://doi.org/10.1073/pnas.1019576108

SANQUETTA, CARLOS R, WOJCIECHOWSKI, J., CORTE, A.P.D., BEHLING, A., NETTO, S.P., RODRIGUES, A.L., and SANQUETTA, M.N.I. 2015. Comparison of data mining and allometric model in estimation of tree biomass. *BMC Bioinformatics* **16**(247): 1–9. https://doi.org/10.1186/s12859-015-0662-5

SANQUETTA, CARLOS ROBERTO, WOJCIECHOWSKI, J., PAULA, A., CORTE, D., and RODRIGUES, A.L. 2013. On the use of data mining for estimating carbon storage in the trees. *Carbon Balance and Management* **8**(6): 1–9. https://doi.org/10.1186/1750-0680-8-6

SAOUDI, M., EULER, R., BOUNCEUR, A., and KECHADI, T. 2016. *Data Mining Techniques Applied to Wireless Sensor Networks for Early Forest Data Mining Techniques Applied to Wireless Sensor Networks for Early Forest Fire Detection*. https://doi.org/10.1145/2896387.2900323

SEHGAL, G. 2018. Spatio-temporal networks of social conflicts: analysis and modeling. *2018 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM)*, 740–743. https://doi.org/10.1109/ASONAM.2018.8508266

SHAHAM, U., STANTON, K., LI, H., NADLER, B., BASRI, R., and KLUGER, Y. 2018. SpectralNet: Spectral Clustering using Deep Neural Networks. *ICLR*. Retrieved from http://arxiv.org/abs/1801.01587

SHI, Q., LIU, X., and LI, X. 2018. Road Detection From Remote Sensing Images by Generative Adversarial Networks. *IEEE Special Section on Advanced Data Analytics for Large-Scale Complex Data Environments* **6**: 25486–25494. https://doi.org/10.1109/ACCESS.2017.2773142

SHI, Y., LI, Q., and ZHU, X.X. 2019. Building Footprint Generation Using Improved Generative Adversarial Networks. *IEEE Geoscience and Remote Sensing Letters* **16**(4): 603–607. https://doi.org/10.1109/LGRS.2018.2878486

SHIMABUKURO, Y., DOS SANTOS, J., FORMAGGIO, A., DUARTE, V., and RUDORFF, B. 2016. The Brazilian Amazon Monitoring Program: PRODES and DETER Projects. In *Global Forest Monitoring from Earth Observation* (pp. 166–183). https://doi.org/10.1201/b13040-13

SINGH, A., and SINGH, K.K. 2018. Unsupervised change detection in remote sensing images using fusion of spectral and statistical indices. *Egyptian Journal of Remote Sensing and Space Science* **21**(3): 345–351. https://doi.org/10.1016/j.ejrs.2018.01.006

TANEV, H., ZAVARELLA, V., and STEINBERGER, J. 2017. Monitoring disaster impact: detecting micro-events and eyewitness reports in mainstream and social media. *Proceedings of the 14th ISCRAM Conference*, 592–602.

TRASE. (n.d.). Retrieved July 15, 2019, from https://trase.earth/about/how-does-trase-work?

TUNG, F., WONG, A., and CLAUSI, D.A. 2010. Enabling scalable spectral clustering for image segmentation. *Pattern Recognition* **43**(12): 4069–4076. https://doi.org/10.1016/j.patcog.2010.06.015

UNODC. 2016. *Best practice guide for forensic timber identification*. Retrieved from https://www.unodc.org/documents/Wildlife/Guide_Timber.pdf

WASSER, S.K., TORKELSON, A., WINTERS, M., HOREAUX, Y., TUCKER, S., OTIENDE, M.Y., … WEIR, B.S. 2018. Combating transnational organized crime by linking multiple large ivory seizures to the same dealer. *Science Advances* **4**(9): eaat0625. https://doi.org/10.1126/sciadv.aat0625

WAYLAND, J., and KUNIHOLM, M. 2016. Legacies of conflict and natural resource resistance in Guatemala. *The Extractive Industries and Society* **3**(2): 395–403. https://doi.org/10.1016/j.exis.2016.03.001

WULDER, M.A., and COOPS, N.C. 2014. Satellites: Make Earth observations open access. *Nature*, *513*(7516), 30–31. https://doi.org/10.1038/513030a

WWF DEUTSCHLAND. 2018. *Tropical Wood in Germany's Charcoal*.

XIE, M., JEAN, N., BURKE, M., LOBELL, D., and ERMON, S. 2016. Transfer Learning from Deep Features for Remote Sensing and Poverty Mapping. *Proceedings of the 30th AAAI Conference on Artificial Intelligence*, 3929–3935. Retrieved from http://arxiv.org/abs/1510.00098

ZHANG, L., and YOU, J. 2017. A Spectral Clustering Based Method for Hyperspectral Urban Image. *2017 Joint Urban Remote Sensing Event (JURSE)*, 1–3. https://doi.org/10.1109/JURSE.2017.7924602

Global forest governance and sustainable development: reflections on the life and times of John Spears

H. GREGERSEN[a], P.A. DEWEES[b], H. EL-LAKANY[c], B. SINGER[d] and J. BLASER[e]

[a]*Department of Forest Resources and Department of Applied Economics, University of Minnesota, St. Paul, 1994 Buford Avenue, St Paul, MN, 55100, United States of America*
[b]*Independent researcher, Juntulantie 80, Taipalsaari 54920, Finland*
[c]*Faculty of Forestry, University of British Columbia, 2424 Main Mall, Vancouver, BC, V6T 1Z4, Canada*
[d]*United Nations Forum on Forests Secretariat, 2 United Nations Plaza, DC2-2309A, New York, NY 10017, USA*[1]
[e]*School of Agricultural, Forestry and Food Sciences (HAFL), Bern University of Applied Sciences, Länggasse 81, CH-3052 Zollikoffen, Switzerland*

Email: Hans@walk-about.net, pdewees@gmail.com, Hosny.ellakany@ubc.ca, singerb@un.org, juergen.blaser@bfh.ch

SUMMARY

The late John Spears' international career coincided with the emergence of global forest governance. His contributions at the World Bank, the Consultative Group on International Agricultural Research (CGIAR) and at the World Commission on Forests and Sustainable Development (WCFSD) are characterized by an unfailing call to integrate objectives towards forests and trees into broader development goals and particularly to tap the power of forests and trees to contribute to poverty alleviation.

This paper describes the evolution of global forest governance since the early 1970s, especially focusing on the period when Spears was highly influential in the global forest policy debate. It gives an emphasis to the efforts the international community has made in adopting a more comprehensive perspective toward the role of forests in sustainable development. Despite this, global forest governance has recently tended to focus more narrowly on climate change at the expense of attention to the problem of poverty. While climate change is a major priority in its own right, we argue that this limited perspective needs to be overcome to unlock the full potential of forests in sustainable development, aimed at combating poverty.

Keywords: global forest governance, sustainable forest management, sustainable development goals, poverty reduction, John Spears

Gouvernance mondiale des forêts et développement durable: réflexions sur la vie et le parcours de John Spears

H. GREGERSEN, P.A. DEWEES, H. EL-LAKANY, B. SINGER et J. BLASER

La carrière internationale de feu John Spears coïncida avec l'émergence de la gouvernance mondiale des forêts. Ses contributions à la Banque mondiale, au Groupe consultatif sur la recherche internationale en agriculture (CGIAR) et à la Commission mondiale sur les forêts et le développement durable (WCFSD) se caractérisent par un appel systématique à l'intégration des objectifs relatifs aux forêts et aux arbres au sein d'objectifs de développement plus larges, en particulier au potentiel des forêts et des arbres en matière de réduction de la pauvreté.

Cet article retrace l'évolution de la gouvernance mondiale des forêts depuis le début des années 1970 en se concentrant tout particulièrement sur l'époque où Spears influait de manière significative les débats en la matière. Il souligne les efforts de la communauté internationale dans l'adoption d'une vision plus holistique des forêts dans le développement durable, en dépit de laquelle la gouvernance mondiale des forêts s'est récemment recentrée sur la question climatique et ce, au détriment du problème de la pauvreté. Bien que le changement climatique constitue en tant que tel une priorité majeure, cette vision restrictive doit être surmontée afin que les forêts puissent jouer leur plein rôle dans le développement durable et la lutte contre la pauvreté.

Gobernanza forestal mundial y desarrollo sostenible: reflexiones sobre la vida y la época de John Spears

H. GREGERSEN, P.A. DEWEES, H. EL-LAKANY, B. SINGER y J. BLASER

La carrera profesional internacional del difunto John Spears coincidió con la aparición de la gobernanza forestal mundial. Sus contribuciones en el Banco Mundial, el Grupo Consultivo para la Investigación Agrícola Internacional (CGIAR) y la Comisión Mundial sobre los Bosques y

[1] The views presented in this paper do not necessarily reflect those of the United Nations.

el Desarrollo Sostenible (WCFSD, por sus siglas en inglés) se caracterizan por un afán inquebrantable de integrar los objetivos relativos a los bosques y los árboles en objetivos de desarrollo más amplios y, en particular, de aprovechar el poder de los bosques y los árboles para contribuir a la mitigación de la pobreza.

En este artículo se describe la evolución de la gobernanza forestal mundial desde principios de la década de 1970 y se centra especialmente en el período en que Spears ejerció una gran influencia en el debate sobre las políticas forestales mundiales. Se hace hincapié en los esfuerzos de la comunidad internacional para adoptar una perspectiva más amplia sobre el papel de los bosques en el desarrollo sostenible. A pesar de ello, la gobernanza forestal mundial ha tendido recientemente a centrarse más estrechamente en el cambio climático, a expensas de la atención sobre el problema de la pobreza. Si bien el cambio climático es una prioridad importante por derecho propio, se argumenta que es necesario superar esta perspectiva limitada para liberar todo el potencial de los bosques en el desarrollo sostenible, con el fin de combatir la pobreza.

INTRODUCTION

John Spears may be best known because of his work at the World Bank, where he held the position of Forests Adviser beginning in 1976 when he was recruited with the objective of developing and expanding the Bank's forests programme, until his retirement from the institution in 1990. His perspectives were, however, shaped by his earlier service in the Kenya Forest Department as the country transitioned from colony to independent state, as well as by his subsequent engagement at the Food and Agriculture Organization of the United Nations (FAO) where he worked closely with its group of technical specialists who were charged with finding ways to inform a growing body of development assistance activities focused on supporting broadly-based rural development. And after he retired from the Bank, he continued to stay deeply engaged in a number of formative processes, such as with the work of the Consultative Group on International Agricultural Research (CGIAR) and with the World Commission on Forests and Sustainable Development (WCFSD), of which he was the Secretary General.

As friends and colleagues of John's, we have drafted this article to tease out elements of his influence as a formative and leading thinker and, as Byron and Sayer (2020) suggest, as a 'policy entrepreneur.' We should note at the outset, however, that it is difficult to conclude much about his impact only by examining his written record.[2] His formally published writings are fairly sparse (cf. the discussion in Dewees *et al.* (2020)). Anyone who has worked with or for an international bureaucracy will know that much of the heavy-lifting which goes into formulating the scope for policy change in these institutions (and often in the broader policy arena as well) takes place in haphazard and unpredictable ways, often through trial and error, but bolstered by, say, an informal memo, a fostered professional relationship, a working paper, a thoughtful review, a good argument, carefully placed praise, a well-told narrative, and deep knowledge of what other leading thinkers were saying and writing. John was a master of all these things. And when his own ideas gained traction, he was more often interested in giving someone else credit because he was naturally self-effacing, because he rightly saw these as outcomes of a wider and collaborative process, and because he also saw a lot of utility in supporting and mentoring others.[3]

More generally, the contribution of forward thinkers like John is often overlooked once their ideas have become mainstream. So, the objective of this article is two-fold: first, to explore some of the themes which were dominant in John's thinking and which did indeed gain traction over time, but also to review how global forest governance has evolved over the last four decades both during the period when he had his greatest impact, and since then.

At a very early stage, John and a few other visionaries saw the need for a stronger consensus at the international level of how global forest assets should be managed and conserved. He was of the particular view that this consensus needed more fully to address the links between forests and food, energy, health, water and other sectors beyond the forest sector. More broadly, he was an early convert to and vocal exponent of the perspective that forests could also help meet objectives such as poverty prevention and reduction, biodiversity conservation, and climate change mitigation and adaptation. It is perhaps surprising to say this now, but these linkages were seldom explicit or obvious, except to a few academics, in the sixties and seventies when John emerged on to the international forestry scene. Now, of course, the multi-facetted role of forests – and of trees outside of forests – is commonly recognized by governments and development agencies alike, captured in processes such as the on-going United Nations 2030 Agenda for Sustainable Development, and its related 17 Sustainable Development Goals (SDGs).

This paper is structured to examine the evolution of processes which have led to the current framework for global forest governance over several periods, and to offer some perspectives on John's role and impact in shaping some of the themes which have become dominant. The first section describes the key issues related to forests which began to be articulated in the 1970s, and which culminated with the Rio Earth Summit in 1992. This coincides with the period when John was working at FAO through the period he worked at the

[2] John's key writings are mainly limited to internal memos and informal papers, some of which can be found in the archives of the World Bank, the FAO, the CGIAR, IUFRO, and other organizations with which he was associated.

[3] John thrived when he could work collaboratively with others. The writers of this paper were among the "others" who worked collaboratively with John through various periods in his career in his several roles at the World Bank and at UN agencies, in global forestry research, and in non-governmental entities such as the World Commission on Forests and Sustainable Development.

World Bank. The second section describes the emergence of forests, trees, and agroforestry in the CGIAR and John's role in this, as well as the work of the WCFSD, and covers the period from around 1992 through around 2000. With the end of his tenure with the WCFSD, John's direct influence on the course of various global forests initiatives began to wane, though he stayed hugely active in the informal and robust back and forth between colleagues and peers in both the public and private sectors, for whom he remained a valued source of ideas and inspiration. His indirect influence carried over into subsequent processes discussed in the third section of this paper, such as the emergence of the UN Forum on Forests, the Sustainable Development Goals (SDGs), and the increasing influence of the UNFCCC in capturing the global forests agenda through support for Reducing Emissions from Deforestation and Forest Degradation (REDD+), covering roughly the period since 2000. Finally, we close with some reflections on how the central thesis of John Spears' approach toward forests and development – that forests and trees have a critical role to play in poverty alleviation – is being reflected now.

THE EMERGENCE OF GLOBAL FOREST GOVERNANCE[4] (1972–1992)

Until the early 1970s, the idea that there could be measures which could constitute some sort of shared approach toward international forest governance was embryonic, compared to their scale and complexity today. At the time, there were just a handful of organizations with an international scope and mandate, notably the International Union of Forestry Research Organisations (IUFRO) and the Food and Agriculture Organisation (FAO), and neither had any responsibilities for addressing the broad range of forest policy measures which later formed the basis for a series of international conventions, institutions, and agreements. Where there was a platform for a discourse about forests, it tended to emphasize industrial forestry. For example, the Sixth World Forestry Congress, held in Madrid, in 1966, took this approach and focused heavily on issues related to forests and the forest industry (Singer 2012:98). Despite a few dissenting voices (*e.g.*, Westoby 1962), the general understanding of social aspects of forestry was limited to issues around the safety and welfare of forestry workers. Environmental concerns focused almost exclusively on fighting diseases, pests and forest fires, and to a lesser extent on soil and water conservation (*e.g.*, FAO 1966).

In the course of the 1970s, perspectives which extended beyond the concerns of the timber industry began to emerge. The UN Conference on the Human Environment, held in Stockholm in 1972, ushered in the creation of the United Nations Environment Programme (UNEP), and was the first major global initiative to seek a consensus about how to tackle problems of the environment. Articulating seldom-voiced concerns, Indira Gandhi, in her address to the conference, spoke persuasively about the need to mitigate the impact of environmental degradation on the poor. Later that year, the World Forestry Congress convened in Buenos Aires, and welcomed the messages from the Stockholm Conference. Although none of the 26 principles emerging from Stockholm addressed forests specifically, the Congress Declaration correctly predicted that the Stockholm Plan of Action would "influence forestry development for the years to come" (FAO 1972).

At the same time as these concerns about environmental degradation and its impact on the poor began to emerge, the World Bank, under the leadership of Robert McNamara and supported by vocal advocates like Barbara Ward, began to increase its focus on the problem of poverty. McNamara oversaw a vast expansion of the institution's investments in developing countries, which increased 13-fold from 1968 to 1981, and resulted in a tripling of its staff during the same period. In Nairobi, in 1973, in a speech to the Bank's Board of Governors, he launched a plan significantly to boost its program of support for rural development and to raise the productivity of the rural poor. Agricultural lending, for example, was to be increased by over 40 percent, and 3 out of 4 projects were to include components to help smallholder farmers. And while environmental lending *per se* did not feature strongly in McNamara's poverty reduction program, concerns about potential environmental and social impacts increasingly informed the nature of its investment programs.

Until then, the Bank's work in forestry had been largely restricted to a few industrial forestry operations. These were modest in scope and had limited demonstrated impact on employment or the rural poor. With the support of McNamara, there was a consensus amongst technocrats at the Bank that this had to change, and a small team began considering how best to shift its emphasis more fully to incorporate forests into its rural development agenda. John, who had established a reputation at FAO for his collaborative working style, was recruited by the team, and charged with charting the course ahead as the institution's newly created Senior Forestry Adviser.

Working together under the leadership of Graham Donaldson, John, along with Sydney Draper, Gordon Temple, Ted Goering, and David Dapice assembled one of the first institution-wide 'sector policy papers' which laid out how the institution was going to consider forestry in its future portfolio (World Bank 1978). It was a critical juncture. The 1978 Sector Policy Paper outlined a great expansion of support for forestry, in four areas:

- "environmental forestry" for the conservation of habitats and watersheds;

[4] We use the term 'global forest governance' in the broadest sense to denote efforts to coordinate shared actions towards a consensus of forest-related goals. We distinguish it from the narrower subset of governance arrangements which are sometimes referred to as a global forest regime, which can suggest more or less coercive implementation arrangements grounded in binding international law (Rayner *et al.* 2010).

- "rural development forestry" for fuelwood and timber production, to establish shelterbelts to improve soil conservation, to support the planting of fruit trees, fodder resources, and fibre producing trees, and to encourage small scale forest industries to meet local demands;
- institution building projects, with an emphasis on training, education, and research; and
- industrial forestry projects "where they can continue to be justified within the framework of country programming priorities." (World Bank 1978: 8–9)

By the time it was released, John had already been instrumental in bringing about rapid changes in the Bank's forest-related activities (Lele *et al.* 2019:128). Not only had the number of projects increased sharply, but their focus was shifting rapidly:

> ". . .There is now greater concentration on rural forestry projects, and increased attention is being given to environmental and forestry protection during the formulation of forestry projects. Of the 17 forestry projects assisted by the Bank between fiscal 1953 and fiscal 1976, 13 were oriented toward industrial forestry, and only four were directly concerned with rural development. By contrast, over half [of] the 25 projects currently under study are directly related to rural development (. . .). Forestry components are now being incorporated into Bank-assisted agriculture and rural development projects wherever justified by local circumstances." (World Bank 1978:44–45)

What is striking is the Paper's push to integrate the "forest sector" and "forestry development" into broader development goals, particularly by addressing rural poverty – in 1978, an idea which was well ahead of its time.

Underlying some of the thinking in the Policy Paper was a concern of the impact of a growing population on forests and the environment, including on food security. Population growth and its impact was a subject of deep concern to McNamara, who argued that "the population problem is an inseparable part of the larger, overall problem of development. . . . To put it simply: excessive population growth is the greatest single obstacle to the economic and social advancement of most of the societies in the developing world." (McNamara 1979: 739). The Policy Paper sought to tease out both the impacts of rapid population growth, and efforts which might be taken to mitigate its impacts, both on the environment and on the rural poor.

One of the more controversial aspects of the Policy Paper has to be understood from this perspective, and this pertains to its proposal for how the Bank would be addressing the question of the conversion of high tropical forests to areas of agricultural settlement (World Bank 1978: 47). Regarding the impact of population growth, the Policy Paper pointed out that the resulting ". . .massive spontaneous settlement movements taking place in the tropical forests of the Brazilian Amazon, Indonesia, Ivory Coast, and Venezuela, are proceeding at such a rate (over 15 million hectares each year). . .," and enormous avoidable damage was being done. The Policy Paper proposed introducing a more rational approach, assessing first the extent of forested areas at greatest risk and of greatest value, then implementing development plans to take account of fragile forest lands (for example, in catchment areas and on steep slopes) and putting in place measures for their protection. These would be distinct from those forested areas with the greatest agricultural potential where the Bank would target its investments in introducing sound farming practices. If extensive areas were going to be lost to deforestation anyway, the thinking seemed to be, 'let's make the best out of a bad situation.' Simply acknowledging that the Bank could support land conversion in this way seems enormously risky in retrospect, but at the time, it didn't seem so, particularly as the policy supported clear risk mitigation measures.

These measures notwithstanding, the reality was that the Bank had no effective institutional mechanism for reasonably ensuring that harm to fragile forest ecosystems and to the people dependent on them would be limited by its development programs. Under McNamara, the Bank, as early as 1970, had put in place some rudimentary environmental guidelines, which required screening projects for their potential environmental impact and mitigating those thought to be severe (Shihata 1992). But a series of large investments in Brazil between 1981 and 1983 in support of an infrastructure programme in the Northwest Amazon, known as Polonoroeste, created an enormous outcry because of the resulting deforestation and harm to indigenous peoples which had not been mitigated by the Bank's environmental guidelines or by its forest policy (Wade 2011). These weren't forestry programs *per se*, but many NGOs especially viewed the approach proposed by the 1978 policy as an implicit endorsement of the approach taken in Polonoreste.

Within a matter of a few years, the World Bank underwent a serious crisis when the United States Congress, lobbied by conservation-oriented NGOs, threatened to cut the US contribution to the World Bank budget unless it revised its policy towards tropical forests (Bowles and Kormos 1995, Kolk 1996). A formal revision of its forestry strategy didn't take place until 1991, but the outcry about Polonoreste did accelerate action to meet commitments the Bank had earlier made to more clearly articulate its environmental and social safeguard policies[5]. In May 1984, environmental guidance was consolidated in its Operational Manual Statement 2.36,

[5] The initiative to develop environmental and social safeguards came out of a joint declaration signed in New York in 1980 with other multilateral financing agencies. These included the European Economic Community (EEC), the Organization of American States (OAS), UNEP and UNDP, which all pledged support for the creation of systematic environmental assessment and evaluation procedures (Shihata 1992: 6). The first safeguard developed by the Bank as an outcome of the joint declaration provided guidance about how the rights of indigenous peoples should be considered, issued in May 1982 in its Operational Manual Statement 2.4 *Tribal people in Bank-financed projects*, which was the first such commitment by any development agency.

Environmental Aspects of Bank Work, which remained in place until the adoption in October 1991 of Operational Directive 4.01, *Environmental Assessment*. The Bank's policy on forestry joined the suite of so-called 'Safeguard Policies' in September of 1993 with the adoption of Operational Policy 4.36 *Forestry*.[6,7]

The controversies around the Polonoreste projects, and to a similar extent, around resettlement programs (*Transmigrasi)* in Indonesia, helped fuel a growing awareness about the enormous importance of tropical forests. There was a growing consensus that global action to limit deforestation was becoming necessary. A newly established think tank, the World Resources Institute (WRI), through an initiative called *The Global Possible*, proposed to mobilize leading specialists to work through how to address pressing topics such as population stabilization, poverty alleviation, the conservation of biological diversity, agricultural development, and the control of tropical deforestation. John became deeply involved in this process. (Repetto 1985, Spears and Ayensu 1985). Specifically with respect to deforestation, the WRI effort resulted in the creation of a multi-donor task force comprised of the World Bank, the United Nations Development Program (UNDP), and a number of foundations and, in October 1985, it produced a report called, "Tropical Forests: A Call for Action". At the same time, FAO launched a parallel process to stimulate global action in the area of tropical forestry. FAO's framework Tropical Forestry Action Plan (TFAP), also released in October 1985, proposed that governments should address five priority areas as part of a common framework for tackling tropical deforestation: (i) forestry in land use, (ii) forest-based industrial development, (iii) fuelwood and energy, (iv) conservation of tropical forest ecosystems, and (v) institutions (FAO 1986).

Both of these initiatives converged in 1987, and a broader-based TFAP was eventually launched with the objective of overcoming the perceived lack of political, financial, and institutional support for combatting deforestation through a "common framework for action." The overall approach to the TFAP was resonant with the growing view that something needed to be done. The plight of the Amazon and its peoples captured world media attention because of the publication of the Brazilian Amazon's first deforestation rates and the assassination of rubber-tapper leader Chico Mendes in 1988. These events capped a momentous decade, and gave impetus to the development of a framework for a global consensus about forest governance.

John retired from the World Bank in 1990. Under his leadership, forestry and forest-based investments supported by the Bank had vastly expanded, and hugely diversified in their coverage from a narrow base of industrial forestry activities in the late 1970s to encompass watershed management, social and community forestry, and landscape restoration (known euphemistically at the time as 'wastelands development.'). Annual new commitments for forests for the period from 1979 to 1991 averaged around $200 million per year in nominal terms, making the Bank the most significant multilateral source of finance for forest conservation and management globally – a position it retains today. Under John's leadership, the Bank embraced the integration of forests into the rural development agenda, with its broader links to economic growth, poverty reduction and to the environment. As the institution's lead (and charismatic) spokesperson on forests, he leveraged this role and successfully helped incorporate these dimensions into an expansive policy dialogue with client countries and with other donors (World Bank 1991).

Indeed, within a decade, what had originally been a technical cooperation issue dominated by a small group of international organizations had grown into a highly politicized arena involving a growing number of international organizations, bilateral donors and development banks, national governments with their sectoral bureaucracies and diplomats from developed and developing countries, academics, logging companies and a wide range of civil society stakeholders involved in nature conservation and indigenous rights. The domination of forest science in forest policy had given way to the inclusion of wide range of perspectives from ecology, sociology, economics, political science, history and anthropology (Werland 2009, Singer and Giessen 2017).

EVOLVING APPROACHES TOWARD GLOBAL FOREST GOVERNANCE, 1992 TO 2000

With a growing awareness of the complexity of the issues surrounding forests, there was also a consensus that both the private and public sectors were poorly equipped with the information needed for decision making. As early as 1981, John had co-authored a paper with FAO, for the 17th IUFRO Congress, making a proposal for strengthening global forestry research, including the creation of ". . . a small International Forestry Research Secretariat, the main functions of which might include, for example, keeping scientists in developing countries in touch with what is happening elsewhere in their own field, promoting new research concepts and following up on what is being done to realign national research programs closer to perceived needs. . . ." (World Bank and FAO 1981: 24). The proposal had circulated widely through the organizations of IUFRO, and the idea received wide support, but an institutional 'home' for such an initiative wasn't immediately obvious.

---

[6] The impact and effectiveness of the World Bank's environmental and social safeguards policies can be argued elsewhere. Nonetheless, the Bank was the first multilateral development agency to put in place both a full set of safeguards, as well as the oversight mechanism to deal with harm from World Bank-financed interventions through its independent Inspection Panel.

[7] It is an irony that the push by civil society organizations for the Bank to adopt a forestry safeguard belied the actual negative impact of Bank operations on forests. The vast majority of complaints against Bank operations filed with the Inspection Panel since its creation in 1993 have been triggered by other safeguard policies, and not by the forestry safeguard.

After his retirement from the Bank, John was looking for an opportunity to move the forest research agenda forward. In this role, he began providing advisory services to the Secretariat of the Consultative Group on International Agricultural Research (CGIAR) – the global network of international agricultural research centres dealing with specific research areas such as wheat and maize improvement, rice, potatoes, food policy, and dryland agriculture, and others.[8] The CGIAR was considering expansion to include several global natural resource research centres, including one working on forest research and one working on agroforestry research. John, working closely with the newly appointed forestry members of the Technical Advisory Committee (TAC) of the CGIAR, and considering the ultimate goals of the CGIAR related to poverty alleviation in the context of food security, recommended establishment of an integrated agroforestry-forestry centre with strong regional nodes. While he convinced the TAC of the logistical and technical logic of the integrated centre model, the CGIAR Members decided, mainly for political reasons, in favour of two distinct centres for forestry and agroforestry, the Centre for International Forestry Research (CIFOR) and the International Council for Research in Agroforestry (ICRAF – now the World Agroforestry Centre). ICRAF was incorporated into the CG system in 1991 and CIFOR was established as a new centre of the CG in 1993. [9]

Under preparation for a number of years, the 1992 United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil resulted in three primary outcomes. Its principal outcome was the Rio Declaration on Environment and Development, a short statement signed by 175 UN member states comprised of 27 principles. Agenda 21, the second outcome, was a nonbinding but more detailed and extensive action plan, outlining how the Rio Declaration would be implemented. Finally, the so-called Forest Principles, formally known as the more descriptive "Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of all types of Forests," comprised the third Rio outcome (United Nations 1992). It represented a historical milestone in the global forestry debate by providing, for the first time, a common basis for commitment and action at international, regional and national levels to manage forests sustainably. Two conventions on climate change and biodiversity (UNFCCC, CBD)[10] were opened for signature at Rio as well, and the process of putting in place a desertification convention (UNCCD)[11] was launched as an outcome of Agenda 21, with forests accorded looming global importance in each of these three conventions.

During preparations for Rio, no fewer than 9 proposals were tabled for a legally-binding forests convention, but a coalition of developing countries (including Brazil, the host country) opposed these because of the view that it would be an infringement of national sovereignty. The follow-up to the Rio Summit was the charge of the Commission on Sustainable Development (CSD), established under the UN Economic and Social Council, which in turn established the Intergovernmental Panel on Forests (IPF) in 1995, and in 1997, its successor Intergovernmental Forum on Forests (IFF) and these collectively produced more than 280 proposals to enhance the "management, conservation and sustainable development of all types of forests" (Rayner *et al.* 2010). But the development of a forests convention remained elusive.

Shortly after the Rio Conference concluded and before the CSD had begun its work in earnest, anticipating the long and laborious process of reaching a consensus about the way forward and the need for what Norman Myers called 'a fresh policy approach toward forests' (Myers 1995), a group of eminent persons, including scientists, policy makers, academics, retired politicians, and civil society activists proposed the establishment of an independent commission, to generate a clearer consensus for, among other things, the prospect for a forests convention, as well as about the more general approach which should be taken toward the world's forests. The proposal was taken up by InterAction Council of Former Heads of State and Government, and in 1995, it invited the group to establish the World Commission on Forests and Sustainable Development (WCFSD). John Spears was appointed its Secretary-General.

John's role in the Commission was to be the catalyst to move it forward. But it is clear from discussions with those who worked with him during that time, that he also provided a great deal of intellectual leadership for it. The Commission itself was composed of a wide range of environmental and political luminaries from the north and south, whom John had crossed paths (or swords) with earlier in his career at the Bank or at the CGIAR, people like Kamla Chowdry (the former head of the Indian National Wastelands Development Board), George Woodwell (cofounder of the Environmental Defence Fund, and one of the first scientists to sound the alarm on climate change), Nikolay N. Vorontsov (the Soviet scientist and head of the USSR State Committee for Nature Protection), M.S. Swaminathan (the plant geneticist and "Father of the Green Revolution in India"), Jose Goldemberg (Brazil's Secretary of Environment during the Rio Summit), Yolanda Kakabadze (the founder of Fundación Natura in Ecuador, NGO liaison at the Rio Summit and later the President of the IUCN) and others. It was a roster of environmental advocates and collaborators never assembled before to foster this type of process, and its work moved ahead reflecting the urgency they all shared.

---

[8] The CG was first proposed by the Rockefeller Foundation in 1970, was established in 1971, and was originally supported by the World Bank, FAO, and UNDP. It currently constitutes a global network of 15 agricultural research centers.

[9] It should be noted that, more than two decades after Spears' recommendation to the TAC that it should support an integrated forestry and agroforestry research centre, ICRAF and CIFOR were merged under a common governance framework in 2019.

[10] The UN Framework Convention on Climate Change and the Convention on Biodiversity.

[11] The UN Convention to Combat Desertification.

Over the next several years, the WCFSD held extensive hearings and consultations with a diverse group of stakeholders, giving its report what some described as a distinct radical edge, "as an attempt to offer an alternative worldview to neoliberalism" (Humphreys 2006:58). In an analysis of the Commission's final report, *Our Forests, Our Future* (WCFSD 1999), Humphreys suggested that some of the more radical ideas were filtered out of the report, including language critical of business, such as mentions of boycotts and "coercive measures" (2006:60). For his part, Norman Myers acknowledged it was "a fine book," and went far in recommending "radical reform, a new political agenda, greater civil society involvement, and more science in policy making," but also suggested that, "it could have been more adventurous" (Myers 1999).

Ultimately, the WCFSD remained agnostic about the prospect for a forests convention. The Commission concluded that:

- ". . . there is little basis for confidence in the prospects for a forest convention being implemented because of the lack of political will;
- enshrining commitments in a legally binding convention is no guarantee that those commitments will be carried out;
- there exist several international conventions which await implementation. When implemented, they would go a long ways towards dealing with the objective of sustaining forests." (WCFSD 1999: 27)

While the WCFSD was obviously a one-off non-governmental initiative undertaken by a group of eminent people in their personal capacity, meant to provide recommendations to reflect the circumstances at the time, some observers have suggested that it ultimately failed because it operated outside the channel of normal and continuing international processes. It was also dogged by perceived competition with the Intergovernmental Panel on Forests (1995–1997) and its successor the Intergovernmental Forum on Forests (1997–2000) which, some observers have argued, benefited from broader intergovernmental representation and therefore legitimacy (*e.g.*, Humphreys 2006:65). Indeed, these processes carried on long after the WCFSD wrapped up its work with publication of its final report in 1999. The Intergovernmental Forum on Forests, for example, was succeeded by the establishment of the United Nations Forum on Forests in 2000 which continues to provide a platform for addressing issues of global concern about forests.

Yet the Commission's legacy lies elsewhere. Perhaps above all, the report of the Commission placed a major emphasis on the role of forests in community livelihoods and poverty alleviation. After a generic first recommendation on the imperative of arresting the decline of forests, the second of the Commission's 10 recommendations highlighted the urgent need to ". . . use the world's rich forest resources to improve life for poor people and for the benefit of forest-dependent communities" as a priority, an idea which had been a consistent theme in John Spears' work since helping to draft similar language 20 years before which appeared in the 1978 World Bank Forest Sector Paper. By the late 1990s, in many respects this was no longer considered an innovative idea, but seemed more like the conventional wisdom, and it happened to sit well with the efforts of the United Nations which had already launched the process of designing the Millennium Development Goals, the first of which would be to eradicate extreme poverty and hunger.

Back at the World Bank, with respect to forestry, the institution had entered a challenging period. Its revised forestry policy, introduced in 1993, supported widely-shared and by then increasingly familiar aspirations ". . . to reduce deforestation, to enhance the environmental contribution of forested areas, to promote afforestation, reduce poverty and encourage economic development." It banned support for the purchase of logging equipment in primary tropical moist[12] as well as support for 'commercial logging operations.' At the same time, it conditioned forestry lending on borrower government commitment to undertake sustainable management and conservation-oriented forestry. The goals were in many respects contradictory – on the one hand, supporting 'sustainable forest management' (SFM) while on the other, limiting any support for any activities which could be construed as support for commercial logging. Of course, sustainable forest management depends critically on an economically viable business model which in turn depends on a market for timber and for commercial logging to deliver it, and so these two goals were highly incompatible. Lele *et al.* (2001) subsequently noted that the revised policy had a 'chilling effect' on the Bank's forests portfolio. "Direct forest lending (for mainstream activities of forest ministries and departments) has stagnated. . . . Nearly two-thirds of it is concentrated in China and India (and). . . Forest lending has plunged in Africa, where the need for forest assistance is greatest and where the poor are overwhelmingly dependent on forest products and services" (Lele *et al.* 2001:44).

Both inside and outside the Bank, there was frustration that the private sector should be seen to be a critical partner in supporting sustainable forest management, rather than as an agent of tropical forest destruction. The WCFSD also made the observation that greater private capital flows, which were increasingly outstripping sectoral public investments and development assistance for forests, could have a profound effect on strengthening sustainable forest management if ways could be found to mobilize and direct this investment constructively. It explicitly supported measures to expand programs of forest certification (which are meant to independently verify that timber is being harvested from forests which are being managed to meet standards of sustainable forest management), and proposed establishing codes of conduct for the industry, with clear penalties for non-compliance (WCFSD 1999: 22).

[12] This condition mostly affected the International Finance Corporation, the private sector oriented part of the World Bank Group. This type of investment had never figured significantly in the IDA/IBRD portfolio.

The call for greater engagement with the private sector was being echoed in other quarters beyond the WCFSD. The World Wildlife Fund, for example, entered into a partnership with the World Bank to promote more constructive private sector engagement in sustainable forest management. The so-called "World Bank/WWF Alliance for Forest Conservation and Sustainable Use," led the Bank's then president, James Wolfensohn, to convene a group of CEOs from the forest industry and NGOs in January 1998 to discuss some of the key and contentious issues. A follow-up working group called for a broader dialogue to develop a shared vision among governments, the forest industry, NGOs and private forest owners around sustainable forestry (TFD 2020). Strictures on Bank lending for forests were eventually lifted in 2002, but were conditioned on support for independent third party certification of sustainable forest management.

After the Commission's work wrapped up, John turned his attention increasingly to the problem of the private sector, and how it could be more proactively engaged in supporting sustainable forest management. He carried out some advisory work for the International Finance Corporation (IFC), but also helped launch, with the support of the Program on Forests (PROFOR) (an initiative housed within the World Bank to generate forest-related policy analysis), a series of Forest Investment Fora, which had the objective of involving the private sector in a sustained discussion about social and environmental sustainability in the forests sector. At one level, without the broader platform afforded by the WCFSD or by the Bank, John had neither the visibility nor official entrée to move this agenda forward. At the same time, he continued to work in his low-key and collaborative way, supporting others who were able to do this both in the public and private sectors.

We turn now to some of the processes which followed John's tenure with the World Bank, the CGIAR, and the WCFSD. We don't consider these his specific 'legacies' *per se*, but are rather a reflection of how some of the earlier themes championed by Spears and other formative thinkers and policy makers have been mainstreamed into the global debate about the future of the world's forests.

THE FRAMEWORK FOR GLOBAL FOREST GOVERNANCE SINCE 2000

How has the global forest governance framework changed since 2000? In a way, the implicit weakness of the WCFSD – despite its effectiveness as a non-governmental organization in engaging a broad range of stakeholders – rested in its perceived lack of legitimacy as a permanent intergovernmental consultative organization. The need for this type of body was evident during UNCED, as well as in its aftermath which saw the creation of the IPF and the IFF, which were both temporary bodies. A more permanent institutional architecture for global forest governance, broadly defined, was bolstered by the establishment, in 2000, of the United Nations Forum on Forests (UNFF), with the aim to promote "the management, conservation and sustainable development of all types of forests and to strengthen long-term political commitment to this end" (ECOSOC 2000:64). Arguably, the UNFF benefits from legitimacy conferred by its universal membership (197 members in 2020, more than the United Nations General Assembly itself) and its mandate as the sole intergovernmental policy forum on forests.

The UNFF is further strengthened by the Collaborative Partnership on Forests (CPF), an interagency body composed of 15 of the main international organisations with significant programmes on forests[13] whose aim, among others, is to support the UNFF and to support countries in their efforts to implement sustainable forest management. Depending on their specific mandates and strategies, their programmes include measures to improve forest management; to strengthen the conservation of forest biodiversity; to reduce deforestation; to enhance global forest cover; and to improve legality in the forests sector by curtailing illegal logging. Globally focused activities in this regard include:

- improving forest governance, and forest policy, legal and institutional frameworks;
- supporting Forest Law Enforcement, Governance and Trade (FLEGT) initiatives and linking these to climate-related programs;
- helping countries comply with environmental and social safeguards;
- integrating the sustainable management of forests more fully into development decisions;
- providing new knowledge, technology, and capacity for collaboration across sectors for renewed impact;
- promoting trade from legally harvested sources through timber tracking systems;
- enhancing the capacity of small and medium size enterprises to produce and trade in timber from legal and sustainable sources; and
- promoting principles of good governance enshrined in the rule of law, including rights-based and participatory approaches, as well as gender-sensitive policies, legislation and capacity development.

Beyond the CPF, many international non-government organisations, research institutions, non-profit organizations, and allied bodies have been active in addressing similar

[13] Member organizations of the CPF are: the Center for International Forestry Research (CIFOR); Convention on Biological Diversity (CBD) Secretariat; Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Secretariat; Food and Agriculture Organization of the United Nations (FAO); Global Environment Facility (GEF) Secretariat; International Tropical Timber Organization (ITTO); International Union for Conservation of Nature (IUCN); International Union of Forest Research Organizations (IUFRO); United Nations Convention to Combat Desertification (UNCCD) Secretariat; United Nations Development Programme (UNDP); United Nations Environment Programme (UNEP); United Nations Forum on Forests (UNFF) Secretariat; United Nations Framework Convention on Climate Change (UNFCCC) Secretariat; World Agroforestry Centre (ICRAF); and The World Bank.

issues and implementing complimentary activities including compiling and publishing national and global data on deforestation and illegal activities; advocacy and raising public awareness; developing safeguards; communication and capacity building; and project implementation. Many of these organizations share a strong emphasis on both generating and using the best available scientific data, knowledge and expertise, and as a result are highly influential amongst development assistance organizations.

Among the UNFF's successes since its inception was the 2007 adoption by the United Nations General Assembly of the "Non-Legally Binding Agreement on All Types of Forests," the world's first international agreement on forests. Among other objectives, it aimed to "enhance the contribution of forests to the internationally agreed development goals." These of course were the 8 Millennium Development Goals, adopted by the United Nations Development System in 2000 (United Nations 2000) and which placed the "eradication of poverty and extreme hunger" at the top of its priorities. Goal 7 prioritized ensuring environmental sustainability, which remained a stand-alone goal (though forests were not explicitly mentioned.)

The Non-Legally Binding Agreement was updated in 2015 and renamed the United Nations Forest Instrument (United Nations 2015a). It is seen to be an important complement to the 2030 Agenda for Sustainable Development and its backbone, the 17 Sustainable Development Goals (SDGs) and their associated targets (United Nations 2015b). Forests are explicitly mentioned in Goal 6 (clean water and sanitation) and in Goal 15 (life on land), but could arguably be seen to be contributing directly or indirectly to implementing each of the 17 goals.

The second major achievement of the UNFF has been the 2017 adoption of the United Nations Strategic Plan for Forests (UNSPF), an ambitious UN-wide plan to implement sustainable forest management centred on 6 global forest goals (Text Box 1) which echo some of the themes captured, for example, in the WCFSD's findings (United Nations 2017). The UNSPF is even clearer in its relationship with the 2030 Agenda for Sustainable Development than the Forest Instrument was with the Millennium Development Goals since it explicitly "provides a framework for forest-related contributions to the implementation of the 2030 Agenda for Sustainable Development."

We turn now to a reflection on how the early views of John Spears and other forward thinkers like him are playing out, in ensuring that poverty alleviation objectives are incorporated into actions to improve the management and conservation of forests and trees.

THE CHALLENGE OF ACTING ON WHAT WE KNOW. GLOBAL FOREST GOVERNANCE AND MEASURES FOR ALLEVIATING POVERTY

The 2030 Agenda for Sustainable Development and the expected contribution of forests and trees to meeting the SDGs reflect a significant evolution in an understanding of the link between the poverty alleviation objectives, the plight of the rural poor, and better management of forests and trees. When these links were first posited by John Spears and others in the mid-1970s, they were often directly associated with the dominant uses for wood and wood products, especially woodfuel. An understanding of the role of forests and trees in the rural economy has increased phenomenally since then, as a result of on-the-ground experience in delivering on these objectives, as well as of a growing body of research into the links between poverty and the environment.[14]

Box 1 Global Forest Goals described in the UN Strategic Plan for Forests

Goal 1. Reverse the loss of forest cover worldwide through SFM, including protection, restoration, afforestation and reforestation, and increase efforts to prevent forest degradation and contribute to the global effort of addressing climate change.

Goal 2. Enhance forest-based economic, social and environmental benefits, including by improving the livelihoods of forest dependent people.

Goal 3. Increase significantly the area of protected forests worldwide and other areas of sustainably managed forests, as well as the proportion of forest products from sustainably managed forests.

Goal 4. Mobilize significantly increased, new and additional financial resources from all sources for the implementation of SFM and strengthen scientific and technical cooperation and partnerships.

Goal 5. Promote governance frameworks to implement SFM, including through the UN Forest Instrument, and enhance the contribution of forests to the 2030 Agenda.

Goal 6. Enhance cooperation, coordination, coherence and synergies on forest-related issues at all levels, including within the UN System and across CPF member organizations, as well as across sectors and relevant stakeholders.

[14] We note particularly the work of researchers at CIFOR whose Poverty-Environment Network studies generated a wealth of enormously useful information about these linkages. Amongst the 8000 or so households studied, fully 28 percent of household income was derived from environmental sources, and 77 percent was coming from forests. Environmental income shares were higher for the poorest households, but households in the highest income quintile had absolute environmental and forest incomes that were about five times higher than the two bottom quintiles. These studies suggest that there are important local benefits from maintaining forest cover and that the potential for both climate mitigation and livelihood benefits might be larger than often assumed (Angelsen *et al.* 2014, Wunder *et al.* 2014).

To what extent have poverty alleviation objectives been incorporated into the body of development measures which are supporting the conservation and management of forests and trees? The record is mixed. On the one hand, it is certainly the case that governments and development agencies continue to articulate an interest in the contribution of forests to reducing poverty in developing countries by addressing land and tree tenure issues, and supporting community forestry, indigenous rights and agroforestry. Environmental and social safeguards – first introduced by the World Bank in 1985 – have now become commonplace (though their effectiveness can be debated). Most if not all global forest conservation and management initiatives include specific safeguards meant to directly or indirectly promote the role of forests in reducing poverty and/or improving livelihoods. REDD+ safeguards[15], for instance, include (i) respect for the knowledge and rights of indigenous peoples and members of local communities, (ii) the full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities, and (iii) the need for sustainable livelihoods of indigenous peoples and local communities and their interdependence on forests, all of which illustrate the link between forests and the rural poor.

On the other hand, the emerging *focus* of global forest governance measures has fundamentally been elsewhere. REDD+ for example, and its association with measures to limit climate change from forest loss and degradation, has occupied a considerable space in the forest-related policy agenda (Singer 2012, Singer and Giessen 2017). The underlying rationale for REDD+ – that forests constitute a cost-effective way of mitigating climate change – is powerful and compelling. Yet the focus on the forest-climate nexus has primarily been on global benefits, causing concern that the contribution of forests and trees to poverty alleviation at the local level would not only be side-lined, but that trade-offs between carbon storage and benefits to rural households and local communities would be to the detriment of the poor (*e.g.*, Chhatre and Agrawal 2009, Oldekop *et al.* 2019). REDD+ implementation has yet to translate into improving tenure security, while forest dwellers, notably indigenous populations, continue to be largely excluded from decision-making (Sunderlin *et al.* 2018:93).

Likewise, one of the original ideas for REDD+ (and for a range of other forest conservation initiatives) was that local forest owners and users would be compensated by payments for ecosystem services, specifically for the foregone agricultural rent from not converting forest land to crops or pasture (Angelsen *et al.* 2018:52). Yet, even as a number of countries have graduated to Phase III of REDD+ and a handful have actually begun receiving results-based payments, the question of whether local communities should benefit at all remains.

So while the relationship of forests and trees to poverty alleviation remains at the centre of global forest governance agreements articulated through, for example, the UNSPF, the means for delivering more broadly on these objectives at the household level remains challenging. It is not as if poverty is expected to somehow disappeared, and forests and trees will no longer be providing a critical safety net for poor rural households. Indeed, as poor households may be less able to adapt or to rely on alternative sources of income, they stand to suffer disproportionately as their livelihoods are affected by climate change. Droughts, floods, fires and more extreme weather patterns could disrupt harvests for the rural poor who in turn would rely all the more on forests for survival. The accelerating loss of forest and tree cover increases their exposure to these risks. So improving the contribution of forests to alleviating poverty will likely become a matter of survival for millions.

Some initiatives, notably those focused on tree and forest-based adaptation, are beginning to address the ways in which these resources could enhance their role as safety nets for those most affected by climate change. In Côte d'Ivoire, where the cocoa industry has recently been largely responsible for the highest deforestation rates in Africa, cocoa smallholders have found that reduced precipitation, particularly in the eastern half of the country, has affected productivity. A consortium of international organisations, including the UN-REDD Programme, the EU-REDD Facility and the UNFF Secretariat have responded by designing sustainable agroforestry models which would not only reverse current deforestation trends but which would also enhance food security and diversify and increase smallholder income, thus reducing poverty (EU-REDD 2019).

Agroforestry is by no means a new farming practice. Governments and aid agencies are in many respects latecomers in supporting the fuller integration of trees into farming systems. In fact agroforestry is one of the oldest, and certainly most successful, forms of integrated agro-ecological landscape management. Agroforests, defined as agricultural land with more than 10 percent tree cover, cover more than 1 billion hectares of land, and support more than 900 million people, or 30 percent of the world's rural population (Zomer *et al.* 2014). As primary forests continue to recede in the face of growing human populations, agroforestry is poised to become an increasingly common win-win solution for both forest cover on one hand and food security, livelihoods and poverty reduction on the other and has emerged as a robust means for tackling the loss of environmental services at the household level.

More generally, interest in forest landscape restoration (FLR), which has also been around for several decades, is currently witnessing a comeback. FLR is most commonly understood as the process of regaining ecological functionality and enhancing human well-being across degraded and deforested large-scale areas comprising overlapping ecological, social and economic activities and values (FAO and

[15] These were the seven safeguards, also known as the "Cancun safeguards", which were agreed at the 16th Conference of the Parties to the UNFCCC in 2010.

UNECE 2019:3). Promoted by a handful of organisations such as the World Conservation Union (IUCN) and UNEP in the early 2010s, it grew considerably in popularity with the Bonn Challenge, an ambitious global goal initiated in 2011 to bring 350 million hectares of deforested and degraded land into restoration by 2030 (IUCN 2019).

Since then, the Bonn Challenge has been emulated at regional levels with the creation of Initiative 20x20 in Latin America and the Caribbean, aimed at restoring 20 million hectares of forested landscapes by 2020; AFR100, aimed at restoring 100 million hectares in Africa by 2030; and most recently ECCA 30, adopted in 2019 with the aim to restore 30 million hectares in Europe, the Caucasus and Central Asia (UNECE 2019). As of December 2019, over 172 million hectares of land had been pledged for FLR by 62 contributors (FAO and UNECE 2019:2), exceeding the interim goal of 150 million hectares set by the Bonn Challenge for 2020, while 43.7 million hectares were already undergoing FLR (Dave *et al.* 2018:vii).

In 2018, the Global Environment Facility even dedicated one of the three impact programmes to the restoration of degraded landscapes among other issues, signalling a strong interest in financing such activities (Global Environment Facility 2018:76). Large-scale and even country-wide initiatives have also been witnessed such as in China, Ethiopia and Rwanda. With the creation of the United Nations Decade on Ecosystem Restoration for the period 2021 to 2030 by the United Nations General Assembly (United Nations 2019), FLR is likely to continue growing in popularity.

One of the specificities of FLR is its inclusion of social aspects of landscape management and concern for agricultural practices, livelihoods and food security. In this respect it aims to integrate sustainable natural resource management and the well-being of rural communities, including poverty alleviation. One of the earliest examples of FLR, the restoration of China's Loess Plateau by the World Bank in the 1990s, is believed to have lifted more than 2.5 million people out of poverty (World Bank 2007).

These trends are promising indications that poverty reduction could once again become the focus of global forest governance in the future. It would certainly be consistent with the stage set by the United Nations Strategic Plan for Forests and the 2030 Agenda for Sustainable Development at large, where the "zero poverty" goal still stands first and foremost. As the international community continues to struggle to work in an integrated manner under the umbrella of the 2030 Agenda, it is time once again to take heed of the approach of forward thinkers like John Spears and ensure that forests become a genuine building block of the global agenda to eradicate poverty and implement sustainable development at large.

ACKNOWLEDGEMENTS

The authors would like to recognize the helpful observations on an earlier draft elicited through the peer review process, which resulted in a substantial revision.

REFERENCES

ANGELSEN, A., JAGGER, P., BABIGUMIRA, R., BELCHER, B., HOGARTH, N.J., BAUCH, S., BÖRNER, J., SMITH-HALL, C. and WUNDER, S. 2014. Environmental income and rural livelihoods: a global-comparative analysis. *World Development* **64**: S12–S18.

ANGELSEN, A., HERMANSEN, E.A.T., RAJÃO, R. and VAN DER HOFF, R. 2018. Results-based payment: Who should be paid, and for what? *In* ANGELSEN, A., MARTIUS, C., DE SY, V., DUCHELLE, A.E., LARSON, A.M. and THUY, P.T. (*eds*), *Transforming REDD+: Lessons and New Directions.* Bogor, Indonesia: CIFOR, pp. 41–54.

BOWLES, I.A. and KORMOS, C.F. 1995. Environmental reform at the World Bank: The role of the U.S. Congress. *Virginia Journal of International Law* **35**(4): 777–840.

BYRON, R.N., and SAYER, J.A. 2020. The past, present and future of tropical forests – the Spears legacy. *International Forestry Review* **22**(2).

CHHATRE, A. and AGRAWAL, A. 2009. Trade-offs and synergies between carbon storage and livelihood benefits from forest commons. *Proceedings of the National Academy of Sciences of the United States of America* **106**(42): 17667–17670.

DAVE, R., SAINT-LAURENT, C. MURRAY, L., ANTUNES DALDEGAN, G., BROUWER, R., DE MATTOS SCARAMUZZA, C.A., RAES, L., SIMONIT, S., CATAPAN, M., GARCÍA CONTRERAS, G., NDOLI, A., KARANGWA, C., PERERA, N., HINGORANI, S. and PEARSON, T. 2018. Second Bonn Challenge progress report Application of the Barometer in 2018. Gland: IUCN, 96 pp.

DEWEES, P.A., KISHOR, N., and IVERS, L. 2020. John Spears, A life in forestry: An introduction to the special issue. *International Forestry Review* **22**(2): 1–8.

ECOSOC. 2000. Report of the Fourth Session of the Intergovernmental Forum on Forests. ECOSOC Resolution 2000/35 available at https://www.un.org/esa/forests/wp-content/uploads/2013/09/2000_35_E.pdf (accessed 14 December 2019).

EU-REDD. 2019. Partenariat 1 pour 20: mobiliser un milliard de dollars de financements pour restaurer 20% du couvert forestier ivoirien. EFI Policy brief. Barcelona, Spain: European Forestry Institute, 4 pp. Available at http://www.euredd.efi.int/documents/15552/431687/1+pour+20+FR.pdf/58b53b10-e2ad-55df-c6da-704ae1338c70 (accessed 21 December 2019).

FAO. 1966. Sixth World Forestry Congress. *Unasylva* 82. Article available at www.fao.org/3/44279e/44279e01.htm (accessed 15 December 2019).

FAO. 1972. Seventh World Forestry Congress: Declaration. *Unasylva* **25**(104). Available at http://www.fao.org/3/d4956e/d4956e01.htm (accessed 15 December 2019).

FAO. 1986. FAO's Tropical Forestry Action Plan. Unasylva Vol. 38. http://www.fao.org/3/r7750e/r7750e06.htm#fao's%20tropical%20forestry%20%20%20action%20plan (accessed March 6, 2019).

FAO and UNECE. 2019. Forest landscape restoration and the Bonn Challenge in Eastern and South-East Europe: Background paper. Geneva, Switzerland: United Nations Economic Commission for Europe, 4 pp.

GLOBAL ENVIRONMENT FACILITY. 2018. GEF-7 replenishment programming directions (prepared by the Secretariat). Document GEF/R.7/19 for the Fourth meeting for the seventh replenishment of the GEF Trust Fund. Washington, D.C.: Global Environment Facility, 155 pp.

HUMPHREYS, D. 2006. *Logjam: Deforestation and the Crisis of Global Forest Governance*. London: Earthscan, 302 pp.

IUCN. 2019. Forest landscape restoration pathways to achieving the SDGs. IUCN policy brief. Gland, Switzerland: IUCN, 12 pp.

KOLK, A. 1996. *Forests in International Environmental Politics: International Organisations, NGOs and the Brazilian Amazon.* Utrecht, the Netherlands: International Books, 336 pp.

LELE, U., KUMAR, N., HUSAIN, S.A. and ZAZUETA, A. 2000. *The World Bank forest strategy. Striking the right balance*. Operations Evaluation Department, Washington, D.C., World Bank.

LELE, U., LJUNGMAN, L., KISHOR, N., DEWEES, P., ROWE, C., ROBERTS, R., EL LAKANY, H. and GREGERSEN, H. 2019. Obituary, John Spears. *International Forestry Review* **21**(1): 128-129.

MCNAMARA, R.S. 1979. McNamara on population growth: The 1980s and beyond. *Population and Development Review* **5**(4): 736–739.

MYERS, N. 1995. The world's forests: Need for a policy appraisal. *Science* **268**(5212): 823–824.

MYERS, N. 1999. Everyday extinctions in embattled forests. *Nature* **400**: 231–232.

OLDEKOP, J.A., SIMS, K.R.E., KARNA, B.K., WHITTINGHAM, M.J. and AGRAWAL, A. 2019. Reductions in deforestation and poverty from decentralized forest management in Nepal. *Nature Sustainability* **2**: 421–428.

RAYNER, J., BUCK, A', and KATILA, P. 2010. Embracing complexity: Meeting the challenges of international forest governance. A global assessment report. Prepared by the Global Forest Expert Panel on the International Forest Regime. IUFRO World Series Volume 28. Vienna. 172 p.

REPETTO, R. (ed.) 1985. The global possible. Binghamton, World Resources Institute and Yale University Press.

SHIHATA, I.F. 1992. The World Bank and the environment: A legal perspective. *Maryland Journal of International Law* **16**(1): 1–42.

SINGER, B. 2012. *Putting the National Back into Forest-Related Policies: The International Forests Regime and National Policies in Brazil and Indonesia*. Saarbrücken, Germany: Editions Universitaires Européennes, 440 pp.

SINGER, B. and GIESSEN, L. 2017. Towards a donut regime? Domestic actors, climatization, and the hollowing-out of the international forests regime in the Anthropocene. *Forest Policy and Economics* **79**: 69–79.

SPEARS, J. and AYENSU, E. 1985. Resources, development, and the new century: forestry. In, Repetto, R. (ed.) The global possible. World Resources Institute. pp. 299–335.

SUNDERLIN, W.D., LARSON, A.M. and SARMIENTO BARLETTI, J.P. 2018. Land and carbon tenure: Some – but insufficient – progress. *In* ANGELSEN, A., MARTIUS, C., DE SY, V., DUCHELLE, A.E., LARSON, A.M. and THUY, P.T. (*eds*), *Transforming REDD+: Lessons and New Directions.* Bogor, Indonesia: CIFOR, pp. 93–104.

TFD. 2020. If trees could talk: 20 years of The Forests Dialogue. New Haven: The Forests Dialogue.

UNECE. 2019. New call to bring 30 million hectares of degraded and deforested landscapes into restoration in Europe, the Caucasus and Central Asia by 2030. UNECE press release available at http://www.unece.org/info/media/presscurrent-press-h/forestry-and-timber/2019/new-call-to-bring-30-million-hectares-of-degraded-and-deforested-landscapes-into-restoration-in-europe-the-caucasus-and-central-asia-by-2030/doc.html (accessed 21 December 2019).

UNITED NATIONS. 1992. Statement of Forest Principles. Report of the United Nations Conference on Environment and Development. A/CONF.151/26 Volume III. New York: United Nations, 19 pp.

UNITED NATIONS. 2000. United Nations Millennium Declaration. United Nations General Assembly resolution 55/2. New York, USA: United Nations, 9 pp.

UNITED NATIONS. 2014. Report of the Intergovernmental Committee of Experts on Sustainable Development Financing. United Nations General Assembly resolution 69/315. New York, USA: United Nations, 54 pp.

UNITED NATIONS. 2015a. United Nations Forest Instrument. United Nations General Assembly resolution 70/199. Available at https://undocs.org/en/A/RES/70/199 (accessed 8 December 2019).

UNITED NATIONS. 2015b. Transforming our world: the 2030 Agenda for Sustainable Development. General Assembly resolution 70/1. New York: United Nations, 35 pp.

UNITED NATIONS. 2017. United Nations strategic plan for forests 2017–2030. United Nations General Assembly resolution 71/285. Available at https://documents-dds-ny.un.org/doc/UNDOC/GEN/N17/115/46/PDF/N1711546.pdf?OpenElement (accessed 8 December 2019).

UNITED NATIONS. 2019. United Nations Decade on Ecosystem Restoration (2021–2030). United Nations General Assembly Resolution A/RES/73/284. New York: United Nations, 6 pp.

WADE, R.H. 2011. Boulevard of broken dreams: the inside story of the World Bank's Polonoroeste Road Project in Brazil's Amazon. Grantham Research Institute on Climate Change and the Environment Working Paper No. 55. London.

WCFSD. 1999. *Our Forests, Our Future. Final Report of the World Commission on Forests and Sustainable Development*. Cambridge, UK: Cambridge University Press, 228 pp.

WERLAND, S. 2009. Global forest governance – bringing forestry science (back) in. *Forest Policy and Economics* **11**(5): 446–451.

WESTOBY, J.C. 1962. Forest industries in the attack on economic underdevelopment. *Unasylva* **16**(4).

WORLD BANK. 1978. *Forestry Sector Policy Paper*. Washington, D.C.: World Bank, 65 pp.

WORLD BANK and FAO. 1981. Forestry research needs in developing countries – a time for reappraisal? Paper prepared for the 17th Congress of the International Union of Forestry Research Organization, 6–17 September 1981, Kyoto, Japan.

WORLD BANK. 1991. *Forestry: The World Bank Experience*. Operations Evaluation Department. Washington, D.C. World Bank.

WORLD BANK. 2007. Restoring China's Loess Plateau. Press release. Available at http://worldbank.org/en/news/feature/2007/03/15/restoring-chinas-loess-plateau (accessed 14 December 2019).

WUNDER, S., BÖRNER, J., SHIVELY, G. and WYMAN, M. 2014. Safety nets, gap-filling and forests: a global-comparative perspective. *World Development* **64**: S29–S42.

ZOMER R.J., TRABUCCO A., COE R., PLACE F., VAN NOORDWIJK, M. and XU, J.C. 2014. Trees on farms: an update and reanalysis of agroforestry's global extent and socio-ecological characteristics. Working Paper 179. Bogor, Indonesia: *World Agroforestry Centre (ICRAF).*