ASSESSMENT OF FOREST LANDSCAPE RESTORATION OPPORTUNITIES IN GHANA

Final Report

SEPTEMBER 2011

WORLD RESOURCES INSTITUTE

List of Acronyms

CBO	Community Based Organization
CERSGIS	Centre for Remote Sensing and Geographic Information Services
CREMA	Community Resource Management Areas
DBH	Diameter at Breast Height/Base Diameter
EI	Economic Index
EU	European Union
FC	Forestry Commission
FLEGT	Forest Law Enforcement, Governance and Trade
FORIG	Forestry Research Institute of Ghana
FSD	Forest Services Division
GHI	Genetic Heat Index
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HFZ	High Forest Zone
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
MTS	Modified Taungya System
NCRC	Nature Conservation Research Centre
NGO	Non Governmental Organization
N-REG	Natural Resources and Environmental Governance
PI	Pioneer Index
PROFOR	Program on Forests
REDD	Reducing Emissions from Deforestation and Forest Degradation
RMSC	Resource Management Support Center of the Forestry Commission
SDSU	South Dakota State University
TZ	Transition Zone
UNFCCC	United Nations Framework Convention on Climate Change
UNESCO	United Nations Educational, Scientific and Cultural Organization
WD	Wildlife Division of the Forestry Commission
WRI	World Resources Institute

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1. Introduction

The importance of forest landscape restoration in addressing climate change and other societal needs was brought home in November 2009 when the Global Partnership on Forest Landscape Restoration (GPFLR) concluded that more than 1 billion hectares of lost forests and degraded lands worldwide present restoration opportunities that could sequester significant amounts of carbon. The large magnitude of the estimate suggests that ongoing restoration efforts are insufficient and not at scale. They are not consistent with the opportunities, not to mention the need. This suggests that restoration is an overlooked opportunity for improving the lives of rural people in degraded landscapes and for enhancing carbon stocks and resilience to climate change.

While the global assessment suggested that huge areas provide opportunities for restoration, it also had important limitations. It was coarse, building exclusively on global datasets. It was made without consultation with stakeholders, again due to its global scope. To overcome these limitations, more refined assessments at the national scale are needed.

No methodology for national level restoration opportunity assessments exists, however. A methodology for national level assessment therefore needs to be developed and tested. Ghana volunteered to provide a "laboratory" in which such a methodology could be developed and PROFOR agreed to support this initiative. Later, the German International Climate Initiative has also decided to provide follow-up support.

This report presents the first results of PROFOR supported project to develop and apply a methodology for assessing restoration opportunities in Ghana and their potential contribution to REDD-plus strategies for climate change mitigation, poverty alleviation and sustainable forest management.

The report presents a methodology for restoration opportunity assessment, using forest reserves as a starting point, and first results of its application to forest reserves. It also reviews the existing context in Ghana with respect to national forest policy, legal and technical framework for forest resource management within the forest sector agencies, and future plans for reform.

2. Approach

2.1 The global assessment method

The global assessment was carried out by posing a sequence of questions and then answering them in terms of maps, using globally consistent datasets. This sequence goes as follows:

A. Set the stage

1. **What is the area of analysis?** Delineate the lands to be examined.

B. What has been lost or degraded?

2. **Where can forests potentially grow?** Map the potential extent of forests and woodlands if the only constraints were climate and soils.
3. **Where are forests growing today?** Map the current extent of forests and woodlands.
4. **Where have forests been lost or degraded?** Contrast the potential with the current extent of forests in light of current land use.

C. What can be restored?

5. **Where are the constraints on restoration?** Map human pressure.
6. **Where are the opportunities for restoration?** Map the areas where human pressure is low enough to provide opportunities for restoration of different types.

D. What are the carbon benefits of restoration?

7. **What are the opportunities for carbon sequestration through restoration?** Assign carbon values to the restoration opportunities.

2.2 An assessment method for Ghana

The global method is not appropriate for a direct application to Ghana.

- A higher spatial resolution is needed. At the same time, there is no need to use global datasets or globally relevant definitions. National datasets can and must be used to the extent possible.
- Richer information is needed. The global method was severely constrained by lack of data on potentially relevant institutional and social factors such as land ownership and conflicts.
- National stakeholders and experts must be engaged. The global method does not include such engagement for feasibility reasons but a national method can and must do so.

A new or modified method must therefore be developed. The following underlying principles for the Ghana assessment were adopted:

1. Stakeholder participation is a key feature of the project and will ensure that the analysis and recommendations are appropriate and credible;
2. Visualization techniques that communicate landscape characteristics to all stakeholders need to be employed;
3. Governmental ownership of the process through the Forestry Commission is needed to ensure that results are incorporated into government programs;
4. The most promising starting point for developing a national restoration opportunity assessment methodology for Ghana is the forest reserves; and
5. The final product should incorporate field validation and verification by major stakeholders.

The methodology developed and applied in Ghana therefore included two major components:

- stakeholder participation from all related sectors, and
- the use of remote sensing tools for the geospatial assessment.

2.3 Constraints

Ghana is not a data-rich country. At the start of the project, Ghana did not have a recent land cover/land use map of sufficient detail, nor was a recent Landsat mosaic available. The technical infrastructure for acquiring and processing data was also a major constraint and remains so.

2.4 Strategy

A strategy was adopted that consists of two parallel and mutually supporting streams of activity:

- A consultation process, and
- A mapping process.

The idea is that the consultation process be informed and constrained by maps, so that it is underpinned by good and realistic information, while the mapping process is informed and inspired by the consultations.

Ghana is a highly diverse country in terms of natural geography (see Appendix I). The different forest zones present very different challenges for the opportunity assessment. While canopy density is a useful criterion of degradation in the high forest zone, it is problematic in the savannah zone where the trees are naturally far apart. Ghana is also diverse in terms of available data and information. The high forest zone is much better known than other zones and forest reserves are much better known than off-reserve lands.

The forest reserves were selected as a spring board for a step-wise process of constructing and applying an assessment method that is applicable across the whole country. There are several seasons for this decision:

- The condition of the forest reserves was described in detail by Hawthorne and Abu-Juam in 1995. This study provides an excellent point of reference. In general, the information about the reserves is much richer than for other areas in Ghana.
- The Ministry for Lands and Natural Resources and the Forestry Commission are very interested in information on the current condition and restoration opportunities of the forest

reserves. There is a concern that they have suffered significant degradation since 1995, although no new condition assessment has been undertaken since then. There is a strong demand for a re-assessment and for a cost-effective method that can be applied regularly at affordable cost for monitoring purposes.

- The immediate opportunities for restoration that would lead to carbon sequestration were deemed to be the greatest in the reserves, given their protected status.

A consultation strategy with several steps was adopted:

1. An initial national consultation
2. Subsequent regional consultations, tentatively four
3. A concluding national workshop, at which the results for the whole country would be presented and discussed.

A multi-step strategy was also adopted for the mapping part of the assessment methodology:

1. Develop and apply a method for assessment/scoring of condition and restoration opportunities in the forest reserves in the high forest zone. The method would use satellite imagery as the main source of information in order to be cost effective and use a scale for scoring of condition that is consistent, if not identical, with the scale used by Hawthorne and Abu-Juam (1995), so that comparisons can be made.
2. Apply this method to off-reserve areas in the high forest zone.
3. Construct condition scoring scales that are appropriate for other ecological zones of Ghana and can be used with satellite imagery.
4. Apply these scales first to reserves and then to off-reserve areas.
5. Construct degradation maps and assess opportunities for restoration.

3. Methodology and Implementation

3.1 National Stakeholders' Workshop:

A national stakeholder workshop was held in Accra on March 22 (a detailed account is given in Appendix II).

The purpose of the workshop was to create a platform for open and objective discussion on the need for forest restoration at landscape scale.

The stake holders were invited from the forestry sector, civil society organizations working in the forestry sector, community based organizations, Development Partners, research institutions, and the Ministry responsible for Forestry.

Break –out sessions were held on the following themes:

- Criteria for degradation scoring of forest areas (reserves)
- Criteria for mapping of sacred groves, mangroves
- Options for restoration of reserved forests, sacred groves and mangroves and their costs, consequences, and constraints
- Restoration issues within off reserve areas

The workshop registered significant interest in restoration from the participants. Nobody disputed that the need and the opportunities for restoration in Ghana are very significant and strong interest in the output of the assessment project was expressed.

3.2 Develop/Review Criteria for Forest Condition Scoring

A scale for scoring vegetation condition and restoration opportunities that can be used together with satellite imagery was developed for the three key ecological zones in Ghana: the high forest zone, the transition zone, and the savannah zone (see Appendix III for details).

It is essential that forest landscape restoration at national scale be preceded by a characterization of vegetation types over the landscape. Furthermore, a landscape approach to restoration also takes

into account the various land uses and ecosystems (forest, savannah, forest-savannah transitional belt, mangrove, etc). A multiple-use landscape is often a mosaic of land use types, in which some parts may be formally protected (e.g. forest reserves) while others are sustainable-use communal areas, private farmland and/or other types of productive use (e.g. off-reserve areas serving as agricultural landscapes).

3.3 Use of visualization Techniques

A coarse restoration opportunity map of Ghana was developed and used during the national workshop (see Appendix II).

Satellite images have been used in this assessment to cost effectively show levels of deforestation and degradation within reserved areas in both the forest and savannah ecological zones. Map outputs from classified satellite images have been used by the institutional stakeholders as field validation tools for preliminary assessment of landscape restoration potential, and possibly used to guide forest investment programs. The maps could be used for preliminary cost computations, as well as advocacy tools for forest landscape restoration at the local and community levels, by depicting in "real world" terms the extent of deforestation and its spatial distribution.

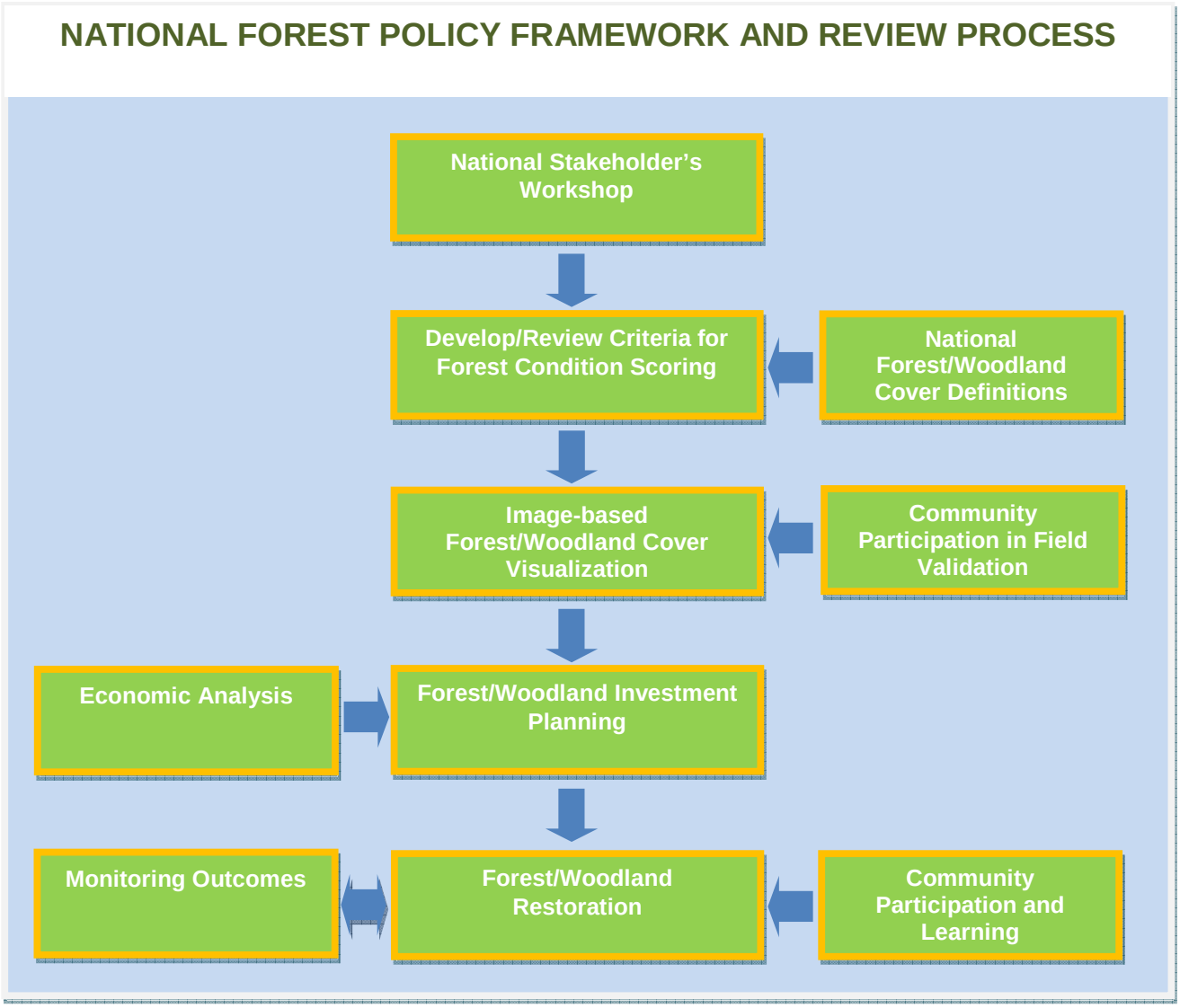
Consensus building is key in any participatory process, thus appropriate tools for facilitating this process should be identified from the onset. Participatory mapping and the use of GIS overlays as negotiation support tools are well tried and tested in rural development at local scales. (Lewis et al 2005, Sheppard, 2006)

3.4 Preliminary costs for FLR Implementation

This phase of the assessment did not perform a detailed economic analysis. Preliminary cost figures could be obtained by applying per unit area costs for implementation options to areas identified in forest/woodland cover maps as potential restoration sites.

Figure1 attempts to represent in the form of a flow chart the different steps that we have used in this assessment for forest landscape restoration.

Figure 1: Methodological Framework



4. Conclusions

4.1 Difficulties

The work has been more difficult than anticipated.

The project has revealed serious shortcomings in the geodata infrastructure of Ghana. Lack of data and processing capacity has turned out to be a significant obstacle that has slowed down progress. The project has created a mosaic of cloud-free Landsat images but this mosaic has limitations, particularly for assessment of the savannah zone, as it does not take seasonal variations into account, and the resolution (30m) is insufficient to identify individual trees. For assessment of the high forest zone, these limitations are less critical.

The common habit of thinking about landscapes from the viewpoint of forests and ecosystems has also been difficult to overcome. Restoration in terms of farmer managed natural regeneration in northern Ghana and agroforestry system has so far received less attention than classical tree planting.

In general, the need for restoration in Ghana is, at the same time, both obvious and overlooked. Little attention is being paid to the opportunities for restoration in relation to the need to stop deforestation and degradation. This balance seems to be inconsistent with the realities on the ground in Ghana, where decades of deforestation and degradation have left huge areas in need of restoration.

4.2 Next steps

The project will continue with the goal of presenting a national map of restoration opportunities and an assessment of the associated opportunities for carbon sequestration.

4.3 Recommendations

Ghana should take immediate measures to improve the availability of geodata, as the current lack of such data is a severe limitation on planning and development far outside the theme of restoration. A mosaic of recent Landsat imagery or similar should be created and made available to organizations and to the public. The web-based interactive atlas of DRC is a good example of something that

could easily be done. Such data, particularly if they are made broadly available, can help substantially in planning of monitoring of REDD plus related activities. Having access to an accurate and detailed geodata platform would also help actors in Ghana implement countless of other projects that depend on good map information.

5. References

1. Annette den Hollander H.J. (2008): Precipitation influence on savannah vegetation: cover, biomass, leaf area index and c3:c4 ratio. ESS-80436, Wageningen UR, The Netherlands. 47pp.
2. C.S.A (1956): Phytogeography. Cons.Scient. Afr. Sud Sahara, Comm. Coop. Tech. Afr Sud Sahara. London.
3. Forestry Commission Compilation Reports: Forest Inventory Project of 1986-1990; Multi-resource inventory program of 2001 and RMSC updated inventory data of 2009.
4. Hall and Swaine (1981): Hall, J.B., Swaine, M.D. 1981. Distribution and vascular plants in a tropical Rain forest (forest vegetation in Ghana). Geobotany1. W. Junk, The Hague. 383 pp.
5. Hawthorne, W.D., Abu-Juam, M. (1995): Forest protection in Ghana. IUCN, Gland, Switzerland.
6. House and Hall (2001): House, Jo I.; Hall, David O., (2001) Productivity of Tropical Savannahs and Grasslands (16), Terrestrial Global Productivity (363-400).
7. Keay, R.W.J. (1949): An example of Sudan zone vegetation in Nigeria.
8. Ntiamoah-Baidu, Y. 2001: Indigenous versus introduced biodiversity conservation strategies: the case of protected areas in Ghana. In Weber, W., White, J.T.L., Vedder, A., Treves, L.N. (eds.): African Rain Forest Ecology and Conservation. Yale Univ. Press, New Haven. pp. 384−394.
9. Scholes and Hall (1996): Scholes, R.J., and Hall, D. O. (1996). The carbon budget of tropical savannahs, woodlands and grasslands. In "Global Change: Effects on Coniferous Forests and Grasslands, SCOPE," (A. I. Breymeyer, D. O. Hall, J. M. Melillo, and G. I. Agren, eds.), Vol. 56, pp. 69-100. Wiley, Chichester.
10. UNESCO (1973): International Classification and Mapping of Vegetation. UNESCO, Paris.
11. White, F. (1983): The vegetation of Africa: a descriptive memoir to accompany the UNESCO/AETFAT/UNSO vegetation map of Africa.
12. World Bank (2007): Ghana Country Environmental Analysis. Report No. 36985-GH: Environment and Natural Resources (AFTERN) Africa Region.

Appendix I. The Forest and Policy Context of Ghana

1. Forests in Ghana

Forests play a crucial role in the socioeconomic wellbeing of the people of Ghana. They are particularly important to the rural population, which constitutes about 60% of Ghana's population (Ghana Statistical Services, 2000). In addition to their role in protecting and enriching soils, forests also provide food items, fuel wood, raw materials for building as well as site for eco-tourism and recreation.

Ghana was richly endowed with forest resources vital for her development. Records indicate the existence once of relatively undisturbed forests, which preserved abundant biodiversity (Alpert 1993), protected fragile soils (FAO, 1999; FAO, 2007; UNEP, 2002), and regulated the supply of scarce water resources (Glantz & Katz 1985,). However, deforestation and forest degradation have accelerated loss of biodiversity in recent decades. The degradation of forests and the loss of biodiversity in Ghana have increased sharply in recent decades (Dixon et al., 1996). The reserved forest is made up of 11,590 km² of production forests; 4,323 km² of protection forests; and about 1,980 km² of game production reserves (Siaw, 2001; Ghana Forestry Commission, 1995).

Ghana is currently experiencing one of the highest deforestation rates in the World (~2%) and had between 1990 and 2010 a net forest loss of 125,000 ha/yr. It is estimated that vegetation in forests in Ghana contains 103-200 tC/ha and 90% of the carbon in vegetation is released when forests are cleared (FAO 2010b). Most of the forests have lost their pristine interior habitats that are critical for the protection of vulnerable species (FAO 2001; Forest Services Division of Ghana, 1995). The Government took steps to address the startling deforestation by introducing the Ghana National Plantation Project to plant 20,000 ha per annum (Domson et al., 2007; Ghana Forestry Commission, 2005; IUCN, 2006).

The forests in Ghana cover an area of 4,939,958 ha (FAO 2010b) and are divided into on-reserve and off-reserve areas, where the on-reserve are legally demarcated forested areas vested in the traditional land-owning communities but set aside to be managed in trust for the nation by the state (Osafo 2005) and covered ~1.6 million ha in 1996 (Kotey et al. 1998). The off-reserve forests are on

land vested in and controlled by local communities who, along with the landowners have the right of usufruct to land but not the rights to timber (Osafo 2010).

The unsustainable exploitation of forest resources, coupled with the lack of environmental awareness, has devastated the country's forests. Subsistence agriculture and fuel wood exploitation is common throughout Ghana and have been increasing over the years due to a population growth. Logging and mining activities in certain areas have also contributed to the degradation of the country's forest resources. The consequence of forest loss in Ghana has been droughts, bushfires and loss of livelihood to communities that depend on eco-services provided by the forest. Desertification is encroaching on some deforested lands and soil erosion is rampant. The continuous incidence of forest degradation and deforestation is contributing to climate change with its concomitant adverse effects on the biophysical environment as well as social and economic lives of the people.

In view of the negative effects, there is the need for mitigation strategies to reverse the looming dangers associated with forest degradation and deforestation on such an unprecedented scale. This requires a paradigm shift from the traditional site level forest restoration efforts to a landscape level. This entails restoring forests and landscapes to reinstate ecological integrity and enhance human wellbeing in deforested or degraded forest landscapes, recognition of the rights of local as well as institutional stakeholders, the identification and active participation of such stakeholders in the entire process of learning and adapting, and policy reviews which provide mutually beneficial incentives to all stakeholders, thereby creating an enabling environment for the successful implementation of forest restoration at landscape scale, and ensuring the resolution of competing claims on forests.

2. Forest and Landscape Restoration in Ghana

Forest restoration efforts are not new in Ghana. However restoration based on the principles of Forest and Landscape Restoration (FLR) differs from the conventional restoration approaches employed in Ghana, due to its goal to enhance human well-being through restoration of forest functionality and productivity at the landscape level.

The concept of FLR was introduced in Ghana, when the Government of Ghana supported the establishment of a National Working Group on Forest Landscape in 2004 to develop a National Plan of Action on FLR and encourage innovative restoration efforts. In addition, a National workshop on ITTO guidelines for the restoration, management and rehabilitation of degraded and secondary tropical forest was held in Ghana in 2006.

There was consensus subsequently at a national workshop, where participants acknowledged the need for building the capacity of the stakeholders in practical use of the techniques. They also reiterated the need for the production of Ghana specific manual on Restoring Forest Landscapes, which can be used as a guide and a reference material. This was followed by a participatory resource assessment to determine relevant principles and actions that could form the basis for forest restoration guidelines specific to Ghana. Four workshops were held at which stakeholders from six degraded forest areas were invited to validate and finalize the responses gathered from the stakeholders. Official approval of the guidelines is being sought from the Ministry of Lands and Natural Resources.

The following guiding assumptions were proposed by the stakeholders for forest landscapes restoration in Ghana:

- Forest resources provide the direct source of livelihoods for the majority of the rural population and that poverty reduction and wealth creation in the country are dependent upon effective management of these resources;

- However due to different anthropogenic activities the forest resources are gradually being degraded and hence need to be restored;

- Restoration requires collaboration among stakeholders;

- District Assemblies (DAs), Traditional Authorities (TAs), opinion leaders and local community groups, including women and youth groups are important actors in the restoration process;

- Restoration activities at all levels will be carried out based on effective and efficient planning and networking; and

- Capacity of communities and community structures will be developed in Forest Landscape Restoration and this will be sustained through the provision of adequate and appropriate logistic and technical support by taking into consideration their indigenous knowledge.

3. Collaborative Landscape Restoration in Ghana – An example

A typical forest restoration success story carried out in Ghana was the ITTO/FORIG Community Collaborative Restoration Project in the Pamu Berekum forest area situated in the Brong-Ahafo Region of Ghana. The area had been severely disturbed after years of unsustainable logging, rampant bushfires and shifting cultivation, resulting in nutrient-deficient soils, reduced primary productivity and low biodiversity.

Based on forest landscape concepts and techniques, restoration efforts were directed at plantation establishment, involving communities at various locations in the reserve. Plantations include Taungya, monocultures of Tectona grandis and Cedrela odorata, also mixed with Terminalia superba, Terminalia ivorensis and Cedrela odorata. Successes attributable to the project include increased food production by the local farmers involved in the project, which translated into increased income to the farmers and improvement in rural livelihoods. Besides these positive social developments, a general improvement in biophysical resources of the area has also been observed.

Name of landscape: Pamu Berekum Forest Reserve

Location: Brong Ahafo Region, Ghana

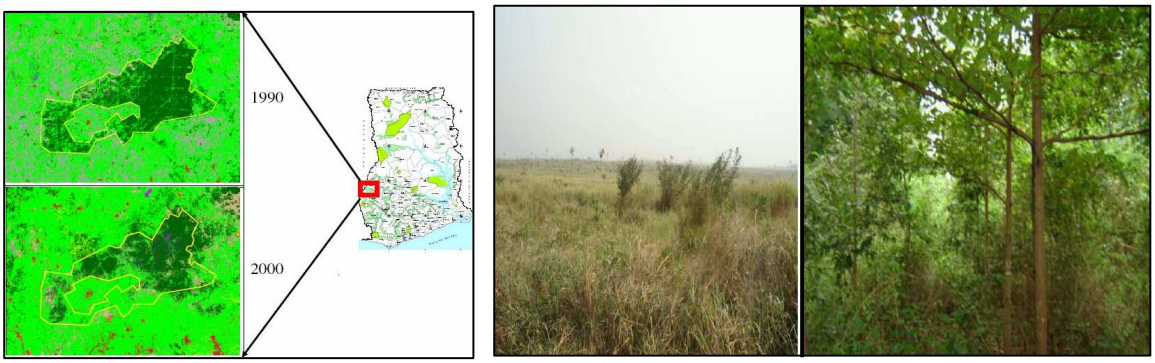


Figure2 Two-data satellite image classification of project area

Before FLR Four years after FLR

Landscape Characteristics

An area of about 189 sqkm had been severely disturbed after years of unsustainable logging and rampant bushfires Size, degraded area, nutrient-deficient soils, reduced primary productivity and low biodiversity.

Response

ITTO and FORIG initiated restoration programme

Point of significance

Involvement of community stakeholders should lead to agreement on roles and responsibilities, as well as benefit sharing arrangements.

Envisaged outcomes:

Planting target of 1800 ha/year and an annual planting target of 20 ha for farmers involved in the ITTO/FORIG community project.

Results

Availability of land for farming by land-hunger communities, increased food production, increased income to farmers and an improvement in biophysical resources

Lessons Learnt

1. Participatory planning and implementation ensures success;
2. Importance of addressing the needs of local communities to achieve stakeholder collaboration; Conflict resolution should be an integral part of any Restoration project;
3. Mainstream remote sensing and GIS tools to do initial assessment and monitor progress.

4. Forest Policy Framework

4.1 Historical Perspective

Policies for resources management in Ghana dates back to 1906 when legislation was enacted to control the felling of commercial tree species. The demarcation of forest reserves was in the main completed by 1939 and a forest policy was adopted in 1948 (Ghana Forestry Commission, 1994). Since then, a consistent policy of demarcation, reservation, protection of water supplies, and the promotion of research and public education have been vigorously pursued. However, most of the early forest policies mainly emphasised a sustained supply of timber for the wood industry and promoted over-exploitation and an eventual demise of unreserved forests. As a consequence, by the end of 1978, the Government placed about 3,267,250 ha of forests under permanent forest estate.

In addition, quite a number of policies and attempted remedies were initiated by government and its agencies such as Forest Commission Act of 1960; forest improvement fund Act of 1960; Concessions Act of 1962; Forest ordinance for the protection of forests including reserves of 1972; Trees and timber (chain saw operation) regulation of 1983; Administration of land (amendment) degree of 1984; Forest products inspection Bureau Law of 1985; Forest protection (amendment) Law of 1986; Control and prevention of bushfires Law of 1990 and Trees and timber (chain saw operation) regulation of 1991 as guides for forests resources management in the country Forest (Ghana Forestry Commission 1994). These policies and related laws were contained in various official documents and vested in specific Ministries and state agencies for implementation. The agency responsible for forest resources management in Ghana is the Forestry Commission which was established under Act 405 - Ghana Forestry Commission Act, 1980 to coordinate the activities of the forestry sector institutions, namely: the Forestry Department, Department of Game and Wildlife, Forest Products Research Institute and Ghana Timber Marketing Board. Section 6 of the Act mandated the Commission to regulate and manage the utilization of all forestry and wildlife resources of Ghana and also coordinate the policies in relation to forest resources (Forest and Wildlife Policy, 1994)

4.2 Current Framework

Ghana's Forest and Wildlife Policy was drawn up in 1994, with the aim to conserve the nation's forest and wildlife resources for maintenance of environmental quality and perpetual flow of

optimum benefits to all segments of society. The Forestry Development Master Plan (1996-2020) was subsequently prepared as a basis for implementing the policy.

The specific objectives of the policy are:

- Management and enhancement of Ghana's permanent estate of forests and wildlife resources;
- Promotion of viable and effective forest based industries, particularly in secondary and tertiary processing;
- Promotion of public awareness and involvement of rural people in forest and wildlife conservation so as to maintain life-sustaining systems, preserve scenic areas, and enhance the potential of recreation;
- Promotion of research-based and technology-led forestry and wildlife management, utilization and development, to ensure resource sustainability, socio-economic growth and environmental sustainability;
- Development of effective capability at national, regional and district levels for effective forest and wildlife management.

A number of implementation strategies including restoration of degraded forest estate; regulation of uncontrolled harvesting, protection of forest reserves and wildlife protected areas; encouragement of local community initiatives to protect natural resources for traditional, domestic and economic purposes; encouragement of value-added processes in the timber sector to maximize income and related benefits; increasing public awareness and people's involvement in the conservation of forests and wildlife; public participation through the development of consultative participatory mechanisms to enhance farmers' land and tree tenure rights; and ensuring access to traditional use of natural products have been clearly spelt out in the policy. These notwithstanding, Poku et al, cites fair access to forest resources, fair benefit sharing, corporate exploitation, and greater participation in forest policy-making and management as major governance challenges that has a direct bearing on the ability of mandated institutions to enforce the laws that restrict industry's access to resources, develop rules that will facilitate greater communal access to timber and non-timber forest products, and to enforce the revenue sharing schemes set out in the Constitution of Ghana. Furthermore, stakeholders have pointed out that there is a disconnect between official policy and legislation, citing

collaborative forest management as an important component of the 1994 Policy, which has still not been captured in legislation (Tropenbos, 2005).

4.3 Restoration of Degraded Lands

About 69% of the total land surface area is estimated as being prone to severe or very severe soil erosion. Farming practices and the removal of vegetation cover are some of the direct causes of soil degradation, with deforestation and mining, especially illegal mining activities, contributing the most serious forms of natural resource degradation. Land degradation has a significant impact on the environment and natural resource base of the country. Key policy objectives identified to address this, include reversing land degradation through investments and encouraging appropriate land use (GSGDA, 2010).

4.4 Reversing Land and Natural Resources Degradation through Investments

Various strategic actions have been identified to reverse natural resource degradation. Appropriate agriculture intensification techniques that provide irrigation infrastructure and promote correct soil conservation techniques will be applied, while afforestation of degraded forests and off-reserve areas would be encouraged, including the adoption of a medium to long-term plan for public and private programmes. Investments would be encouraged in industrial scale tree farming in specific depleted Forest Reserves and on degraded land, and in commercial forestry outside forest reserves and along dried up and flowing streams and rivers. Other strategies include the promotion of plantation and woodlot development to meet the needs of society; human- centred biodiversity conservation initiatives; the use of Lesser Used Species (LUS), particularly for the construction industry on the domestic market; and the utilization of non-traditional tree species such as rubber-wood, coconut and bamboo to supplement raw material supply from natural forests.

4.5 Biodiversity Conservation

REDD+ goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. Although Ghana is a signatory to the Convention on Biodiversity (CBD), a national CBD Forest Programme of Work does not exist. What does currently exist is Ghana's 2002 National Biodiversity Strategy (NBS), which neglects a number of CBD's programs of work including that on forest biological diversity. In order to bring the country's strategy up to the current requirements of the Convention, and to

include the CBD Expanded Programme of Work on Forest Biodiverity, the NBS is currently undergoing a review. Additionally, the existing NBS does state that Ghana's policy relating to the conservation of biodiversity and the sustainable utilization of biological resources are guided by the three objectives of the CBD Convention, namely:

- Conservation of biological diversity
- Sustainable utilization of biological resources; and
- Fair and adequate sharing of the benefits arising from the use of genetic resources.

Ghana's Medium-Term National Development Policy Framework: 2010 -2013 recognizes that the loss of biodiversity is proceeding at an alarming rate, and has thus become a major area of concern. The policy framework proposes the setting up of a Steering Committee with the following mandate:

- Mainstream biodiversity issues into sector programmes to facilitate the development of relevant sector biodiversity policies. Another drawback is the lack of research,
- Promote public education and awareness on biodiversity and ecosystem services.

The Ministry of Environment, Science and Technology will during the period facilitate the collaboration and harmonization of the biodiversity-related agreements, and establish monitoring mechanisms for biodiversity activities.

4.6 Equitable Benefit Sharing

Access of local communities to resources, such as forests, already exists in Ghana, and form the basis for common law in certain traditional jurisdiction. Benefit sharing for natural forest timber revenue, including royalties, and social responsibility agreements, which give forest communities a financial stake in commercial timber operations exist, and timber permit holders are also required to negotiate social responsibility agreements with local communities. In practice however, fair access to resources, fair benefit sharing from corporate exploitation, greater participation in policy-making processes, and enforcing the laws are the main governance challenges (Amelia et al, 2007).

Although, equitable benefit sharing in the forest sector is seen globally to be one factor that could contribute to sustainable forest management practices, and policy frameworks have been proposed and implemented in many parts of the world, some of the mechanisms seem not be working in

Ghana, payment of royalties and social responsibility agreements, the main incentive frameworks between resource extractors, Forestry Commission and forest fringe communities were evaluated and found not to be accomplishing the policy objectives.(Green Dove, 2007). This has been shown by the clashes between communities and the Forestry Commission and or logging companies. There have also been eruptions between rival forest communities over entitlements of royalties (Amelia et al, 2007).

4.7 Implications of Participating in REDD+

Ghana's participation in the REDD+ provides a good opportunity to align its forest sector policy, legislation and governance, towards achieving low carbon economy, in the medium to long term. Accordingly, new legislation on carbon rights and the rights of people to their own natural resources would have to be formulated to create the enabling environment for implementing the nationally proposed REDD+ strategies. Currently, the laws on forestry as well as the National Biodiversity Strategy are being reviewed, and a new Wildlife Bill is being drafted. The Government also intends to constitute a multi-sectoral body to upgrade and possibly separate wildlife policy from forest policy as contained in the 1994 policy (GSGDA, 2010).

The introduction of forest carbon and carbon rights into the country's sector policies and legislation will provide legal backing for carbon trading in Ghana, thereby providing the legal basis for slowing its rate of greenhouse gas emissions, in principle, and possibly having access to multilateral support to meet her development objectives. It is worthy to note however that the introduction of such new laws and pieces of "carbon-friendly" legislation with emphasis on forest carbon could transform the forest management landscape in a manner that diminishes all the other important roles that forests play in Ghana economic development. Pilot projects under the REDD+ should therefore be used as test beds to assess the risks and opportunities of any "carbon-friendly" policy. In cases where related sector policies such as biodiversity and agriculture are incongruous to the forest policy they should be aligned to make them compatible in responding to the objectives of the REDD+.

The 1994 forestry policy of Ghana recognises the need for collaboration and decentralisation, with the expectation that involvement of all stakeholders could contribute to sustainable forest management and improvement in forest governance at the community level. As a result, there has emerged a number of CBOs and NGOs working the sector ministry, the forestry commission and

the donor community to execute programs such as forest boundary cleaning with forest fringe communities, Modified taungya systems etc) all aimed at encouraging good forestry governance and livelihood enhancement of forest fringe communities.

These programs, and by extension, the 1994 forestry policy however failed to address underlying causes of conflict with regards to tree tenure and tree related livelihoods experienced by the local stakeholder. A critical review of the forest policy does not only require the inclusion of sound forest governance principles, but the recognition of indigenous ownership and registration of land and tree tenure at the community level with the aid of Geographic Information Systems. Certification of such title to land and trees by respective owners in the presence of certified Government Surveyors could provide an objective documentation of these tenural arrangements and promote the use of evidence-based conflict resolution mechanisms and thus enhance pro-poor forest governance.

Appendix II. National Stakeholder Workshop

The involvement of key stakeholders in any landscape restoration program is essential for the successful implementation of the program. Sectoral and cross-sectoral coordination should therefore be established with formal and informal institutions in the forest and related sectors.

The restoration opportunity assessment process begun with organising a national stakeholder workshop to sensitize participants and to receive commitment from institutions represented during forest restoration implementation efforts.

1 Workshop Objectives

1. Sensitize participants on the project objectives and FLR principles
2. Receive commitment from institutions represented by participants to collaborate with project partners during project implementation and beyond
3. Discuss general condition and trends affecting forest areas across Ghana and review criteria for forest condition scoring defined by Hawthorne and Abu-Juam (1995)
4. Develop suitable forest condition scoring criteria for reserves within and outside the high forest zone (including savannah and mangrove areas) based on Landsat-type satellite imagery (30 meter resolution).
5. Identify and develop assessment criteria for sacred groves as important starting points for landscape restoration.
6. Determine options for restoration of reserved forests: costs, consequences, and constraints
7. Identification of restoration issues, off reserved areas and propose practical approaches to dealing with such issues

2 Expected Outcomes

1. Participants sensitized on the project objectives and FLR concepts, and principles
2. Institutional commitment received to collaborate with the project
3. Participant understanding of the concept of forest landscape restoration and its components
4. Forest condition scoring proposed for reserves within and outside the high forest zone based on current forest condition

5. Standard benchmark for Forest condition scoring proposed
6. Options for restoration of reserved forests: costs, consequences, and constraints proposed
7. Forest landscape restoration issues outside reserved areas identified and practical approaches proposed

3 Organization and Participation

The one-day workshop was held on March 22, 2011, from 9am to 5pm, with snack and lunch breaks. The agenda was prepared in collaboration with the International Partners, WRI and IUCN. The welcome address was delivered by a representative of CERSGIS, followed by three presentations by the International Partners. Four break-out sessions were organized after the presentations to discuss and report to a plenary four thematic areas identified by the project partners as relevant to the objectives of the project. This ensured the full participations of each participant, and provided the platform for extensive discussions on each thematic area.

Major stakeholder organizations, agencies, departments and government ministries as well as civil society, NGOs and the private sector actors working on forest management and rehabilitation of degraded forests were invited to the workshop to share knowledge and discuss the feasibility and options for institutionalizing forest landscape restoration in Ghana.

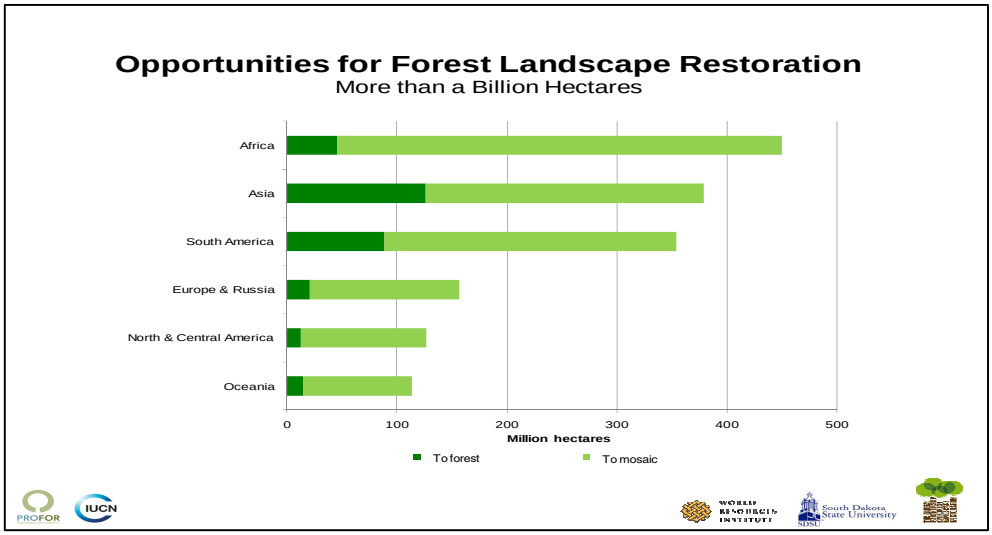
Twenty-six (26) participants from the Ministry of Lands and Natural Resources, Forestry Commission, Non-Governmental Organizations, the private sector, and representatives from International Bilateral Agencies took part in the workshop. Most of the participants were of the senior or middle management level, involved in forest management activities related to the subject matter of the workshop. The list of Participants is in Section 9, and the agenda for the workshop is in Section 10.

4 Presentations

4.1 Assessing opportunities for forest landscape restoration: Why? What? How?

This first presentation was made by Lars Laestadius of WRI. He gave a background to deforestation on a global scale using examples from countries such as Sweden, Germany and USA in the 1620s, 1850s and 1920s. Maps displayed later in the presentation showed restored lost forests after many years. Dr Lars pointed out that 5.5 billion hectares of forest has been lost globally and thus the need

for forest landscape restoration. At the local scale, the presentation showed the spatial distribution of degraded forest areas extracted from the Global Landscape Restoration Opportunities dataset, and indicated that Ghana, and by extension Africa has immense opportunity for forest landscape restoration. The graph in the figure below illustrates the statistics for forest landscape restoration opportunities globally.



Opportunities for Forest Landscape restoration

4.2 Restoration in Ghana: What are the experiences to date? What are the needs, options, benefits, and constraints?

This second presentation was done by Wale Adeleke of IUCN. The presentation centred on combating climate change through forest restoration. He explained forest landscape restoration and the stakeholder participation process required as a necessary step for making restoration projects feasible. This includes bringing people together to identify projects, collective decision making on projects and negotiating strategies for implementing such projects. He also explained the principles of forest restoration such as the need to improve ecological integrity; restore ecosystem balance and collaboration among stakeholders.

Wale enumerated the challenges to forest restoration in Ghana as illegal logging, encroachment on farms and forest fires, and gave graphic examples of how these driving forces have contributed to forest cover loss in the Afram Headwaters from 1990 – 2000. The presentation also listed initiatives by the Forestry Commission to restore lost/degraded forests as, implementation of the national

forest plantation development project and the modified 'Taungya System' – A Community-based forest management system designed to alleviate poverty at community level.

4.3 Assessing Restoration Opportunities in Ghana: Strategy and Process

This third and final presentation made by Lars Laestadius of WRI, focused on the objectives of the forest restoration project in Ghana, the process of implementation, and how it feeds into other national initiatives such as N-REG, FLEGT, and REDD+.

4.4 Sample comments made after the presentations

1. "Major drivers of deforestation vary spatially. For example in the Afram plains, charcoal burning is the main driver whereas in the mining areas 'galamsay' activities are common drivers of deforestation".

2. "The District Chief Executives of Afram Plains Nkoranza North, Kintam,po North District has been focusing on charcoal production for revenue generation in their his district without considering the negative effects of the act on the environment. All district assemblies have to be educated on negative effects of deforestation on the environment. Charcoal production could be allowed but it has to be sustainable. This requires planting woodlots for charcoal since its production is a basic source of livelihood for the people".

3. "Restoration along river banks may require a different restoration approach from forest and savannah landscapes hence the methods of landscape restoration have to be specific to the issues at stake".
4. "There is the need to integrate socio-economic, environmental and legislative instruments into the forest restoration process in Ghana".

5. "Savannah areas make up two-thirds of Ghana's land mass hence when talking about restoration in Ghana the savannah must be considered".

6. "The Government of Ghana will need these maps for its forest investment project decisions.

7. "Apart from the UNFCCC arena the map should be finished for showcase at the 2013 UN Forest Forum"

8. "Current baseline data on forest resources in Ghana is non-existent, thus most figures are quoted based on outdated information. This project provides us with an opportunity to produce current maps and thus provide current data for decision makers in the forestry sector"

9. "National statistics on forest condition are out-dated. The credibility of data concerning Ghana can be in question. It is therefore necessary that reputable institutions such as the stakeholders assembled at the workshop make the right inputs so that the project results can become credible and relevant for Ghana".

5 Break-Out Sessions

Four work groups were constituted with guidelines to address the following issues:

Group1: Criteria for degradation scoring of reserves
Group 2: Criteria for mapping of sacred groves and mangroves
Group 3: Options for restoration of the above categories and their costs, consequences, and constraints
Group4: Restoration issues concerning off reserves

6 Guidelines for Group Work

6.1 Group 1: Criteria for degradation scoring of reserves

The most immediate opportunities for restoration of forest landscapes in Ghana are in the forest reserves. A country-wide assessment of the forest quality in the reserves was made in the mid 1990's (Hawthorne and Abu-Juam, 1995). This assessment has two limitations:

- It has not been updated
- It is limited to the high forest zone

Updating and expanding the degradation assessment across the whole country is a high priority. New satellite images will help make this feasible.

Tasks for the group:

1. What is the general condition and trends affecting reserves across Ghana? Please state your opinion by forest type.

2. How can degradation in reserves be scored using Landsat-type satellite imagery (30 meter resolution)? Please propose criteria that are suitable for:
    a) Reserves within the high forest zone
    b) Reserves outside the high forest zone

3. What are the significant issues and options, and what are the reasons for your suggestions? Please list for each set of criteria.

6.2 Group 2: Criteria for mapping of sacred groves, mangroves

Sacred groves and mangroves provide important starting points for restoration of an otherwise degraded landscape. The location and condition of these should therefore be known.

Tasks for the group:

1. What is known about sacred groves and mangroves? Please list known sources of information on their location and condition, e.g. maps, databases, books, people who know, etc.
2. How can we map the location of sacred groves and mangroves? Please propose ways, including criteria that would work with satellite imagery of Landsat type (30 meter resolution) or better
3. Where do mangroves need to be restored? What areas are the most important to restore? What are the constraints? Which areas provide the best opportunities and why? Please indicate your answers by drawing on the map and provide commentary.

6.3 Group 3: Options for restoration of reserved forests: costs, consequences, and constraints

Forest reserves can be restored in many ways, from community based fire control to intensively managed plantations. Different conditions require different treatments.

Tasks for the group:

1. What are the constraints on restoration in reserves? List by forest type.
2. What are the realistic options for restoration of reserves? List by forest type.
3. What are the typical costs of each option? Please list by forest type.
4. Where is restoration most likely to be possible and what kind of restoration is realistic? Please show on the map.

6.4 Group 4: Restoration issues off reserves

Most of the degraded lands in Ghana are off reserves. Restoring these lands is obviously difficult. It is important to understand the issues concerning off reserves in order to systematically map the opportunities for restoration.

Group Task: Identification of factors militating against forest restoration in Ghana.

7 Summary of Group Presentations

7.1 Group 1: Criteria for degradation scoring of reserves

Hawthorne and Juam (1995) applied a single score to each forest reserve in the high forest zone, to summarise its general condition. The condition score run from 1 to 6, with condition 1 for forest reserves with minimal signs of disturbance and condition 5 forests being seriously degraded, with few upper canopy trees. Condition 6 described reserves with no significant forest left.

The group agreed that the Hawthorne and Juam (1995) condition scores be reviewed to reflect current forest conditions, taking into consideration the new definition for "forest" proposed by the Forestry Commission of Ghana. The Group also proposed the definition of woodland condition scores for the savannah zone to take account of woodland patches in reserved and non-reserve areas. Detailed description of the format for defining condition scores for forest and savannah vegetation types can be found in Appendix III.

Where intact forest can be found in the landscape, this could be used as reference for forest condition scores. Forest relics such as sacred groves, which constitute areas of intact forests reserved by traditional authorities due to religious and traditional beliefs, should for instance be used as benchmark for defining Excellent Condition or Condition Score 1 for the forest or woodland reserves. This is because such sacred groves are usually kept intact than are poorly represented in state-managed Forest Reserves due to a variety of underlying beliefs and prohibitions against felling of trees which add considerable genetic value to forests or woodland within such groves.

Proposed criteria for Condition Scoring:

1. Canopy cover
2. Human disturbance
3. Natural regeneration
4. Logging damage
5. Fire damage

7.2 Group 2: Criteria for mapping of sacred groves, mangroves

The group defined sacred groves as forest relics preserved by traditional norms customs and taboos. These groves are of religious and cultural importance to the people living around it. Widely distributed across the country and found in small patches, they used to be burial grounds for traditional rulers. Some of these groves are getting degraded and need to be restored. Mapping and inventory of sacred groves are required to identify the areas to generate digital maps of the sites

Sources of information were identified as community and traditional authorities, Forest Services Division, UNDP and Wildlife Division of the Forestry Commission.

The following specific sources of information were identified:

1. Forestry Commission - List and status of sacred groves in Ghana
2. Resource Management Support Center - Map of sacred grove distribution in Ghana.

The group identified the following constraints for restoration within mangrove areas:

1. Accessibility: The mangroves are easily accessible to the people due to the location of settlements close to them as such they are cut for domestic wood energy and for commercial fish smoking.
2. Resources/logistics: It requires a lot of financial and logistical resources to restore mangroves but such needed resources are not easily available.
3. Technical Capacity: Mangrove restoration requires much technical knowledge which is limited.
4. Policy initiatives: For mangrove restoration to be successful government policy and laws to protect them have to be in place.
5. Urbanization: Urbanization of coastal mangrove areas is contributing to development of settlements and other land use activities that result in the rapid loss of mangroves.

7.3 Group 3: Options for restoration of the above categories and their costs, consequences, and constraints

The group's analysis was done for each ecological zone namely, high forest, transition and savannah eco-zones. The results are presented by ecological zone in the 3 tables below.

Cost elements such as social, environmental and economic are associated with landscape restoration for each ecological zone. The tables also give information on suggested areas for restoration, as well as some relevant information sources.

HIGH FOREST ZONE Options	Constraints	Costs			Proposed Restoration	Relevant Projects/Sources of Information
		Social	*Environmental*	*Economic*		
Conversion to plantations e.g. through Modified Taungya System and use of indigenous species. Avoid monoculture to improve survival rates	Compaction of soil by logging machinery affects natural regeneration	Lack of access and ownership of land by migrant farmers thus affecting tree tenure	Loss of biodiversity especially under plantations	Land-preparation pegging, ploughing, planting	Cultivation of multipurpose trees in admitted farms	GSBAs
Enrichment planting (filling in the gaps)	Nutrient availability		Introduction of alien and invasive species	Cost of seedlings		Carbon map
Natural regeneration	Inadequate capacity and motivation/ remuneration for Forest Commission staff	Loss of access to land and thus connected to livelihood activities	Sometimes sources of drinking water are disturbed under plantations	Plantation Maintenance Fire protection		FLR Map
Sustainable logging		Indigenous cultural systems may be adulterated or lost due to influx of migrants		Fire protection		The current Plantation Development Programme under the FC
		Time and other resources invested in restoration by farmers/ communities	Compaction of soil	Transportation		High Forest Biodiversity Programme
				Cost of maintaining feeder roads		Climate Change Unit, FC
				Average cost of establishing a plantation/ Ha. is GH¢2030 (Ref: Plantation Dept-FC)		
				Logging damage control		

TRANSITION ZONE Options	Constraints	Costs			Proposed Restoration	Relevant Projects/Sources of Information
		Social	*Environmental*	*Economic*		
Conversion to plantations e.g. through Modified Taungya System (MTS) to avoid monoculture to improve survival rates	Lack of Maintenance of trees by farmers especially under MTS	Lack of access and ownership of land by migrant farmers thus affecting tree tenure	Loss of biodiversity especially under plantations	Irrigation facilities e.g. dug outs	Around ecologically sensitive areas e.g. water bodies (enrichment planting)	Carbon map
Enrichment planting (filling in the gaps)	Breach of contract by farmers e.g. under MTS		Introduction of alien and invasive species	Land preparation-pegging, ploughing, planting	Law enforcement to back restoration	FLR map
Natural regeneration under controlled fire and grazing	Competition from food crops; once farmers are given access to reserves, they give priority to the food crops especially in the savannah where soil moisture is very low	Loss of access to land and thus connected livelihood activities	Sometimes sources of drinking water are disturbed under plantation	Cost of seedlings	Woodlots especially (charcoal endemic areas)	The current Plantation Development Programme under the FC
	Fire and grazing	Indigenous cultural systems may be adulterated or lost due to influx of migrants		Maintenance	Cultivation of multipurpose trees in admitted farms	
	Illegal logging	Time and other resources invested in restoration by farmers/ communities		Fire protection	Because a lot of the forests have been lost, the transition zone provides a good opportunity for restoration	The FC Climate Change Unit
	Inadequate capacity and motivation/ remuneration for FC staff			Transportation		
				Increased wear and tear of roads		

SAVANNAH ZONE Options	Constraints	Costs			Proposed Restoration	Relevant Projects/ Sources of Information
		Social	*Environmental*	*Economic*		
Conversion to plantations e.g. through Modified Taungya System and better to avoid monoculture to improve survival rates	Lack of Maintenance of trees by farmers especially under Modified Taungya System (MTS)	Influx of migrants into the community with different motives which might lead to social vices such theft, promiscuity, etc ; implications on reproductive health and population growth	Loss of biodiversity especially under plantations	Irrigation facilities e.g. dug outs	Around ecologically sensitive areas e.g. water bodies i.e. the black, white and Red Volta (enrichment planting)	Carbon map
Enrichment planting (filling in the gaps)	Breach of contract by farmers e.g. under MTS		Introduction of alien and invasive species	Land preparation- pegging, ploughing, planting	Law enforcement to back restoration	FLR map
Natural regeneration under controlled fire and grazing	Competition from food crops; once farmers are given access to reserves, they give priority to the food crops especially in the savannah where soil moisture is very low		Sources of community drinking water are disturbed under plantations	Cost of seedlings	Woodlots especially (charcoal endemic areas)	Savannah resource management project
	Fire and grazing	Loss of access to land and thus connected to livelihood activities	Indigenous cultural systems may be adulterated or lost due to influx of migrants	Maintenance	Cultivation of multipurpose trees in admitted farms	The current plantation Dev't programme under the FC
	Customs and taboos which prevent planting of certain tree species may be a constraint. The fire festival in the north may attest to how fire use as a customary practice can affect restoration			Fire protection		
	Fire is sometimes used as catalyst for initiating buds in trees such as shea and dawadawa. Poor control of the fires my result in destruction of vegetation	Time and other resources invested in restoration by farmers/ communities		Transportation		
	Droughts			Increased wear and tear of roads		
	Illegal mining	Inadequate capacity and motivation/ remuneration for FC staff		Average cost of establishing a plantation/ HA is 2030 (plantation dept)		

7.4 Group 4: Restoration issues off reserves

The group identified the following as factors militating against forest restoration in Ghana.

7.4.1 Land and Tree Tenure

Problems of who owns the land, and who owns the trees on the land do exist. This negatively affects restoration efforts. Fragmented land use systems also do not encourage forest restoration as land parcels are too small for forest restoration projects.

7.4.2 Crop Types

Crops such as maize, rice, beans cannot do well under shade hence when such crops are grown in an area it will be difficult to practice forest restoration using agroforestry method. Tree crops like hybrid cocoa does not do well under much shade hence it will not be practicable for forest restoration in such areas. Establishment of jatropha plantations for bio-fuel may constrain forest landscape restoration in that land preparation practices for such plantations may not be useful for forest restoration.

7.4.3 Forest fires and land uses

Particular areas within Ghana are susceptible to frequent forest fires hence forest restoration will have challenges to deal with. Sand wining, 'Galamsey' (Illegal mining), charcoal production and wood fuel exploitation are further threats to forest restoration.

7.4.4 Benefit sharing

Once there are laws that declare trees on individual farm lands as Government property, farmers deliberately destroy timber species on their farms since they know they are not the beneficiaries when the trees mature to timber size.

7.4.5 Physical development

Physical development such as, road construction and the expansion of communities, towns and cities, could militate against restoration efforts. The Accra plains for instance has been affected by massive estate developments around the Shai Hills National Park.

7.5 Existing efforts to restore forests in Ghana

1. Plantation development and restoration of degraded forests by the Forestry Commission
2. Private sector initiatives such as Samatex Ghana Forestation
3. Establishment of Community Resource Management Areas (CREMA) in Wasa Amenfi District
4. Collaborative Mangrove Restoration Projects in Muni Ramsar Site, Songor and Ada Ramsar Sites
5. In an effort to protect wildlife some protected areas such as Boabeng Fiema and Tafi Atome monkey sanctuaries have been created and expanded.

7.6 Some Practical Approaches

1. In the savannah areas, planting of trees along rivers and other water bodies will be useful.
2. Community participation is very important. For example, the Densu Restoration Project was not successful due to lack of adequate community participation.
3. Natural regeneration should be encouraged in savannah ecological zones.
4. Social approaches: Preservation of burial grounds by turning them into forest as they mostly have some existing tree cover.

7.7 Map Requirements.

1. Land Use and Land Cover
2. Land suitability
3. Land ownership: stool lands and family lands.

7.8 Short Term vrs. Long Term Benefits

Traditional Rulers who benefit from land use activities that contribute to deforestation will not be willing to stop such activities in favor of forest restoration. For example, chiefs in the Gonja Traditional Area who benefit from charcoal revenue in their traditional areas will not be willing to enforce laws banning charcoal production.

Conversely, traditional areas where sacred groves are found welcome restoration efforts to expand the groves.

7.9 Potential Users of FLR Map

1. The group identified the following as potential users of the FLR Map:
2. Climate Change Unit of the FC
3. District Offices of the FC
4. Ministry of Lands and Natural Resources
5. Ministry of Environment Science and Technology
6. District Assemblies
7. Environmental NGOs (National and International)

8. Workshop Recommendations

1. Consultation and participation of all stake holders is necessary before any landscape restoration project is initiated. This is to ensure the participation and commitment of communities to the project.
2. The integration of indigenous knowledge into proposed Forest Landscape Restoration (FLR) concepts and approaches is very essential for the acceptance of restoration projects in communities.
3. There is the need to build on already existing initiatives regarding forest landscape restoration. This will ensure the harmonization of project outcomes for national development thus avoiding duplication of efforts.
4. Restoration of forest landscape in Ghana has to conform to global standards to be considered credible and accepted internationally.

9. List of Participants

	Name	Institution	Position
1	Musah Abu-Juam	Ministry of Lands and Natural Resources	Technical Director
2	Raphael Yeboah	Forestry Commission -FSD	Executive Director
3	Kwakye Ameyaw	Forestry Commission -FSD	Operations Manager
4	Roselyn F. Adjei	Forestry Commission	Assistant Manager
5	David Kpelle	Forestry Commission	Consultant
6	Charles Amankwa	Forestry Commission-WD	Wildlife Co-odinator
7	Richard Gyimah	Forestry Commission	Manager
8	Sulemana Adamu	Forestry Commission	Asst. Programme Manager
9	Nana Poku Bosompim	Forestry Commission	Administrative Officer
10	Yakubu Mohammed	Forestry Commission -RMSC	Manager GIS
11	Grace Gyabaah	Forestry Commission -RMSC	Administrative Officer
12	James Agyei-Ohemeng	NCRC	Comm. Rel. Officer Tech.
13	Winston Asante	NCRC	Research Officer
14	Aristotle Boaitey	Kumasi Wood Cluster	Nat. Service Personnel
15	Alex K. Dadzie	Ghana Timber Association	Vice President
16	Osofo Quarm	Wassa Amenfi West District	Executive Director
17	Justice Odoi	USAID-Ghana	Environmental Specialist
18	Susanne Bouma	Royal Netherlands Embassy	Intern
19	Clare Bragon	EU Delegation	Advisor
20	Evyon Pfeil	GIZ	Team Leader
21	Vincent Awotwe-Pratt	Conservation Alliance Int.	Programme Manager
22	Lars Laestadius	World Resources Institute	Senior Associate
23	Wale Adeleke	IUCN	Coordinator
24	Saadia Bobtoya	IUCN	REDD Project Officer
25	Opoku Pabi	CERSGIS	Landscape Ecologist
26	Selase Adanu	CERSGIS	Environmental Systems Spec
27	Kwadwo Kyerematen	CERSGIS	Remote Sensing/GIS Spec
28	Foster Mensah	CERSGIS	Executive Director

10. Program

Dialogue on
REDD+ OPPORTUNITIES THROUGH FOREST LANDSCAPE RESTORATION

Date: Tuesday 22 March, 2011

Venue: Alisa Hotel, Accra

9:00 Welcome and opening (Foster Mensah)

9:15 Assessing opportunities for forest landscape restoration: Why? What? How? (Lars Laestadius)

9:45 Forest landscape restoration in Ghana: What is it? What are the experiences to date? Are there any bright spots in Ghana or elsewhere? What are the needs, options, benefits, and constraints? (Wale Adeleke)

10:45 Assessing restoration opportunities in Ghana: strategy and process (Lars, Foster)

11:15 Breakout group session
Introduction of break out groups
Criteria for degradation scoring of reserves
Criteria for mapping of sacred groves, mangroves
Options for restoration of reserved forests, sacred groves and mangroves and their costs, consequences, and constraints
Restoration issues off reserves

12:15 Lunch

13:00 Breakout group sessions (continued)

13:30 Breakout group reports and discussion

15.30 Plenary discussion

16:30 Conclusions, next steps

17:00 Closing Remarks

Appendix III. Method

1. Ecological Zones in Ghana

It is essential that forest landscape restoration at national scale be preceded by the characterization of vegetation types over the landscape which the restoration is intended and the criteria that qualify an area for restoration. Furthermore, landscape approach to restoration also takes into account the various land uses and ecosystems (forest, savannah, forest-savannah transitional belt, mangrove, etc). A multiple-use landscape is often a mosaic of land use types, in which some parts may be formally protected (e.g. forest reserves) while others are sustainable-use communal areas, private farmland and/or other types of productive use (e.g. off-reserve areas serving as agricultural landscapes).

A country-wide assessment of the forest condition in Ghana's reserves was made in the mid 1990's (Hawthorne and Abu-Juam, 1995). Currently, reliance on this assessment has two limitations in the sense that it has not been updated since 1995 and it is also limited in scope (i.e. only for forest reserves in the high forest zone). Updating and expanding degradation assessment across the whole country is of a high priority. This therefore requires a review of the Hawthorne and Abu-Juam forest condition that takes into consideration the major vegetation types and hence ecological zones of Ghana.

In order for such broad ecological zone classification to be relevant, there is the need to define the scope and limits of the major vegetation types and develop suitable condition scoring criteria for the vegetation types within and outside the high forest zone (including savannah and mangrove areas) based on 30 meter resolution Landsat satellite imagery.

1.1 Classification of Ecological Zones

Ghana, which is in the western part of the African continent (0−3° W and 5−11° N), has a land area of approximately 239,000 km². Identifiable ecological zones in the country include rain forest (3 %), moist forest (31 %), interior savannah (57 %), coastal savannah (5 %) and swamp vegetation (4 %) (Ntiamoah-Baidu, 2001).

Broadly two major kinds of vegetation cover the surface of Ghana: forest and savannah; these and the various formations into which they may be subdivided were defined at a Pan-African conference at Yangambi (C.S.A. 1956), UNESCO (1973) and the most recent by Hall and Swaine (1981).

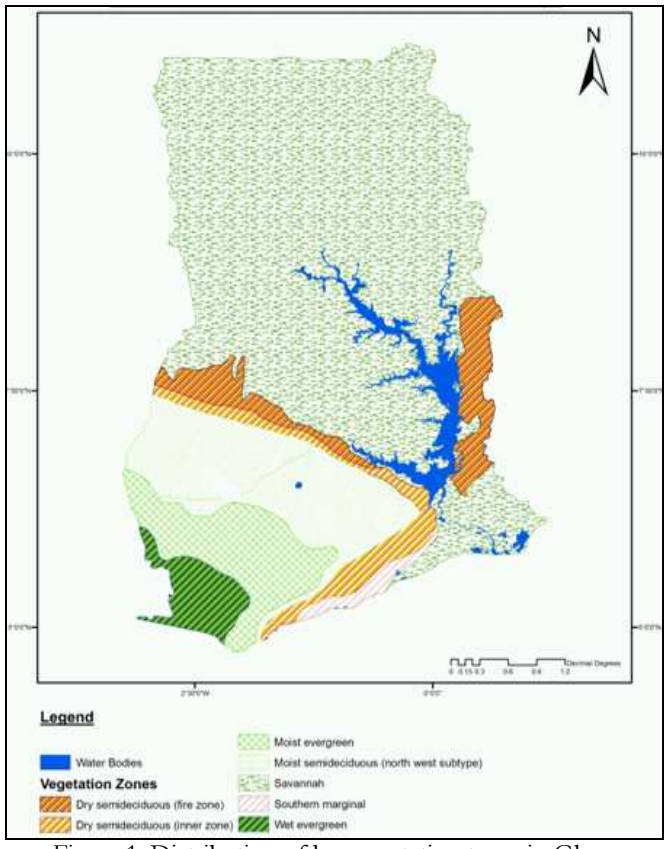


Figure 1: Distribution of key vegetation types in Ghana

1.2 Extent of Ghana's forest and Trends over the last half century

Forest is dominated by trees at least 5 m high, whose crowns interlock, and lacks a continuous grassy ground layer. The area of forest zone in Ghana is about 82,000 km2, representing 34% of the total area of Ghana. The forest zone is occupied by various forest types as described in detail in Table 2 (Hall and Swaine, 1981).

Table 2: Areas occupied by the various forest-types in Ghana

	Area (km^2)		Percent of total forest area
Types and subtypes	subtype	type	
Wet Evergreen		6,570	8.1
Moist Evergreen		17,770	21.9
Upland Evergreen		292	0.3
Moist Semi-deciduous		32,890	40.4
South-east	18,460		
North-east	14,430		
Dry Semi-deciduous		21,440	26.4
Inner Zone	8,630		
Fire Zone	12,810		
Southern Marginal		2,360	2.9
South-East Outlier		20	0.03
Total Forest Area		81,342	100

1.3 Forest Reserves

Although the vegetation within forest reserves is less heterogeneous it is by no means uniform. It is on record that forest quality and quantity in the reserves have decreased over the years.

Forest ordinances were established from 1927 for the reservation and subsequent management of forests. The then Forestry Department had powers to reserve areas for management by the state, in some (but not all) cases in agreement with chiefs to whom the land belong. With these powers, reserves were defined in all the major hills and watersheds. Furthermore, barrier and shelterbelt reserves were established to hold back wildfires, and to maintain local rainfall and humidity levels respectively. Shelter belts are corridor strips 1-2 km wide stretching northwest to south east. The barrier reserves fringe the savannah zone. Some of these included savannah woodland even when reserved, and were (some still are) managed with early burning in the

belief that eventually forest would return if the severity of the annual fires was kept to a minimum (Hawthorne and Abu-Juam, 1995).

The boundaries between northern savannah woodland and the southern high forest used to be abrupt but the frequent interventions of wildfires have changed extensive portions of the northern part of the high forest into semi-forest and savannah and therefore has decreased the forest resource diversity gradient between the northern savannah and the high forest zone. The gazetted forest and wildlife reserves of Ghana stands as 266 forest reserves, 15 Wildlife Reserves and Parks and Ramsar Sites. The total area covered by these reserves is approximately 3,800,000 ha and constitute about 16% of the total land area of Ghana.

The present state of the reserved forests is in a worse condition compared to the time of their reservation. The reserves have had a long history of human interference and its cumulative effect today, is obvious. Several factors have contributed to the bad or secondary phases of the forest mosaic. For instance, excessive logging and uncontrolled fire have destroyed some reserves in the Brong-Ahafo region which were originally kept as shelter belt reserves protecting the forest zone in the south from the advancing savannah from the north. It is on record that the original area (82,000 km2) of forest zone in Ghana at the turn of the century has shrunk to about 16,000 km2 this does not include plantation forest and others due to natural regeneration.

1.4 Unreserved Forest Areas (Off-reserves)

Off-reserve areas are lands that are currently (or were) forests but where the forest policy presumes these lands would be converted to other use—in particular, agriculture. This includes about 5,000 km² of unreserved forests, approximately 60,000 km² of bush fallow, approximately 36,000 km² of unimproved pasture, and about 29,000 km² of tree and annual cropland World Bank (2007).

The rate of forest clearing outside forest and wildlife reserves is such that intact forest will soon have virtually disappeared except within reserves and in small patches of sacred forest near villages. The proportion of forest outside reserves declined from 20% in 1995 to 5% in 1972 according to estimates in annual reports of the Forestry Department for those years (Hall and Swaine, 1981).

In most cases forest clearing in unreserved areas is for agricultural purposes. In cash crop farms such as cocoa, more shade trees are left standing over the cocoa farms whereas in food farms most trees are cleared and burnt. Swamp vegetation often dominated by raphia palms occur in isolated areas across the High Forest Zone but is common in some parts of the Western Region (e.g. Tarkwa), where they are sometimes cleared for rice-farming. The unreserved landscape is therefore characterized by a mosaic of agricultural landscape and secondary vegetation showing different stages in regrowth on old farms. When a forest is cleared, tall herbaceous or sub-shrubby weeds emerge ("forb regrowth") which may be followed by thicket with abundant woody climbers and young trees which shade out and kill the light demanding weeds. The pioneer trees are quick growing and short-lived species which form the early succession phase of the secondary forest. Taller and long-lived species take over after 10-20 years to give older secondary forest from which the mature forest gradually develops. Thus the unreserved forest areas are greatly influenced by anthropogenic factors compared to the reserved forest areas.

1.5 Extent of Ghana's Savannah & Trends over the Last Half Century

The boundary between forest and savannah is usually described as a transitional zone. This zone has been greatly influenced by combined effect of geology, topography and rainfall. The stability of the forest-savannah boundary is enhanced by annual savannah wildfires which tend to prevent the spread of forest (Hall and Swaine, 1981). The crowns of trees in the savannah are not continuouses but are separated by a distance depending on the stand density, or in extreme cases trees may be absent; there is always a seasonally dense under storey of grasses (Hall and Swaine, 1981). Approximately 66% of the total area of Ghana is savannah. Savannah ecosystems and dynamics are currently poorly understood because little attention has been paid to these areas in the past.

In Ghana, vegetation trends for savannah ecosystems have not been well been documented and national inventory programmes have only been restricted to forest zones. Data on the dynamics of savannah vegetation is therefore non-existent and poorly described. However, it is widely acknowledged that rainfall amount, soil types, fire history, grazing and farming practices have influenced the savannah vegetation over the years in Ghana to develop into what is commonly termed "fire climax" vegetation. Hawthorne and Abu-Juam, (1995) observed that a number of reserves in the savannah zone of Ghana never had forest in them, but rather are savannah or open woodland reserves. Examples of these could be cited in forest

reserves north of Sunyani in the Brong-Ahafo Region and in the Volta Region.

Most of the degraded reserves in the transitional zone were once forested or partly forested at the time of reservation, but which have subsequently been destroyed. Some were burnt, farmed, and then suffered failed Taungya with subsequent repeated wildfires. Most of the transitional zone vegetation contains scattered fragments of forest that require attention for further enhancement and/ or protection. The ecological significance of the transitional zone forming a barrier protecting the forest zone from the rapid advancement of the savannah from the north requires that their forest restoration potential is carefully considered and uniquely managed. Hence the transitional zone is considered as a key ecological zone in this assessment.

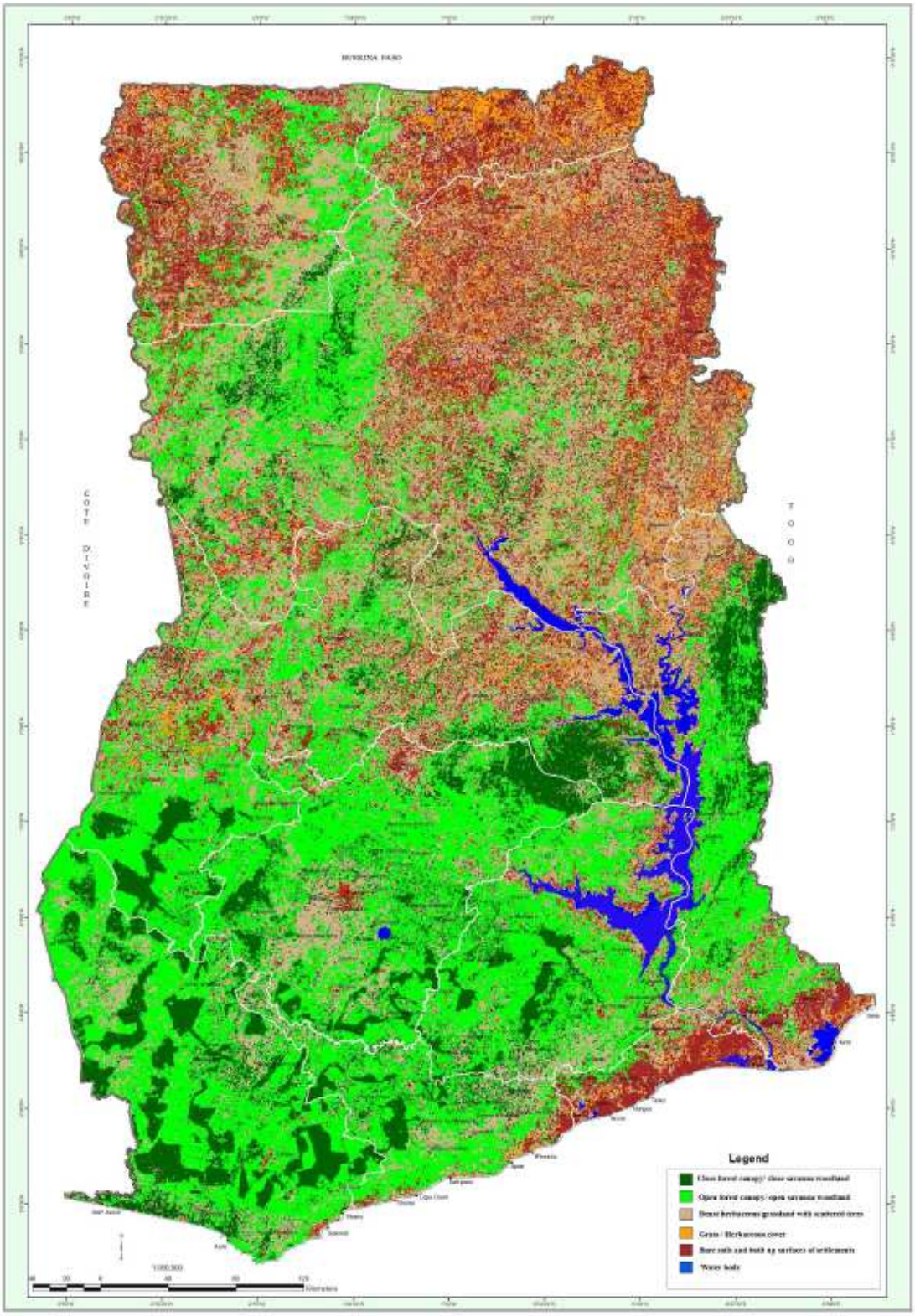


Figure 2: land cover classification from mosaic of Landsat images

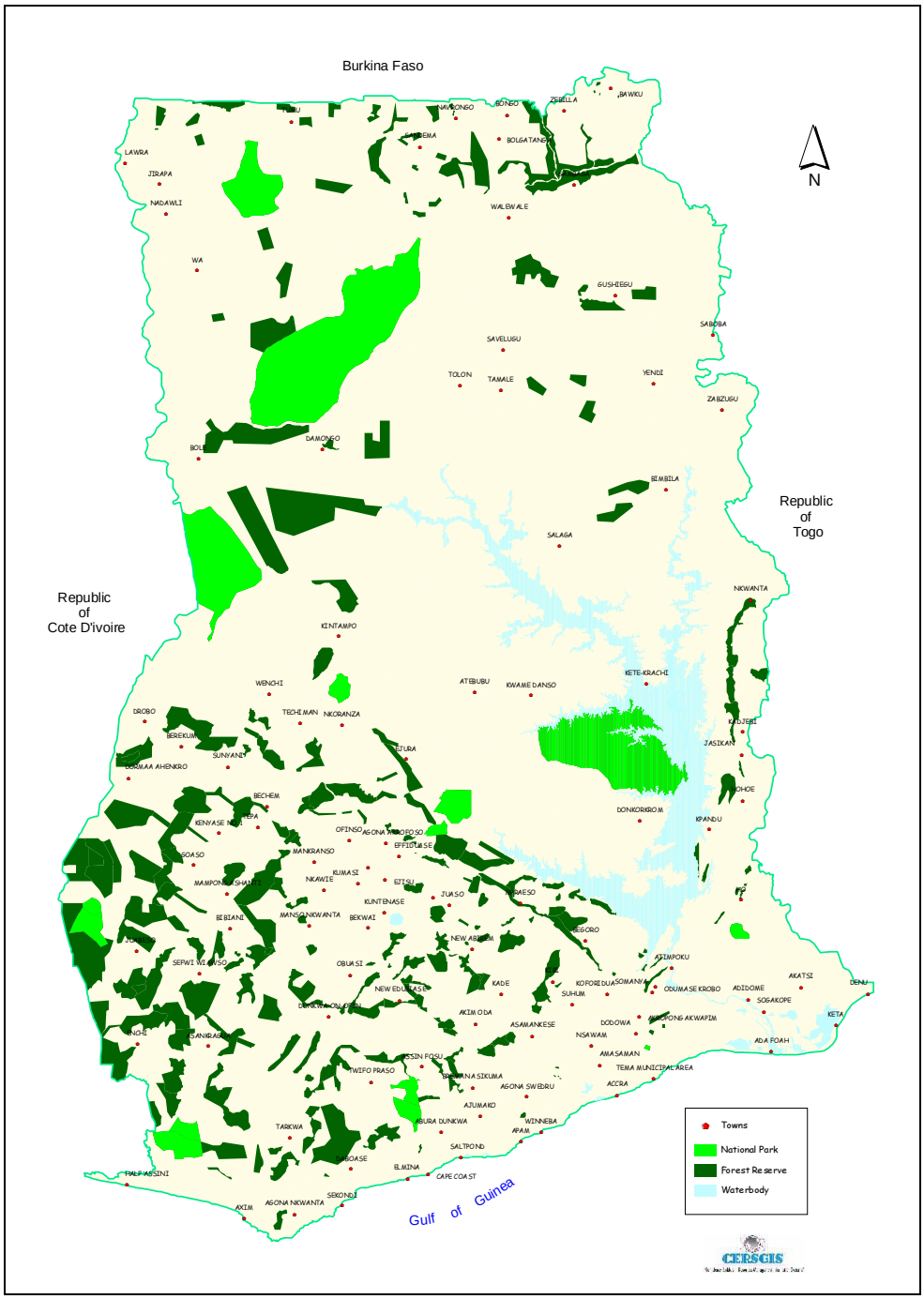


Figure 3: Spatial Distribution of Forest Reserves and National Parks in Ghana

2. Forest Condition Scoring

Hawthorne and Abu-Juam (1995) applied a single score to each forest reserve, to summarize its general condition as indicated in Table 2. The condition score runs from 1 to 6, with condition 1 forest reserves showing minimal signs of disturbance and condition 5 forests being seriously degraded, with few upper canopy trees. Condition 6 reserves have no significant forest at all. Scores 1-3 are low to moderate, and ecologically tolerable, with healthy, vital parts of the mosaic in the ascendance and regeneration of timber trees and other forest plants usually abundant. Well-managed selective logging should generate condition 2-3 forest by the end of a felling cycle. Scores 4-6 are applied to forests that have suffered slight degradation over more than half the reserve or heavy degradation over more than one-quarter of it. Very often significant parts of the mosaic have poor regeneration of timber trees and other forest plants, partly because of lack of 'good' parts of mosaic nearby. Badly managed logging typically produces condition 4-5 forest. In dry areas these forests are susceptible to repeated wildfires because of the density of flammable, young pioneer plants in the dry season, and this has often lead to deterioration of forests to condition 5 or 6, particularly where Taungya has been encouraged.

The scores applied in the work of Hawthorne and Abu-Juam (1995) were based on observation, conversations with forest staff working in the area, the inventory results and use of satellite imagery in decreasing order of importance. A combination of inventory data from a 0.25% Temporary Sample Plot (TSP) gathered around 1986 and botanical surveys of the early to mid 90s were used in the forest condition scoring. From the botanic survey canopy trees (exposed to sun,>30 cm dbh) recorded were used to estimate Pioneer Index (PI), Economic Index (EI) for those trees and Genetic Heat Index (GHI). The PI is a weighted average with pioneers scoring 2, non-pioneer light demanders scoring 1, and others scoring zero. The sum of these scores (i.e. over all species for PI over all tree stems > 30cm dbh for PI (trees) is multiplied by 100 and divided by the number of stems or species in the sample. The EI (trees) is similarly a weighted average of stem scores multiplied by 100, where each stem of a scarlet species scores 3, Red star stems score 2, pink star stems score 1, other stars score zero. The GHI is a similar index for species content, relating to global conservation concern. Indices based on GHI were included if enough species (>30) were included in the botanic survey sample. Additionally, 'average forest type' was estimated from average ordination score as used by Hall and Swaine (1976; 1981).

According to Hawthorne and Abu-Juam (1995) in many cases the scores allocated is open to

debate. Nevertheless, they ctaught the general trend and reflected the true situation. Although the pioneering work by the authors is commendable, the level of subjectivity is fairly high. Vide Table 3 for condition score used to summarize forest reserves (Hawthorne and Abu-Juam, 1995). This assessment is most critically limited to only forest reserves in the southern part of Ghana. Since 1995, there has not been any attempt to evaluate and re-assess the forest condition scores put forward by the authors mentioned above.

Table 3: Scale used by Hawthorne and Abu-Juam (1995) to Condition scores used to summarize the condition of forest reserves

Score	Definition
1	EXCELLENT with few signs (<2%) of human disturbance (logging/farming) or fire damage, with a good canopy and virgin or late secondary forest throughout.
2	GOOD with <10% heavily disturbed. Logging damage restricted or light and well dispersed. Fire damage none or peripheral.
3	SLIGHTLY DEGRADED: Obviously disturbed or degraded and usually patchy, but with good forest predominant. Max 25% with serious scars and poor regeneration; max. 50% slightly disturbed, with broken upper canopy.
4	MOSTLY DEGRADED: Obviously disturbed and patchy, but with bad forest predominant; 25-50% serious scars but max. 75% heavily disrupted canopy. Or forest lightly burnt throughout.
5	VERY POOR: Forest with coherent canopy < 25% (more than three-quarters disturbed), or more than half of the forest with serious scars and poor or no forest regeneration; or almost all heavily burnt with conspicuous *Eupatorium* and other pioneers throughout. Not, however, qualifying as condition 6.
6	NO SIGNIFICANT FOREST LEFT: Almost all deforested with savannah, plantation or farm etc; <2% good forest; or 2-5% v. disturbed forest left; or 5-10% left in extremely poor condition e.g. as scattered trees or riverine fragments remnants with little chance of surviving 10 years.

2.1 Savannah Condition Scoring

Globally, the Savannah biome is diverse, including formations ranging from almost pure grasslands to closed woodlands with considerable variation in plant composition, biomass and net primary productivity (House and Hall 2001). The distinction between what is forest, grassland, and different structural savannah types can only be set with arbitrary limits and various descriptions such as those defined by Scholes and Hall (1996):

- Forests: complete tree canopy cover and three or more overlapping vegetation strata,
- Woodlands: 50-100% tree canopy cover, and a graminaceous layer,
- Savannahs: 10-50% cover by woody plants and well-developed grass,
- Grasslands: Less than 10% tree cover.

The Dry Semi-deciduous type forest is a fairly good starting point for tracing the path of savannah and hence, scoring the different types of savannah vegetation that exists in Ghana. The Dry Semi-deciduous type forest exists under a wide range of environmental conditions and it forms a peripheral band around the moister forest types and is adjacent, in the north, to the Guinea savannah zone. Two sub-types of this forest (i.e. Fire Zone subtype and inner Zone subtype) provide a useful vegetation clue of a transition from forest to savannah vegetation. Vegetation in the Volta region and Afram Plains in the Eastern region indicate such trends. Southern Marginal type also exists as coastal thicket and scrub. Relatively little of this type is today covered by forest (e.g. Amoawa hill between Winneba and Mankesim. The land is mostly covered by thicket, farms and savannah (partly derived from more woody vegetation by farming). Forests occur as small patches mostly on rocky hills not favored for farming. The south-east outlier is forest at its driest extreme in Ghana with the lowest mean annual rainfall reaching about 650 mm. Canopy trees in this forest are short. This type of forest occupies a small area of Ghana. Example is the Shai Hills Game Production Reserve.

Unlike the forest zone of Ghana, the savannah zone lacks detail inventory studies that could be relied upon for savannah condition scoring. The relative dominance of trees versus grasses in savannah systems of Ghana varies widely according to rainfall amount, soil type and fire history, as well as grazing intensity and the overall extent of past disturbance.

Annette den Hollander H.J. (2008) conducted a study in savannah sites in Mali, Burkina Faso, Ghana, and Cameroon all in the African continent. The aim of this study was to make observations concerning other driving variables in the savannah ecosystem. The Gentry methodology used in this study consist of an inventory of the vegetation:

1. Estimating percentage cover of the lower vegetation layer (<1.5 m).
2. Weighing grass 'clipping' sample for biomass.
3. Measuring crown of the shrubs (>1.5 m) and DBH1.3 of trees.
4. Measuring crown separation ratio of the shrubs and trees (>1.5 m).
5. Estimating percentage canopy cover.

The Mole National Park in Ghana which constitutes northern Guinea savannah was used as the study site for Ghana. The long history of this park as a conservation area in Ghana and also a typical savannah ecosystem makes it a good proxy as far as savannah inventory data is concerned. The study revealed that the total lower vegetation layer (shrub, grass and herb) covered about 35% of the area whereas woody vegetation layer by way of canopy trees and crown cover was 51 and 23%, respectively. The canopy cover measured with the spherical densitometer and varies between 4 and 60%. Data from the Mole National Park was relatively high in canopy cover because of the relatively abundance of woody vegetation. The crown cover is estimated from the crown separation ratio, which is estimated from the crown of individual trees and the gap between the crowns of trees. From this crown cover the savannah can be categorized in different savannah vegetation types (see Table 4).

In open savannah the trees are more widely separated; trees are fairly closely and evenly spaced but do not form a closed canopy in the case of open savannah woodland. In savannah woodland the trees form a more or less complete canopy. Canopy Cover underestimates the crown cover compared to the Australian crown separation method. An explanation for this could be the method of measuring the canopy cover with the spherical densitometer, which is hold at breast height. Because of this the lower canopy is not included, while in the crown separation ratio method, this is included (Annette den Hollander H.J. 2008).

Table 4: Savannah Classification with Crown Cover for the sampled area in Mole National Park [Annette den Hollander H.J. (2008)]

% Crown Cover in Mole National Park	Cover Class described by Hnatiuk *et al. 2009*	Vegetation Type According to		
		Scholes & Hall 1996	Kaey 1949	White 1983
23	**Sparse**	**Savannah**	**Open Savannah Woodland**	**Wooded Grassland**

The woody vegetation included shrubs < 2.5 cm DBH1.3, small trees of DBH1.3 between 2.5-10 cm and, relatively large trees > 10cm DBH1.3 cm. Those trees> 10 cm DBH1.3 further had a subdivision between10-20, 20-30, 30-40, and 40-50 (see Table 5).

Table 5: Number of stems per ha for the sample areas in Mole National Park [Annette den Hollander H.J. (2008)]

DBH Class	Vegetation Layer life-form Type	# of Trees/ha in Savannah
< 2.5 cm	Shrubs	16
2.5-10 cm	Small trees	75
> 10 cm	Trees	22

3. Criteria and Indicators for Ecological Zone Classification

Criteria and indicators that may be used to define the condition score for any ecological zone type could be formulated alongside the work of Hawthorne and Abu-Juam (1995). However, in an effort to reduce the level of subjectivity of any scoring description, measurable indicators that can be verified with relative ease and also show consistency in application must be aimed at.

Firstly, stratifying the ecological zones into forest, savannah and forest-savannah interface (otherwise known as transitional zone) will be a fair approximation for the main eco-zones of Ghana. More especially as an attempt for *assessing forest landscape restoration potential in Ghana to contribute to REDD-Plus strategies for climate change mitigation, poverty alleviation and sustainable forest management.*

Secondly, with the availability of imaging systems for satellite image acquisition such as Landsat with 30 meter resolution or better, corroborated with ground truthing and field observations, requirements for vegetation condition scoring can be reasonably achieved. Criteria worth considering include but not limited to the following:

- Canopy cover
- Human disturbance including logging damage and settlements/farming
- Tree stems number estimates (stems/unit area)
- Basal area
- Natural regeneration (seedlings and sapling count /unit area)
- Wildfire damage

3.1 Basis for Scoring Description

Adopting a country-wide scoring description that encompasses a mosaic landscape of different ecological zones requires careful consideration of the scoring criteria to be adopted. The following measures were adopted:

- Scoring criteria used shall be applicable to all the key ecological zones identified
- For each ecological zone, a scoring description on a gradation scale from 1-4 shall be uniformly applied to all the criteria listed above. This shall be done to reflect the inherent ecological attribute(s) of that particular zone (**see Appendix IV**).
- Score 1 shall be the most ideal condition score; score 2 shall be deemed ecologically tolerable score whereas score 3 shall be described as degraded and 4 shall be an undesirable score.
- In determining the vegetation condition score for a particular eco-zone the average score for all the individual criteria scores (i.e. canopy cover, human disturbance, tree stem number estimates, basal area, natural regeneration and fire damage) shall be used (**see Appendix IV**).
- In general the lesser the gradation scoring the more likely the element of subjectivity will be minimized. However, the precaution here is that the criteria for ecological zone description should be distinct and measurable with less ambiguity.
- Forest condition scoring adopted by Hawthorne and Abu-Juam (1995) remains an important reference point. However, whereas Hawthorne and Abu-Juam (1995) applied the scores based on observation, conversation with forest staff working in the area, the inventory results and satellite imagery in decreasing order of importance, this current approach gives Landsat-type satellite imagery (30 meter resolution or better) prominence followed by ground truthing and field observations.

4. Forest and Woodland Cover Mapping

The satellite image-based mapping was done at the national large scale for all reserves and protected areas in the forest and savannah ecological zones. Landsat TM, ETM+ and ASTER satellite image scenes spanning 2003 – 2010 were used for the analysis. Image classification was done to determine the nature and extent of forest cover loss within the reserves. The spatial framework adopted for the mapping was based on the two broad vegetation types namely, forest and savannah. This is because these vegetation zones serve as a spatial framework for environmental resource management in Ghana. They denote areas that contain a geographically distinct assemblage of environmental conditions, natural communities, and plant species.

The image processing focussed principally on processing Landsat Thematic Mapper (TM) Enhanced Thematic Mapper Plus (ETM+) satellite images, and in certain cases where good Landsat scenes were not available, ASTER Images. Digital topographic data layers including settlement locations, road and stream network were used as ancillary information sources.

The methodology involved the following:

1. Image acquisition and pre-processing
2. Image processing classification and field validation
3. Map composition and presentation

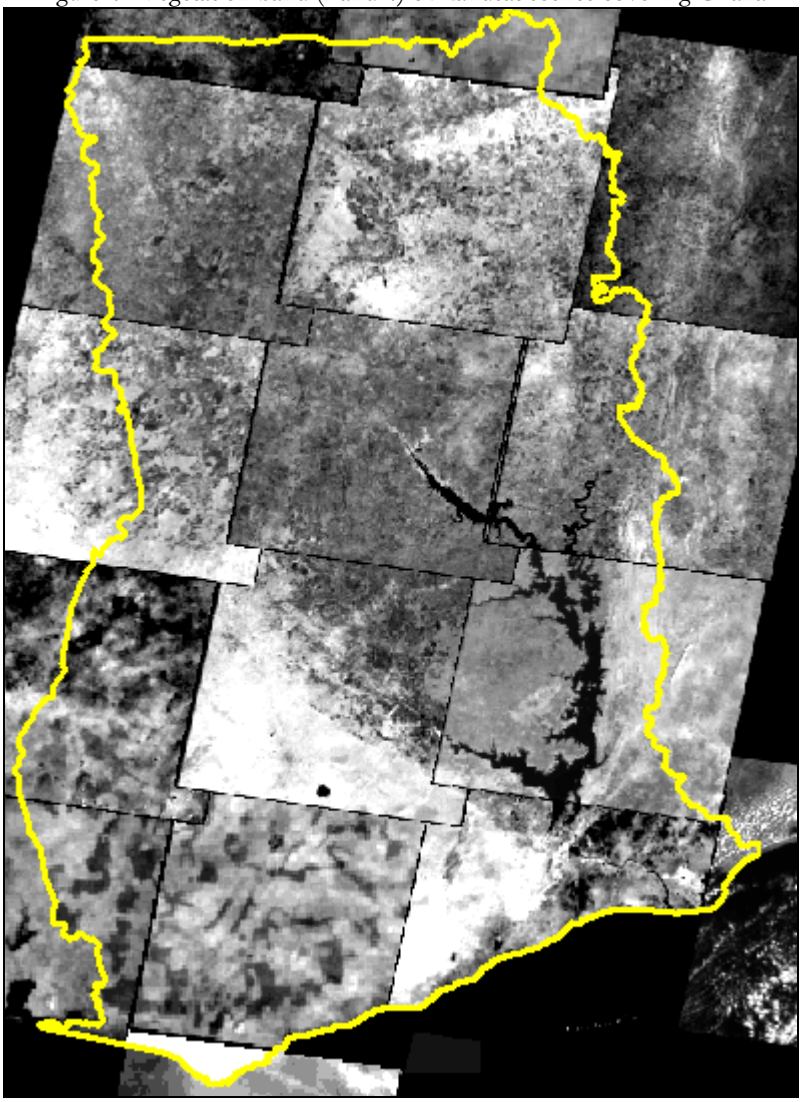
4.1 Image acquisition and pre-processing

Landsat data between 1999 and 2010 images were acquired and examined to judge any missing scenes or data gap including cloud cover. Scenes selected for the mapping were almost cloud free except some patches in some scenes. The vegetation bands (Bands 3 and 4 of Landsat) were further examined and used for the classification after the necessary geometric and radiometric corrections.

Band 3 (Red) is a useful band for discriminating among different kinds of vegetation, and band 4 (Near infrared) is especially responsive to the amount of vegetation biomass present in a scene. It is also useful for distinguishing between vegetation and soil, and for seeing the boundaries of bodies of water.

All images have been georeferenced to UTM Zone 30, WGS 84.

Figure 4: Vegetation band (Band 4) of Landsat scenes covering Ghana



4.2 Image classification

Satellite image analysis can be carried out in two ways: visual or automatic. Visual interpretation is purely subjective interpretation by a human interpreter. Automatic methods are generally preferable where possible because the interpretation is repeatable and efficient, furthermore large areas can be classified much faster than with visual analysis. Automatic classification can be further divided into two categories: supervised and unsupervised classification. In unsupervised classification, the classification software is allowed to sort pixels according to their reflectance values. Unsupervised classification is good in the classification of pixels within a target area without human interference.

An unsupervised classification with an ISODATA (Iterative Self-organizing Data Analysis) algorithm was performed on image scenes to group pixels with similar spectral response into unique clusters of different classes. The homogeneous clusters corresponding to specific forest cover types were assigned appropriate cover classes based on reference data from color composite images, high resolution images where available and expert ground knowledge. Colour composite images helped identify the different forest cover types, thus clusters of homogeneous reflectance were merged together.

The spectral variability during the classification procedure produced 'salt-and-pepper' appearance of the classified image as a result of the pixel by pixel classification. The classified image was therefore resampled with a 3 x 3 majority smoothing filter.

Four cover classes, as described in Tables 6 and 7 were assigned to the satellite image classification as closed canopy, intermediate canopy, open canopy, degraded area.

Forest map unit refers to continuous, multi-storied stand of trees at least 5m high with interlocking crowns, usually lacking a grass ground cover. Forest is sub-categorized at into "closed canopy" where the canopy cover exceeds 50% (>50% canopy cover), and "open canopy" where the canopy cover is less than 50% (<50% canopy cover).

Savannah has been mapped as an area of land comprising a mixture of woodland (a single storied of trees less that 5m high), and/or bushes (woody plant with multiple stems, usually over 2m tall), and/or shrubs (woody plant with multiple stems, usually less than 2m tall), and/or grassland with or without scattered cultivation. Savannah is sub-divided into closed woodland, open woodland, and grassland.

Table 6: Forest Cover Classes

Closed Canopy	Land with a minimum tree crown cover (or equivalent stocking level) of 50% and a minimum area of 1.0 ha
Open canopy	Land with tree crown cover (or equivalent stocking level) between 50%<15% and a minimum area of 1.0 ha
Deforested Area	Land with tree crown cover (or equivalent stocking level) of less than 15% and a minimum area of 1.0 ha

Table 7: Savannah Cover Classes

Closed Woodland	Land with tree crown cover of more than 30% and a minimum area of 1.0 ha
Open Woodland	Land with tree crown cover of between 30<10% and a minimum area of 1.0 ha
Grassland	Land with predominantly covered by grass with scattered trees with crown cover below 10% and a minimum area of 1.0 ha

4.3 Field Validation and Accuracy Assessment

The mapping was validated in the field, in order to assess mapping accuracy. Reserves were randomly sampled for each vegetation zone for field validation. Sample sites easily assessable were selected within each of the sampled Reserves for ground-truthing. The validation concentrated on areas where the accuracy was known to be lower. These areas were edited to reflect the ground-truth, so as to improve mapping accuracy.

4.4 Map composition and presentation

Maps have been produced for each Reserve and statistics for cover classes have been reported.

4.5 Software used

ERDAS IMAGINE 2011 was used for image processing and ArcGIS 9.3, for the map preparation. All maps are in Appendix VI.

Appendix IV. Criteria for scoring condition and restoration opportunities

A set of criteria has been developed for scoring of the condition of the vegetation in Ghana and associated restoration opportunities. These criteria are shown below in four tables:

1. Criteria and associated scales for condition scoring of high forest, transition zone, and savannah (Table 1)

2. Comprehensive scale for scoring the condition and restoration opportunities in key ecological zones
    a. the forest zone (Table 2)
    b. the transition zone (Table 3)
    c. the savannah zone (Table 4)

Forest is defined according to FAO (2000) as:

- "Land with tree crown cover (or equivalent stocking level) of more than 10 percent and an area of more than 0.5 hectares (ha). Ghana recently defined its forest as land with tree crown cover of more than 15 percent and a minimum area of 1.0 hectare (ha).
- The trees should be able to reach a minimum height of 5 meters (m) at maturity in situ.
- May consist either of closed forest formations where trees of various storey and undergrowth cover a high proportion of the ground or open forest formations with a continuous vegetation cover in which tree crown cover exceeds 10 percent.
- Young natural stands and all plantations established for forestry purposes which have yet to reach a crown density of 10 percent or tree height of 5 m are included under forest,
- are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention or natural causes but which are expected to revert to forest."

The classification of savannahs based on crown cover is adopted from Annette den Hollander H.J. (2008) where crown cover is estimated from the crown of individual trees and the gap between the crowns of trees. Thus the crown cover is calculated from the crown separation ratio which is different from that used for forests.

Table 1: Criteria and associated scales for condition scoring in key ecological zones in Ghana

CRITERION	**SCALE FOR CONDITION SCORING**			**VERIFICATION**
	Forest	Transition	Savannah	
Canopy cover	Land with a minimum tree crown cover (or equivalent stocking level) of 50% and a minimum area of 1.0 ha = 1 Land with tree crown cover (or equivalent stocking level) between 30-50% and a minimum area of 1.0 ha = 2 Land with tree crown cover (or equivalent stocking level) between 15-30% and a minimum area of 1.0 ha= 3 Land with tree crown cover (or equivalent stocking level) of less than 15% and a minimum area of 1.0 ha = 4	Land with a minimum tree crown cover (or equivalent stocking level) of 50% and a minimum area of 1.0 ha = 1 Land with tree crown cover (or equivalent stocking level) between 30-50% and a minimum area of 1.0 ha = 2 Land with tree crown cover (or equivalent stocking level) between 15-30% and a minimum area of 1.0 ha= 3 Land with tree crown cover (or equivalent stocking level) of less than 15% and a minimum area of 1.0 ha = 4	Land with tree crown cover of more than 30% and a minimum area of 1.0 ha = 1 Land with tree crown cover of between 20-30% and a minimum area of 1.0 ha = 2 Land with tree crown cover between 10-20% and a minimum area of 1.0 ha= 3 Land with tree crown cover below 10% and a minimum area of 1.0 ha= 4	Satellite imagery + ground truth data/ survey [protocols/methods to be defined including sampling design]
Human disturbance (including logging damage,	Very few signs (<2%) of human disturbance attributable to logging/farms; virgin or late secondary forest visible	Minimal signs[1] (<5%) of human disturbance attributable to logging/farms; late secondary forest visible throughout = 1	Minimal signs (<10%) of human disturbance attributable to agricultural practices including grazing;	Satellite imagery + field observations

[1] Minimal signs of disturbance at that percentage range are conservative average figures judged from observations made in sacred groves dotted throughout the transitional zone. The sacred groves (remnant forest) serve as proxies of near original state of the transitional zone forests

CRITERION	SCALE FOR CONDITION SCORING			VERIFICATION
	Forest	Transition	Savannah	
farms, etc)	throughout = 1 Between 2-10% of forest mosaic heavily disturbed. Logging damage quite visible and extensive= 2 Between 10-50% of forest mosaic heavily disturbed. Logging damage quite visible and extensive= 3 More than 50% of forest mosaic visibly disturbed and patchy; logging damage is extensive and intensive; forest is heavily burnt with conspicuous *Eupatorium* and other pioneers throughout = 4	Between 5-15% of forest mosaic heavily disturbed. Logging damage is evident = 2 Between 15-50% of forest mosaic heavily disturbed. Logging damage is evident = 3 More than 50% of forest mosaic visibly disturbed and patchy; logging damage is extensive; forest is heavily burnt with conspicuous *Eupatorium* and other pioneers throughout = 4	late-stage savannah woodland vegetation[2] visible throughout = 1 Between 10-25% of savannah woodland is heavily disturbed especially through fire and over-grazing, and approaching an "open savannah". = 2 Between 25-50% of savannah woodland is heavily disturbed especially through fire and over-grazing, and approaching "grassland". = 3 More than 50% of savannah vegetation is visibly disturbed and patchy; damage due to fire and over-grazing is extensive; Ground cover predominantly grasses or other herbaceous plants; tree cover is almost absent= 4	
Tree stem number	Average stem frequencies[3] (>450 stems per ha) estimated for all	Average stem frequencies(>250 stems per ha) estimated for all	Average stem frequencies[4] (> 200 stems per ha) estimated	Repeated ground truth data/ survey

[2] Late stage savannah wood land is considered here as climax vegetation which is more stable than other forms of derived savannah

CRITERION	SCALE FOR CONDITION SCORING			VERIFICATION
	Forest	Transition	Savannah	
estimates	trees down to 10 cm dbh in the different forest types = 1 Average stem frequencies(between 300-450 stems per ha) estimated for all trees down to 10 cm dbh in the different forest types = 2 Average stem frequencies(between 200-300 stems per ha) estimated for all trees down to 10 cm dbh in the different forest types = 3 Average stem frequencies below 200 stems per ha estimated for all trees down to 10 cm dbh in the different forest types = 4	trees down to 10 cm dbh in the Dry Semi-deciduous forest type= 1 Average stem frequencies(between 150-250 stems per ha) estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous = 2 Average stem frequencies(between 100-150 stems per ha) estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous = 3 Average stem frequencies below 100 stems per ha estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous = 4	for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types = 1 Average stem frequencies (between 150-200 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types = 2 Average stem frequencies (between 100-150 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types = 3 Average stem frequencies (<100 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types =4	required

[3] Data estimated from Forest Inventory Project of 1986-1990; Multi-resource inventory program conducted in 2001 and more recently RMSC updated inventory data of August, 2009. Stems per ha values (down to10 cm dbh) reflect average values ranging from the highest in Wet Evergreen to the lowest in Dry Semi-deciduous forest type in Ghana

[4] Adopted from Annette den Hollander H.J. (2008) see Table 4

CRITERION	SCALE FOR CONDITION SCORING			VERIFICATION
	Forest	Transition	Savannah	
Basal area (m^2/ha)	Average basal area[5] (>24 m^2/ ha) estimated for all trees down to 10 cm dbh in the different forest types = 1 Average basal area (between 15-24 m^2/ ha) estimated for all trees down to 10 cm dbh in the different forest types = 2 Average basal area (between 10-15 m^2/ ha) estimated for all trees down to 10 cm dbh in the different forest types = 3 Average basal area below10 m^2/ ha estimated for all trees down to 10 cm dbh in the different forest types = 4	Average basal area (>18 m^2/ ha) estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous forest type= 1 Average basal area (between 10-18 m^2/ ha) estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous = 2 Average basal area (between 5-10 m^2/ ha) estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous = 3 Average basal area below 5 m^2/ ha estimated for all trees down to 10 cm dbh in the Dry Semi-deciduous = 4	Data not available	Repeated ground truth data/ survey required
Natural regeneration	Natural regeneration evident through average counts[6] greater than 350/ha of seedlings/ saplings (10-29.9 cm dbh) in the forest floor =1	Natural regeneration evident through average counts greater than 300/ha of seedlings/ saplings (10-29.9 cm dbh) in the forest floor =1	Natural regeneration[7] evident through average counts greater than 150/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh)	Repeated ground truth data/ survey required

[5] Data estimated from Forest Inventory Project of 1986-1990; Multi-resource inventory program conducted in 2001 and more recently RMSC updated inventory data of August, 2009. Basal area per ha values (down to10 cm dbh) reflect average values ranging from the highest in Wet Evergreen to the lowest in Dry Semi-deciduous forest type in Ghana

[6] Data estimated from Forest Inventory Project of 1986-1990; Multi-resource inventory program conducted in 2001 and more recently RMSC updated inventory data of August, 2009. Stems per ha values (10-29.9 cm dbh) reflect average ranges estimated for the various forest types in Ghana

[7] See Table 4 for similar inferences

CRITERION	SCALE FOR CONDITION SCORING			VERIFICATION
	Forest	Transition	Savannah	
	Natural regeneration evident through average counts between 200-350/ha of seedlings/ saplings (10-29.9 cm dbh) in the forest floor =2 Natural regeneration evident through average counts between 100-200/ha of seedlings/ saplings (10-29.9 cm dbh) in the forest floor =3 Poor or no forest regeneration; counts less than100 seedlings/ saplings (10-29.9 cm dbh) in the forest floor = 4	Natural regeneration evident through average counts between 200-300/ha of seedlings/ saplings (10-29.9 cm dbh) in the forest floor =2 Natural regeneration evident through average counts between 100-200/ha of seedlings/ saplings (10-29.9 cm dbh) in the forest floor =3 Poor or no forest regeneration; counts less than100 seedlings/ saplings (10-29.9 cm dbh) in the forest floor = 4	in the lower vegetation layer =1 Natural regeneration evident through average counts between 100-150/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer =2 Natural regeneration evident through average counts between 50-100/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer =3 Natural regeneration evident through average counts less than 50/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer =4	
Fire damage	No signs of fire damage = 1 Fire damage is visible (< 10% of forest mosaic) but not extensive = 2 Between 10-30% of forest mosaic with serious scars of fire damage = 3	Fire damage is visible (< 20% of forest mosaic) but not extensive = 1 Between 20-30% of forest mosaic with scars of fire damage = 2 Between 30-50% of forest	Evidence of annual fires in recent period (past decade) but damage not extensive probably due to better fire management control regimes= 1 Evidence of annual fires with	Satellite imagery + ground truth data/ survey and past fire history record if available

CRITERION	SCALE FOR CONDITION SCORING			VERIFICATION
	Forest	Transition	Savannah	
	More than 30% of forest mosaic with serious scars of fire damage = 4	mosaic with serious scars of fire damage = 3 More than 50% of forest mosaic with serious scars of fire damage; visible evidence of derived savannah due to repeated fires = 4	a medium term history (within the last 50 years) exacerbated by anthropogenic factors including improper fire management regime = 2 Evidence of annual fires with a medium to long-term history (within the last 50-75 years) exacerbated by anthropogenic factors including improper fire management regime = 3 Evidence of annual fires with a relatively longer history (about 100 years or so) exacerbated by anthropogenic factors including improper fire management regime = 4	

Table 2: Comprehensive scale for scoring the condition and restoration opportunities in the forest zone

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
1	Land with tree crown cover (or equivalent stocking level) of more than 50% and a minimum area of 1 ha; very few signs (<2%) of human disturbance; excellent regeneration recording over 350 seedlings/saplings per ha; average stem frequencies for all diameter classes well above 450 stems/ha (very good stock density); basal area > 24 m^2/ha; no evidence of fire damage detected or recorded	Example is Ankasa Forest Reserve in the Western Region	Not **s**uitable for restoration except few pockets of areas requiring enhanced natural regeneration or enrichment planting	Very few isolated pockets of slight human disturbance that should be allowed to undergo natural regeneration. Approx. < 10% of WE forest type (600 km^2)	Wet Evergreen (WE) forest type. Remnants of a typical rain forest ; very few of such forest type is left in Ghana
2	Land with tree crown cover (or equivalent stocking level) of between 30-50% and a minimum area of 1 ha; between 2-10% of forest mosaic heavily disturbed through logging and other human disturbance; good regeneration (200-350 seedlings/saplings per ha; average stem frequencies for all diameter classes in the range of 300-450 stems/ha (good stocking density); basal area between 15 - 24 m^2/ha; fire damage is visible but not extensive over the defined forest area	Examples of forest reserves with similar condition are Bonkoni, Bonsa Ben, Bura River, Tano Anwia, Tano Nimiri, etc and their adjoining off-reserve areas within 20 km radius	Some areas may be suitable for restoration but requires careful intervention strategies that make use of native tree species originally present in the area and other ecological considerations	About 30% (5,300 km^2) of the total forest area classified as Moist Evergreen	Commonly occurs in parts of the forest area classified as Moist Evergreen

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
3	Land with tree crown cover (or equivalent stocking level); of between 15-30% and a minimum area of 1 ha; between 10-50% of forest mosaic heavily disturbed; logging damage is visible and extensive; natural regeneration (100-200 seedlings/saplings per ha; average stem frequencies for all diameter classes between100-200 stems/ha (low stocking density); basal area between 10 - 15 m^2/ha; fire damage is visible. Between 10-30% of forest mosaic with serious scars of fire damage over a defined forest area.	Examples of forest reserves with similar condition are Desiri, Dome River, South Formangsu, Krochua, Mpameso, Tain Tributaries II,	Suitable for restoration through enrichment planting and plantation programs. Requires careful intervention strategies that: **(i)** make use of native tree species originally present in the area **(ii)** ensures effective fire prevention measures	About 50% (27,000 km^2) of the total forest area classified as Moist Semi-Deciduous and Dry Semi-Deciduous forest types potentially qualify for restoration	Commonly occurs in parts of the Moist Semi-Deciduous and Dry Semi-Deciduous forest types
4	Land with tree crown cover (or equivalent stocking level); of less than15% and a minimum area of 1 ha; More than 50% of forest mosaic heavily disturbed and patchy; logging damage is extensive and intensive; forest is heavily burnt with conspicuous *Eupatorium* and other pioneer species throughout; very low regeneration (less than	Examples of forest reserves with similar condition are North Bandai Hills, Pamu-Berekum, Tain Tributaries I,	Suitable for restoration through particularly large-scale plantations. Requires careful intervention strategies that:	About 30% of Dry Semi-Deciduous (inner & fire zone type) + 50% of Southern marginal forest (7,580 km^2) types	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the inner zone type and the Southern marginal forest types

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
	100seedlings/saplings per ha; average stem frequencies for all diameter classes below 100 stems/ha (very low stock density); basal area below 10 m^2/ha; fire damage is visible. More than 30% of forest mosaic with serious scars of fire damage over the defined forest area.	Bodi, Kronwam,	**(i)** make use of native tree species originally present in the area **(ii)** ensures effective fire prevention measures	potentially qualify for restoration	

Table 3: Comprehensive scale for scoring the condition and restoration opportunities in the transition zone

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
1	Land with tree crown cover (or equivalent stocking level) of more than 50% and a minimum area of 1 ha; minimal signs (<5%) of human disturbance; very good regeneration recording over 300 seedlings/saplings per ha; average stem frequencies for all diameter classes well above 250 stems/ha (good stock density); Average basal area (>18 m^2/ ha) estimated for all trees down to 10 cm dbh; fire damage is visible (< 20% of forest mosaic) but not extensive	Examples of forest reserves with similar condition are Opimbo 1, 2, Ongwam 1,2,3 and identifiable sacred groves within Dry Semi-Deciduous (inner & fire zone type)	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native plant species originally present in the area **(ii)** ensures effective fire prevention measures	About 10% of Dry Semi-Deciduous (inner & fire zone type) + 10% of Southern marginal forest (2,400 km^2) types potentially qualify for restoration	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the inner zone type and the Southern marginal forest types
2	Land with tree crown cover (or equivalent stocking level) between 30-50% and a minimum area of 1 ha; minimal signs (between 5-15%) of human disturbance; good regeneration recording between 200-300 seedlings/saplings per ha; average stem frequencies for all diameter classes between 150- 250 stems/ha (good stock density); Average basal area (between 10-18 m^2/ ha) estimated for all trees down to 10 cm dbh; Between 20-30% of forest mosaic with scars	Examples of forest reserves with similar condition are Nsemere and Bomfuom, Bandai Hills (South)	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native plant species originally present in the area **(ii)** ensures	About 20% of Dry Semi-Deciduous (inner & fire zone type) + 10% of Southern marginal forest (4,500 km^2) types potentially qualify for restoration	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the inner zone type and the Southern marginal forest types

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
	of fire damage.		effective fire prevention measures		
3	Land with tree crown cover (or equivalent stocking level) of between 15-30% and a minimum area of 1 ha; about 20% of human disturbance; low-medium natural regeneration recording between 100-350 seedlings/saplings per ha; average stem frequencies for all diameter in the range of 100-400 stems/ha; more than 10% of forest mosaic with scars of fire damage	Examples of forest reserves with similar condition are Kpandu Range (Dayi block)	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native plant species originally present in the area **(ii)** ensures effective fire prevention measures	About 10% of Dry Semi-Deciduous (inner and fire zone types) +30% Southern marginal forest types (2,800 km^2) potentially qualify for restoration	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the fire zone type and the Southern marginal forest types
4	Land with tree crown cover (or equivalent stocking level) of less than 15% and a minimum area of 1 ha; more than 50% of human disturbance in a defined transitional zone; very poor natural regeneration recording less than 100 seedlings/saplings per ha; average stem frequencies for all diameter classes well below 100 stems/ha; More than 50% of forest mosaic in a defined area with serious scars of fire damage; visible evidence	Examples of forest reserves with similar condition are Kpandu RangeWest, and Pru Shelterbelt	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native plant species originally present in the area	About 30% of Dry Semi-Deciduous (inner and fire zone types) +30% Southern marginal forest types (8,000 km^2) potentially qualify for	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the fire zone type and the Southern marginal forest types

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
	of derived savannah due to repeated fires		**(ii)** ensures effective fire prevention measures	restoration	

Table 4: Comprehensive scale for scoring the condition and restoration opportunities in the savannah zone

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
1	Land with tree crown cover of more than 30% and a minimum area of 1.0 ha; minimal signs (<10%) of human disturbance attributable to agricultural practices including grazing; late-stage savannah woodland vegetation visible throughout; average stem frequencies (> 200 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types; natural regeneration evident through average counts greater than 150/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer; evidence of annual fires in recent period (past decade) but damage not extensive probably due to better fire management control regimes	Examples of savannah vegetation with similar condition occurs in parts of Bomfobiri Wildlife Sanctuary and Shai Hills Game Production Reserve	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native tree species originally present in the area **(ii)** considers wildlife habitat **(iii)** ensures effective fire prevention measures	Further validating studies required to confirm present conditions on the ground	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the fire zone type and the Southern marginal forest types
2	Land with tree crown cover of between 20-30% and a minimum area of 1.0 ha; between 10-25% of savannah woodland is heavily disturbed especially through fire and over-grazing, and approaching an "open savannah"; average stem frequencies (between 150-200 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the	Examples of savannah vegetation with similar condition could be found in parts of Mole National Park in the northern	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native tree species originally	Further validating studies required to confirm present conditions on the ground	Commonly occurs in parts of the Dry Semi-Deciduous forest type, especially the fire zone type and the Southern marginal forest types

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
	savannah vegetation types; natural regeneration evident through average counts between 100-150/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer; evidence of annual fires with a medium term history (within the last 50 years) exacerbated by anthropogenic factors including improper fire management regime	savannah zone	present in the area **(ii)** considers wildlife habitat **(iii)** ensures effective fire prevention measures		
3	Land with tree crown cover between 10-20% and a minimum area of 1.0 ha; between 25-50% of savannah woodland is heavily disturbed especially through fire and over-grazing, and approaching "grassland"; average stem frequencies (between 100-150 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types; natural regeneration evident through average counts between 50-100/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer; evidence of annual fires with a medium to long-term history (within the last 50-75 years) exacerbated by anthropogenic factors including improper fire management regime	Examples of savannah vegetation with similar condition are found in Odonkokrom on the Afram Plains; Yilo Krobo area between Huhunya and Asesewa where intensive farming have replaced the forest by a kind of secondary grassland	Suitable for restoration but requires careful intervention strategies that: **(i)** make use of native tree species originally present in the area **(ii)** considers wildlife habitat **(iii)** ensures effective fire prevention measures	Further validating studies required to confirm present conditions on the ground	Commonly occurs in parts of the Northern Region of Ghana
4	Land with tree crown cover below 10% and a minimum area of 1.0 ha; more than 50% of savannah vegetation is visibly disturbed and	Examples of savannah vegetation with	Suitable for restoration but requires careful	Further validating studies required to	Commonly occurs in parts of the Northern and

Avg. Condition Score	Definition	Indicative Vegetation Area	Suitability for Restoration	Potential Area (km^2) Available Restoration	Remarks
	patchy; damage due to fire and over-grazing is extensive; Ground cover predominantly grasses or other herbaceous plants; tree cover is almost absent; average stem frequencies (<100 stems per ha) estimated for all trees and shrubs down to 2.5 cm dbh in the savannah vegetation types; natural regeneration evident through average counts less than 50/ha of shrubs (<2.5 cm dbh) and small trees (2.5-10.0 cm dbh) in the lower vegetation layer; evidence of annual fires with a relatively longer history (about 100 years or so) exacerbated by anthropogenic factors including improper fire management regime	similar condition may be typical of the Upper East and West Regions of Ghana where the Sudan savannah predominates.	intervention strategies that: **(i)** make use of native tree species originally present in the area **(ii)** considers wildlife habitat **(iii)** ensures effective fire prevention measures	confirm present conditions on the ground	Upper Regions of Ghana

Appendix V. Forest and Woodland Cover Classification Maps