Ministry of Environmental Conservation and Forestry
Forest Department

Construction of Forest Emission Reference Level/ Forest Reference Level in Taungoo district, Bago Yoma, Myanmar

in accordance with the
Warsaw Framework on REDD+

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For

ITTO Project on "Capacity building for developing REDD+ activities in the context of sustainable for forest management"

July, 2014

In December 2012 Myanmar launched the project titled “Capacity building for developing REDD+ activities in the context of sustainable forest management” with the support of ITTO. It includes a sub-national REDD+ demonstration initiative in about a million ha of the country famous natural and planted teak forests in Taungoo District in BagoYoma region. A critical part of this demonstration relates to assessment of baseline carbon stocks and setting up of forest reference emission level (FREL) and forest reference level (FRL) as constituents of the overall monitoring, reporting and verification of REDD+ activities in Myanmar in accordance with the relevant decisions of the UNFCCC

In the winters of 2013 the Climate Conference at Warsaw took a big step forward for making implementation of REDD+ possible through result based finance of REDD+ activities that meet the requisite social and environmental safeguards, and are measured, reported and verified in accordance with approved procedures. A prime requirement for this purpose is the construction of FREL/ FRL against which the achievements are to be measured. In setting these reference levels national circumstances and capabilities are to be kept under consideration and the setting should allow improvement by incorporating better data as improved technologies become available in course of time. Keeping the costs low and avoidance of delays are also important constraints. This would be a difficult task anywhere but is more so in Myanmar with limited availability of reliable historical forest inventory data.

In view of inadequate data and limited time, efforts have made to develop separate baselines for deforestation, forest degradation, and enhancement of carbon stock outside the forest areas in the Taungoo district using available data with the baselines expressed in area rather than carbon tonnage as is the norm in climate change projects. In this regard, I wish to commend the authors for their efforts to make relevant REDD+ in the Taungoo district easily measurable, reportable and verifiable.

It needs to be emphasized, however, that this attempt at REDD+ baseline construction for Taungoo district is just a beginning of the development of very important and highly complex MRV systems and it would require continuous improvements to make it more accurate. It is my sincere hope that the publication of this technical report would be a noted landmark in the implementation of REDD+ activities in Myanmar.

Director General of Forest Department

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AFOLU	Agriculture, Forestry, and Other Land Uses
BUR	Biennial Update Report
CoP	Conference of Parties
FCPF	Forest Carbon Partnership Facility
FREL	forest reference emission level
FRL	forest reference level
GHG	Green house gases
GLCC	Global Land Cover Characterization)
GPG	Good Practice Guidance
ICA	International Consultation and Analysis
IPCC	Intergovernmental Panel on Climate Change
ITTO	International Tropical Timber Organization
LULUCF	Land use, Land-use change and Forestry
MODIS	Moderate Resolution Imaging Spectroradiometer
MRV	monitoring, reporting and verification
NFMS	National Forest Monitoring Systems
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus
REM	REDD Early Movers
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations Program for Reducing Deforestation and Forest degradation
VCS-JNR	Verified Carbon Standard’s Jurisdictional and Nested REDD+

Executive summary

In December 2012 Myanmar launched this project titled “Capacity building for developing REDD+ activities in the context of sustainable forest management” which includes a sub-national REDD+ demonstration initiative covering about a million ha of forest lands located in Taungoo District in Bago Yoma region of the country famous for its natural and planted teak forests. A critical part of this capacity building relates to assessment of baseline carbon stocks and setting up of forest reference emission level (FREL) and forest reference level (FRL) as constituents of the overall monitoring, reporting and verification of REDD+ activities in Myanmar in accordance with the relevant decisions of the UNFCCC. This Technical Report presents the background, methodology, activities, and the outcome of this task.

A set of important decisions taken at the Warsaw climate summit of 2013, called the Warsaw Framework for REDD+, now define the shape of REDD+ activities around the world and have also, quite naturally, influenced the course of this project even though it preceded the Framework. An important aspect of the Framework is the acceptance of result based finance of pre-approved REDD+ activities that are fully measured, reported and verified, are transparently carried out and meet the requisite social and environmental safeguards. The reliability of climate change mitigation achievements through REDD+ is sought to be enhanced by the provision of a neutral technical assessment of the FREL/FRL developed by participating countries through a facilitative and non-intrusive technical exchange of information.

A prime requirement in the construction of FREL/FRL for REDD+ is the pursuit of environmental integrity and avoidance of perverse incentives in mitigation achievements while accommodating national circumstances and capabilities which is a key aspect of all mitigation activities under the UNFCCC in general and of REDD+ in particular. Countries could adopt a step-wise approach to national FREL/FRL development that enables improvement by incorporating better data, additional pools and improved methodologies. Countries are encouraged to improve the data and methodologies over time while maintaining consistency with the established FREL/FRL. It would enable adoption of new technologies for MRV as they develop and come within reach while ensuring comparability with the earlier measurements. Also the countries are encouraged to develop their National Forest Monitoring Systems (NFMS) building upon the existing forest monitoring systems with the objective of reducing costs and delays and reflect the phased approach to REDD+.

REDD+ has five distinct components of reducing emissions from deforestation and forest degradation, enhancing forest carbon stock, conservation of forests and sustainable management of forests. These five components will often have different drivers but they have obvious overlaps as they produce only three different outcomes, namely, reduction of emissions; enhancement of the rate of sequestration and maintenance of existing forest reservoirs. A sub-national REDD+ project in Taungoo district will have all these five distinct components. An acceptable approach could be to divide the project area into distinct zones where one or the other of these components predominates and decipher the causal factors.

The result based payment agreed at Warsaw need this bottom up approach because the flow of incentive money to the communities and organizations involved in REDD+ activities must relate to the costs of achieving the agreed series of interim results measured against local baselines incurred by various actors including the individuals, communities and the government agencies like the forest departments. These local baselines, therefore, assume crucial importance in result based payments. But lack of data restricted us to confine the reference level assessment to only deforestation, degradation of forests and afforestation of non-forest lands for which published data was available.

Baseline for deforestation

The availability of forest inventory data in Myanmar is rather limited and the reliability of some, including the very high rate of deforestation implied in the FAO Global Forest Resources Assessment for 2005 and 2010, has been called in question. Since cost and time considerations precluded detailed data collection for this project, it was decided to use the available source considered most reliable. For the purpose of deforestation the assessment by Smithsonian team of Leimgruber and team using wall to wall coverage by Landsat-5 Thematic Mapper (TM) for 1989-1992, and Landsat-7 Enhanced Thematic Mapper (ETM-h) for 2000-2001 was deemed more reliable compared to the earlier estimates that formed the basis of FAO reports which were based on small samples of satellite imagery combined with the skills of the Experts used for extrapolation to the rest of the country. The accuracy of Smithsonian change maps was found to be close to 86% when compared with raw images collected between 2000 and 2002 from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) with 15 m resolution which was used to generate 1558 control points well distributed among forested, non-forested, reforested and afforested landscapes across Myanmar.

The Smithsonian change assessment identified northern Bago Yoma region as a hotspot of deforestation with an estimated rate of 0.5% per annum which is, therefore, used as the closest approximation for historical data up to the year 2000 to construct deforestation baseline for the Taungoo district. In the decade 2001-2010 deforestation has slowed down somewhat across the country with increased awareness and action on the part of the government. Only anecdotal evidence is available for this reducing trend with little hard data and it was, therefore, assumed that the rate of deforestation reduced very modestly from 0.5% in 2000 to 2010.

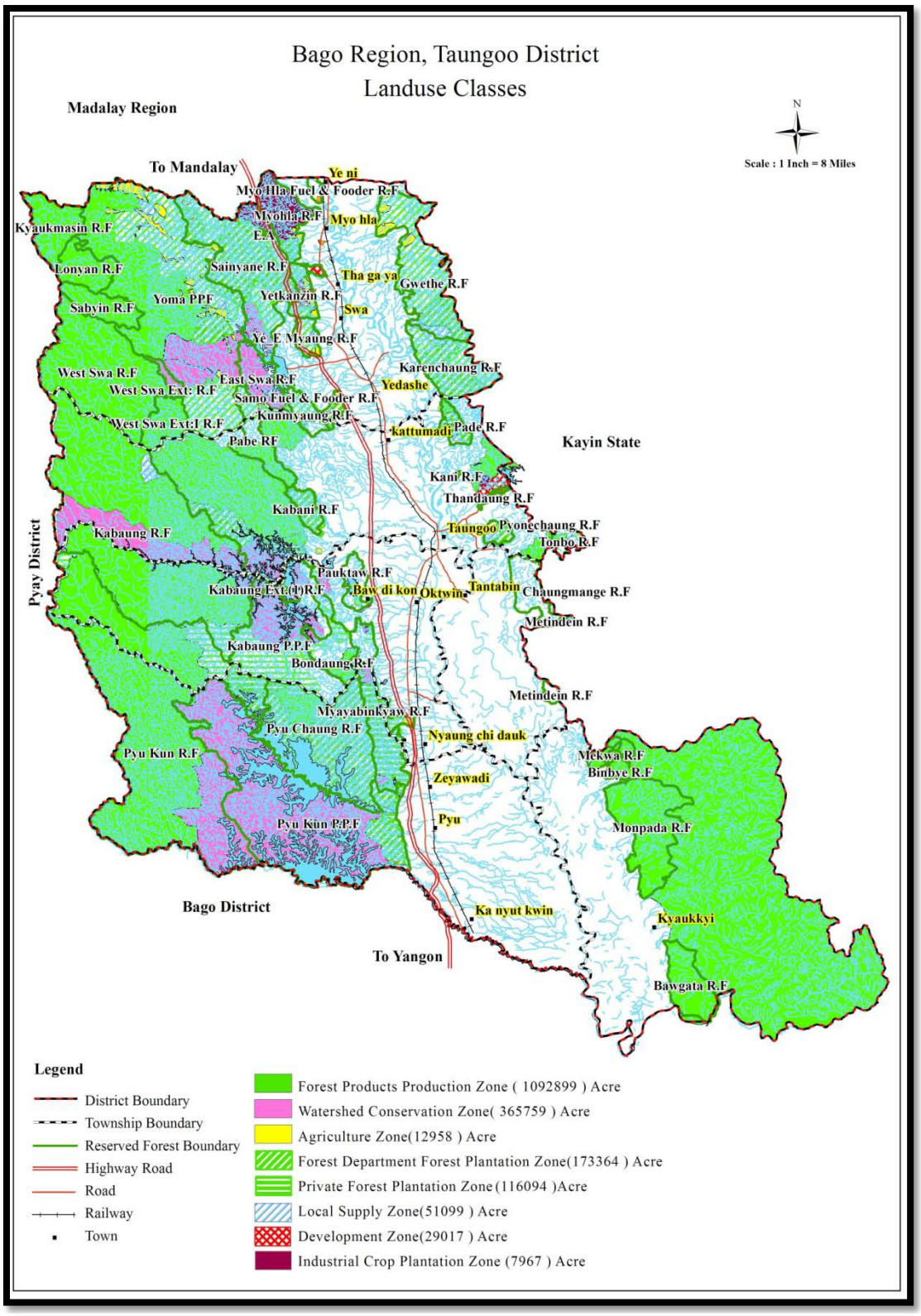


Figure E_1: Baseline map of Taungoo district

For the period 2010 to 2020 projections have been made with regard to the national circumstances. There is renewed emphasis on agriculture and horticulture in the country inviting considerable degree of domestic and foreign investment but the availability of

cultivable wastelands of almost 14 million acres, owned by the state and distributed across the country, offer a degree of protection against forced deforestation on this account. This is particularly so in view of the determination of the Government in recent years to discourage diversion of forests lands for agriculture. Shifting cultivation has traditionally been confined to the lands with the Karen people mostly in the south-eastern part of the Toungoo district and it is apparently in decline though a definitive finding is yet to emerge. But even if decline is not assured we can safely assume that no new forest lands are likely to be exposed to shifting cultivation and thus it is unlikely to contribute to further loss of forests in future. We, therefore, do not see increased investments in agriculture sector in the coming years causing an increase in the rate of deforestation in Taungoo district.

Mining, tourism, urban settlements and roads are likely to become significant causes of deforestation in the country in the coming decade as these activities are increasing at a fast pace. For the country as a whole any reduction in deforestation due to agriculture expansion would likely be compensated by increased losses due to these activities and, therefore, continuance of the past rate of deforestation in Myanmar into the coming decade is a likely course. But in the case of Taungoo district none of these drivers, while present, are likely to become an overwhelming cause of deforestation. The government plans for the immediate future for mining, urban expansion, tourism and road construction activities falling within this district are all on a moderate scale. The loss of forests due to these activities is, therefore, projected to be at lower rate in the coming years.

The overall projected rate of deforestation in the baseline scenario, without any focussed REDD+ efforts, is expected to resemble the graph below.

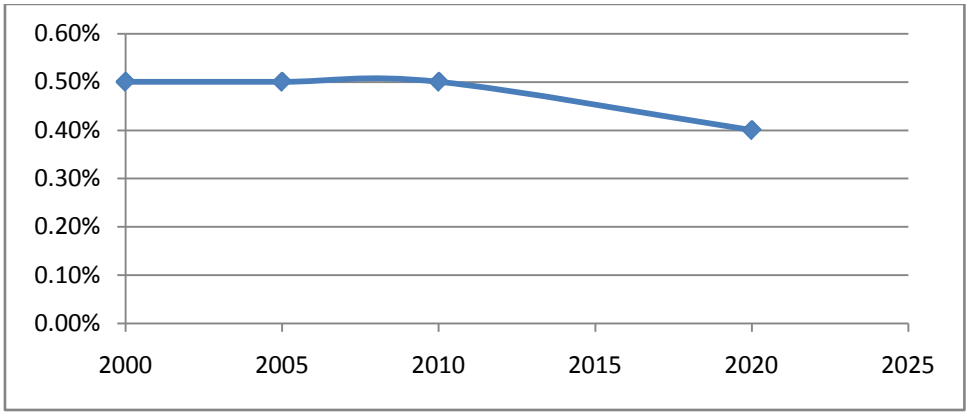


Figure E_2: Deforestation baseline for Toungoo district, Y-axis shows deforestation on percentage area basis

Baseline for forest degradation

For the purpose of baseline assessment of forest degradation in the Toungoo district the study by Dr Myat Su Mon with a team of researchers from Kyushu University using FCD Mapper in Khapaung, Middle Nawin and South Nawin Reserve forests of the Taungoo district provides the closest estimate of historical forest degradation in the project area. FCD Mapper utilizes vegetation index, bare soil index, shadow index and thermal index derived from remotely sensed data. The vegetation index has a positive relationship with the quantity of

vegetation and when there is more tree vegetation there is greater shadow and the shadow index also increases with tree density. The thermal index decreases with increasing vegetation index and decreasing bare soil index.

This study reveals that annual average net forest degradation was 0.76% between 1989 to 1999 which increased to 1.27% between 1999 to 2003 and then sharply escalated to 10.35% between 2003 to 2006. No data are presently available for the period beyond 2006. Beginning 2009 the country has witnessed high economic growth that is expected to touch 6.8% in fiscal 2014. This period of opening economy with highly increased domestic and international demand for teak and other forest products has also been accompanied by increased political opening and, expectedly, a certain measure of lowering of discipline in the management and utilization of natural resources as governance transits into a political and economic future of which it has limited experience.

It would thus be reasonable to state that the annual net forest degradation rate in Toungoo district remained atleast at the same high rate of 10.35% in the years beyond 2006 until 2012. The year 2012 appears to be the time when forest degradation began attracting serious attention from the Government because this was the year when the high powered National Environmental Conservation Committee set up by the Government in the Ministry of Environmental Conservation and Forestry became functional and several key activities were initiated across the country with environmental focus. Teak harvesting by Myanmar Forest Department has turned very conservative and communities are being encouraged to undertake planting on a large scale. So we assume a small but significant decline in forest degradation in the years beginning 2013 with the same but slightly steeper trend continuing into 2020.This graph below, therefore, represents the baseline net forest degradation rate in the Toungoo district using the available data and the above justification.

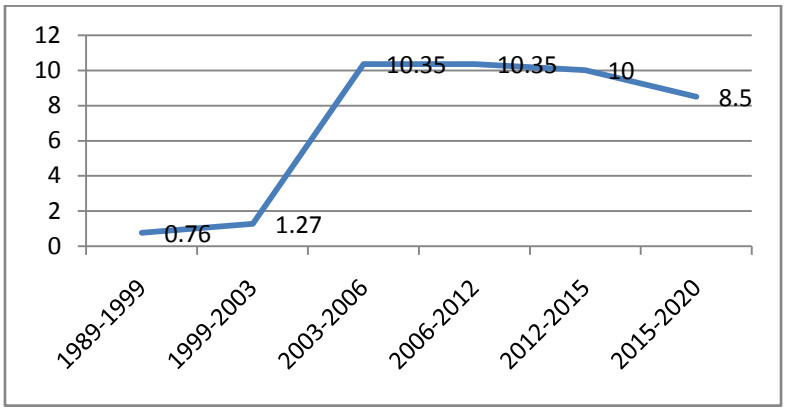


Figure E_3: Baseline for forest degradation . Y-axis shows percentage average annual forest degradation

Baseline for afforestation over non-forest lands in Toungoo district

In the recent years considerable extent of afforestation has been undertaken on non-forest lands by private entrepreneurs. The Figure below shows the trend of afforestation on non-forest lands between 2006 to 2010 in the Toungoo district. The afforestation peaked at about 5510 ha in the year 2009 and before declining to about 4700 ha in 2010. Data for later years

is not available yet. There is an increasing thrust on planting of trees, particularly teak, on private lands by plantation companies as the profitability of these ventures increases. But the limited availability of suitable lands, and the increasing opportunity costs of lands, is likely to limit the annual planting to just about 5000 ha in this district in the baseline scenario. It would require major interventions through policies and measures by the government to take the afforestation of non-forest lands in the Toungoo district to higher extents under REDD+.

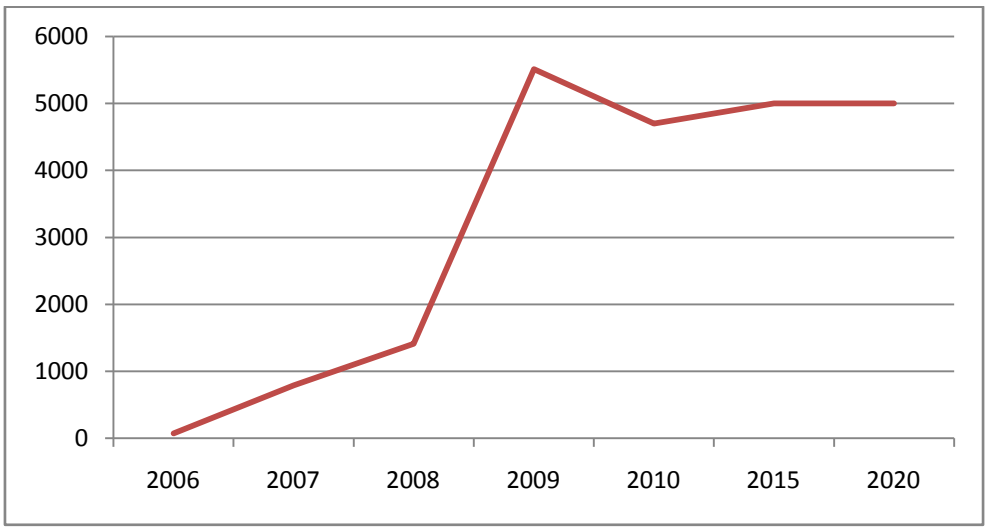


Figure E_4: Baseline for afforestation in Toungoo district

The baseline has been expressed in area rather than carbon tonnage as is the norm in climate change projects. The reason lies in the result based finance for REDD+ agreed to under the Warsaw Framework under which the finance for REDD+ is to be provided based on the planned measurable, reportable and verifiable interim achievements on the path towards reduced emissions from deforestation and forest degradation. The forest department has been conducting a prolonged field estimate, beginning 2010 and not yet completed, of the biomass of trees and bamboo in predefined sample plots in the district that number several hundreds. But the data generated can not be used for the construction of baselines because there is no similar data from preceding decades that could lead us to a trend. Its utility is also limited by the fact that it is not appropriately organized in homogenous strata and sample plots are not randomly selected and are permanent. Also for almost three fourth of the sample plots for which the data has been collected prior to 2012, it does not give a correct picture of the status of forest degradation in 2014. It is for this reason that all activities for which baselines have been proposed in this report, namely reducing deforestation and forest degradation and undertaking afforestation, have been expressed in terms of area which is easily measurable, reportable and verifiable and can also be effortlessly converted to carbon once the average carbon storage in various parts of the forests is known.

It needs to be emphasized that this attempt at REDD+ baseline construction for Toungoo district is just a beginning of this very important and highly complex task and it would require continuous improvements to make it more accurate.

Chapter 1: Introduction

1.1 **Project outline**

With international negotiations still only half way through it is still not clear what ultimate shape REDD+ would assume under the UNFCCC umbrella. Yet some 200 sub-national REDD+, or more correctly, forest carbon initiatives have already been initiated across the world primarily to understand the designing, capacity building and implementing strategies for REDD+ that would ensure willing participation of local people and lead to effective, efficient and equitable mitigation benefits accompanied with a rich basket of ecological, economic and social co-benefits. It is in this context that in December 2012 Myanmar launched the project titled "Capacity building for developing REDD+ activities in the context of sustainable forest management" that revolves around a sub-national initiative with the support of International Tropical Timber Organization (ITTO).

The project covers approximately 1,064,939 ha located in Toungoo District in Bago Yoma region of the country famous for its natural and planted teak forests. The project is part of the Phase I of REDD+ in the country centered on capacity building of all stakeholders within and outside the government which was earlier identified as a national priority by the UN-REDD Program and the ITTO. Some of the most critical part of the capacity building relates to assessment of baseline carbon stocks and setting up of forest reference emission level (FREL) and forest reference level (FRL) as constituents of the overall monitoring, reporting and verification of REDD+ activities in Myanmar in accordance with the relevant decisions of the UNFCCC. In addition, this project also seeks to build capacity in setting FREL/FRL taking into account the Jurisdictional and Nested REDD+ Requirements of the Verified Carbon Standard (VCS-JNR) and the Nested REDD+ Standard of the American Carbon Registry.

This Technical Report presents the background, methodology, activities, and the outcome of this task.

1.2 **Objectives**

The overall objective is to build capacity of appropriate institutions in Myanmar, in particular the Myanmar Forest Department, in establishing an effective monitoring, reporting and verification (MRV) system for of REDD+ in Myanmar that meets the high standards set by the UNFCCC taking into account the most recent decisions under the Warsaw Framework for REDD+. Specific objectives are

1. Setting up of forest reference emission level (FREL) and forest reference level (FRL) of the project site
2. Enhance knowledge of non-UNFCCC mechanisms in relation to MRV like the Jurisdictional and Nested REDD+ Requirements of the Verified Carbon Standard (VCS-JNR) and the Nested REDD+ Standard of the American Carbon Registry

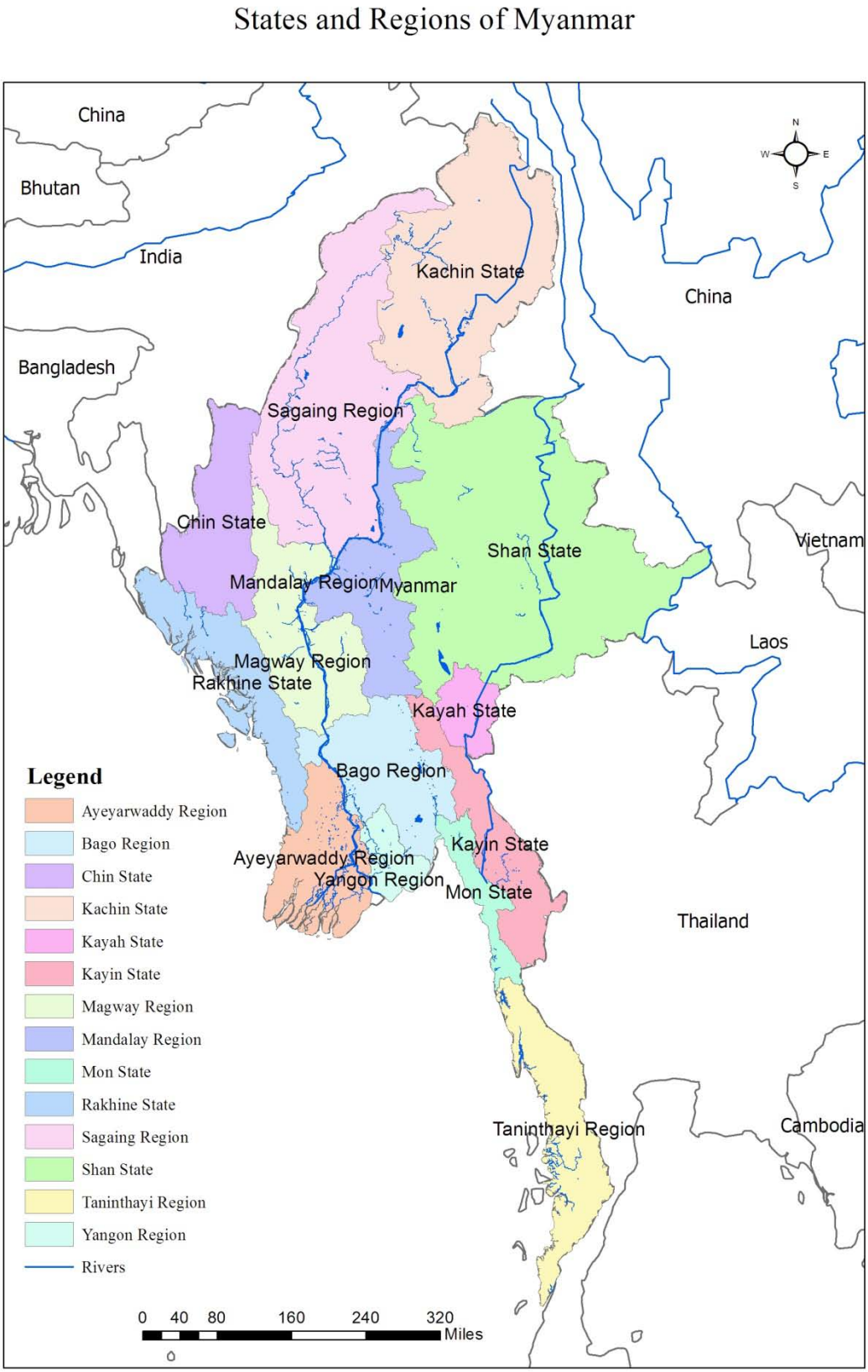


Figure 1.1: Map of Myanmar showing states and regions

1.3 **Background**

At the Warsaw climate summit held in November 2013 a set of important decisions on REDD+ were taken which are called the Warsaw Framework for REDD+. These include

- Work program on result based finance

  The finances may come from a variety of sources, public and private, bilateral and multilateral, including alternative sources, and Parties become eligible for it when their REDD+ activities are fully measured, reported and verified and they provide information on how all safeguards are being met. Entities financing the REDD+ activities are expected to collectively channel resources in a fair and balanced manner, taking into account different policy approaches, for providing access to finance to a larger number of countries. The Standing Committee on Finance will decide on the ways and means of transferring payments for result based actions and make financial resources available for alternative approaches. Exhaustive information on result focused REDD+ activities and corresponding payments are required to be placed on the Information hub.

- Coordination of financial and other support

  Parties have been asked to designate a national Focal Point for REDD+ for liaison with UNFCCC for coordination of support for implementation of REDD+. These Focal points can then further nominate functionally or geographically specialized sub-entities to receive results-based payments from financing entities in accordance with their specific operational modalities for support. These focal points are expected to meet regularly for interaction with the UNFCCC Secretariat and the subsidiary bodies.

- Modalities for National Forest Monitoring Systems (NFMS)

  The CoP 19 decided to build upon the existing forest monitoring systems available in the countries with the objective of reducing costs and delays in setting up entirely new systems. The NFMS should enable the assessment of different types of forests in the country, be flexible and allow for improvements, and reflect the phased approach to REDD+. In previous UNFCCC annual summits it had already been decided to develop transparent, robust, consistent and accurate NFMS using most recent IPCC guidance. A sub-national approach as an interim measure was also accepted.

- Guidelines for technical assessment of FREL/FRL

  In the CoP 17 held at Durban it was decided that developing countries could submit FREL/FRL with their rationale of it and the national circumstances. At the

CoP 19, however, it was decided that these submissions would be subject to a Technical Assessment which shall include facilitative and non-intrusive technical exchange of information on construction of FREL/FRL. The conference also adopted guidelines in accordance with which the Technical Assessment would be carried out.

- Modalities for MRV of forest related emissions and removals

  It was decided that the Monitoring, Reporting and Verification of forest related emissions and removals, forest carbon stocks and forest area changes should be consistent with methodological guidance issued in CoP 15. The data used should be complete, transparent, maintain consistency over time, and be accurate and countries are encouraged to improve the data and methodologies over time while maintaining consistency with the established FREL/FRL.

- International Consultation and Analysis of Biennial Update Report

  Countries taking part in REDD+ are required to submit Biennial Update Report (BUR) which shall be subjected to International Consultation and Analysis (ICA) which would be a facilitative and non-punitive process respectful of national sovereignty. It shall not impose excessive financial costs on the REDD+ programs.

- Addressing drivers of deforestation and degradation

  The CoP 19 acknowledged the enormous complexity of the problem, existence of a multiplicity of drivers, dependence of livelihood on these drivers, high costs of addressing these drivers, and widely different national circumstances. Parties were encouraged to initiate action to reduce these drivers and share results.

1.4 **Measurement, Reporting and Verification after Warsaw**

The decisions on Measurement, Reporting and Verification, and on forest Reference Emission Levels/Reference Levels, are a central part of this Framework. In the preceding UNFCCC Conferences of Parties, beginning with CoP 13 at Bali, there was agreement that the environmental integrity of climate change mitigation achievements under REDD+ would depend upon the quality of MRV but there was little agreement over how it was to be achieved with many countries insisting on the supremacy of national sovereignty over transparency and independent check of the data generated by them. For FREL/FRL also, against which the achievements were to be assessed, the developing countries could submit FREL/FRL with their rationale and national circumstances but there was no provision for a cross-check. As a consequence there was reluctance on the part of funding agencies and developed countries to finance REDD+.

The CoP 19 succeeded in breaking this logjam. In the case of FREL/FRL the country submissions would now be subject to a Technical Assessment which shall include facilitative and non-intrusive technical exchange of information on construction of FREL/FRL. Guidelines for this purpose were adopted according to which technical assessment would examine (i) whether information provided is complete, transparent, consistent, and accurate including that for methodologies, models and assumptions, (ii) consistency with corresponding forest related emissions and removals in national inventory, (iii) how historical data was considered, (iv) description of relevant policies and programs, (v) information on changes to previous FREL/FRL, (vi) pools and gases and activities with justification, (vii) definition of forests used for the purpose.

Similar clarity has also been brought in MRV making it mandatory that the MRV of forest related emissions and removals, forest carbon stocks and forest area changes, should be consistent with methodological guidance issued in CoP 15. Countries are encouraged to improve the data and methodologies over time while maintaining consistency with the established FREL/FRL. This would enable adoption of new technologies for MRV as they develop and come within reach while ensuring comparability with the earlier measurements. Submission of Biennial Update Report (BUR) is now mandatory as also the International Consultation and Analysis (ICA) of BUR for increasing transparency of mitigation action. The process would be facilitative, non-punitive, respectful of national sovereignty, and not impose excessive financial costs. The selection of technical experts for examination of MRV, FREL/FRL and BUR has now been streamlined with adequate representation to both developed and developing countries. These experts would act in their individual capacity rather than as representatives of countries.

While the detailed meaning of results-based finance for REDD+ is still not clear it appears a kind of compromise between the fund and the market-based approaches for rewarding stakeholders who address the drivers of deforestation and forest degradation through changes in their behavior or by undertaking appropriate activities. And results need not necessarily be actual reductions in emissions. Proxy indicators that clearly indicate progress on a pre-determined path would also be acceptable for disbursement of finance. This would ensure shorter gestation payments designed to encourage participation of individual or community stakeholders in the implementation of REDD+ activities on the ground. Early flow of rewards will also mean a better spread of risks inherent in any forest based climate change mitigation approach among the implementing stakeholders and those providing finances for it.

Early flow of finances would also enable larger REDD+ programs in poorer countries in contrast with a truly market-based system that rewards only the final carbon credits. REDD+ finances of this nature would be amenable to integration into existing financing systems like national and provincial budgets, and national and provincial forestry funds, rather than replacing them. Pre-existing REDD+ projects designed for carbon markets can also be brought into this system with suitable changes subject to concurrence by all stakeholders.

There is increasing expectation that REDD+ activities should inherently enhance non-carbon benefits too and a properly designed result based finance system can easily accommodate

accrual of non-carbon benefits as eligible results for payment. These benefits can be assessed through the national REDD+ environmental and social safeguard systems.

1.5 **Construction of FREL/FRL**

A decision of major import in this matter was taken in COP 17[1] under which the forest emission reference levels (FREL) and forest reference levels (FRL), expressed in tons of carbon dioxide equivalent per year (tCO_2e/year), is to act as benchmarks for assessing each country's performance in implementing REDD+ activities. A prime requirement in the construction of FREL/FRL for REDD+ is the pursuit of environmental integrity and avoidance of perverse incentives in mitigation achievements while accommodating national circumstances and capabilities. The requirement that the reference levels be expressed in tCO_2e/year clearly implies that metrics like extent of forest cover are not acceptable as REL/RLs under the UNFCCC. Historical data, adjusted for the dynamic national circumstances, has to be taken in account in a transparent manner in the construction of these reference levels[2].

Countries could adopt a step-wise approach to national FREL/FRL development that enables improvement by incorporating better data, additional pools and improved methodologies. As an interim approach countries could also begin with sub-national FREL/FRL for geographically smaller areas than their entire national territory while transitioning to a national FREL/FRL. But, since it is only an interim measure, the development of sub-national reference levels should be done so as to facilitate scaling up to a national level at an appropriate time in future.

These reference levels should be updated periodically taking into account new knowledge, new trends, and modifications in scope and methodologies that may be needed. FREL/FRL are *ex-ante* estimates and updating, if any, should also be *ex-ante* but in cases of high levels of uncertainty the reference levels may also be revised *ex-post* during the estimation of the actual carbon benefits of a project. This could be based on proxy data from similarly placed lands that reasonably represent the conditions project area would experience in the baseline.

The first step in the construction of FREL/FRL is to identify land use, land-use change and forestry activities in the country or the part of the country under consideration followed by the identification of the drivers of deforestation and forest degradation and historical trends in this regard. All drivers, including local drivers like agriculture expansion and firewood, national drivers such as population, policies, subsidies and expanding domestic markets, and international drivers like increasing demand for palm oil and export of biomass for energy, need to be examined. However, the permitted flexibility in assessment of FREL/FRL allows the possible omission of non-significant carbon pools which not only makes the assessment

[1] Decision 12/CP17
[2] Decision 4/CP15

easier and reduces costs but also leads to a conservative approach in the estimation of forest carbon stock changes.

The next step is the projection of expected future developments and their impacts on forests with their geographical spread and magnitude with detailed justification where projections of future developments differ from historical trends. The assumptions behind the projections would need to take the changing local, national and international trends in consideration which should be backed by evidence and reason.

1.6 **Introduction to IPCC GHG inventory processes**

The assessment of forest based CO2 and non-CO2 emissions and removals are required to be carried out in accordance with the most recent IPCC Guidelines for GHG inventorization and the IPCC Good Practice Guidance (GPG) for using the Guidelines. The most recent GPG in relation to land use and forestry was published by the IPCC in 2003 and the most recent IPCC Guidelines for National Greenhouse Gas Inventories was published in 2006 which combines LULUCF and agriculture into a single Agriculture, Forestry, and Other Land Uses (AFOLU) sector.

The GPG2003 provides methodologies to estimate changes in the five carbon pools of aboveground biomass, below-ground biomass, dead wood, litter, and soil organic matter. Methodologies are also provided for non-CO_2 GHG emissions for all of the six categories of land use, namely, Forest Land, Cropland, Grassland, Wetland, Settlements and Other Land, and for changes between these land uses. Deforestation is estimated as the sum of emissions and removals associated with conversions from forest to other land uses. Forest degradation, conservation of forest carbon stocks and sustainable management of forests are not identified by name in the GPG2003 (or in the 2006GL) but these can be estimated as the effect of human interventions on emissions and removals from forest lands that remain forest lands. Enhancement of forest carbon stocks may occur within existing forests but it also includes conversion of other land uses to forests.

There are two generic methods for estimating CO_2 emissions and removals. The gain-loss method calculates annual emissions and removals directly which are then summed over the period of time under examination while the stock change method calculates emissions or removals from the difference in total carbon stocks at the two extremes of this time period. Non-CO_2 emissions are estimated as product of pre-assessed emission factors and activity data. Thus, for example, use of a thousand tons of fertilizer in a forestry plantation would be the activity data which, when multiplied by the default N_2O emission factor for that fertilizer, would give the total emission of N_2O in the plantation. In addition, auxiliary data such as past history of management, legal and illegal harvesting estimates, forest type, status of regeneration, forest fire and pest damages, is also used for spatial stratification that results in reducing errors in estimations.

1.7 **Combination of *Approaches* and *Tiers***

IPCC Guidance suggests three *approaches* for providing activity data in the six land categories of Forest Land, Cropland, Grassland, Wetland, Settlements and Other Lands. The **Approach 1** uses net managed forest area, is not spatially explicit and changes from one category to another are not tracked while the **Approach 2** provides matrix of changes within and across land use categories and is spatially explicit to that extent. **Approach 3** is fully spatially explicit with locations identified using geographical coordinates where activity data for each unit area are provided through remote sensing or field surveys.

There are also three levels of details called *tiers* as described below:

Tier 1 uses default values for tree growth rates, deforestation rates and emission factors etc that are country-specific but, in its absence, sourced from available information from other similarly placed regions. It is good for initial estimates but must give way to Tier 2 as early as possible.

Tier 2 uses default parameters as Tier 1 but applies values that originate from local, from neighborhood or from country specific data. Higher resolutions and more disaggregated activity data are used in this Tier.

Tier 3 uses higher order methods with high resolution activity data disaggregated at local or sub-national levels thus providing estimates of greater certainty. Methodologies include comprehensive GIS based data collection supplemented by field sampling repeated at regular time intervals and also modeling.

A combination of Tiers and Approaches can be used for National GHG estimation depending upon the national circumstances but in the case of forests spatially explicit information would be needed to track activities and drivers and, therefore, Approach 3 appears necessary to justify result based payments where results would often imply the completion of a REDD+ planned activity at a specific location rather than a final affirmation of climate change mitigation benefit.

1.8 **Matching REDD+ with IPCC Land categories**

REDD+ includes five distinct activities, namely, reducing emissions from deforestation, reducing emissions from forest degradation, conservation of forests, sustainable management of forests, and enhancement of forest carbon stock. These activities relate to the IPCC land classification as indicated in the Table below. The activity ‘enhancement of forest carbon stock’ could occur both in the forest lands remaining forests as in assisted natural regeneration and gap planting in partially degraded forests, and in other lands converted to forests as in afforestation. However, in order to simplify we would consider assisted natural regeneration and gap planting in partially degraded forests as part of activities to reduce emissions from degradation and only afforestation of non-forest lands would be placed under the category ‘Enhancement of forest carbon stock’.

IPCC land conversion category	*REDD+ activities*
Forest lands converted to other lands	Reducing emissions from deforestation
Forest lands remaining forests	Reducing emissions from degradation, Conservation of forests, Sustainable Management of Forests
Other lands converted to forests	Enhancement of forest carbon stock

Table 1.1: Matching IPCC land conversion categories with REDD+ activities

1.9 **Key category analysis**

This analysis is done for prioritizing emissions or removals categories in the estimation of greenhouse gas inventory and helps in the strategic allocation of available resources to collect data. The categories, ordered in decreasing magnitude, which contribute to 95% of total, or trend in, national emissions or removals are termed key categories. Key categories would often consist of sub-categories (or pools), like biomass, dead organic matter and soils in forests, and these sub-categories are considered significant when they make up atleast a quarter of the emissions or removals in their categories. For the sub-categories that are not considered significant it is possible to use Tier 1 methods if country specific data are not available.

1.10 **Good practice in inventory preparation**

Inventories that *contain neither over- nor under-estimates so far as can be judged, and in which uncertainties are reduced as far as is practicable* are considered Good Practice. The attempt is to maximize precision without setting a minimum expectation in order not to overburden the limited resources reasonably available for GHG inventory development. This definition also permits continuous upgradation as more resources and better technologies become accessible.

Good practice also covers sampling strategies, uncertainty estimation, methodological choice based on identification of key categories and sub-categories, quality assurance and quality control including validation (internal self-consistency checks) and verification (check against independently compiled data), and time series consistency. Good practices are expected to lead to;

1. Transparency achieved through adequate documentation enabling reviewers to assess the good practices followed in the entire process
2. Completeness with all relevant categories of emissions and removals estimated and reported
3. Consistency so that differences between years reflect real differences in emissions or removals with changes in methodology or technology appropriately explained
4. Comparability allowing comparison of inventory estimates across countries
5. Accuracy through the use of methods designed to produce neither under- nor over-estimates

Consistency attains a special importance in REDD+ where remote sensing data obtained through varying technologies and resolutions affects time series of CO_2 emission and removal estimates critical for establishing FREL/FRL.

1.11 **Uncertainties**

Any method of estimation of emissions and removals of greenhouse gases would entail uncertainties and reference levels would make sense only if the range and nature of these uncertainties are well understood. This is important always but becomes crucial when the uncertainties are required to be discounted in order to enhance the integrity of the related mitigation results traded in a carbon market. The IPCC 2006 Guidance suggests the manner in which these uncertainties can be quantified and reported. Uncertainties for Tier 1 default values are available from GPG2003 and those for Tier 2 and 3 methods measures of uncertainties should be generated as part of the statistical sampling process. These uncertainty estimates need to be combined into an overall uncertainty estimate associated with REDD+ activities.

Section 6.3 of *GPG2000* identifies the following two rules[3] for combining uncertainties. These rules assume that the uncertainties in the quantities being added or subtracted, or multiplied, are uncorrelated.

Rule A is applied when quantities with an associated uncertainty are combined by addition or subtraction, the uncertainty in the resulting sum or difference is the square root of the sum of squares of the absolute uncertainties of each of the quantities being combined.

Rule B is applied when uncertain quantities are combined by multiplication, the percentage uncertainty of the product is the square root of the sum of squares of the *percentage* uncertainties estimated for each of the quantities being multiplied.

Rule A is exact while Rule B is an approximation provided the uncertainties are not too large.

Uncertainties in sampling designs can be reduced both by increasing sampling density without further sub-stratification and also by further sub-stratification to focus sampling on forest areas likely to be affected by REDD+ activities, after as well as before the transfers between strata or land use change has occurred. It can also be reduced by retaining the same stratification and sampling density but using auxiliary information to verify the direction of change.

1.12 **Consistency over time**

With quick paced improvements in the remote sensing technologies it would often not be possible, or desirable, to use the same technologies over time which may affect the comparability of data accessed at different times. Similar situations may arise when improved

[3] Global Forest Observations Initiative (2014) Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests, Version 1.0, January 2014

national circumstances and enhanced technological capabilities enable a country to higher tier estimates. The IPCC 2006 Guidance suggests recalculating a time series of data with improved methods, use of proxy or surrogate data where monitoring of actual emission is not feasible, and linear or logarithmic interpolation or extrapolation for managing missing data in a time series. Well justified combinations of these can also be used to enhance data consistency over time.

1.13 **Forest definition**

There is no prescribed definition of forests for REDD+ under the UNFCCC. The GPG2003 defines Forest Land as *including all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory, subdivided into managed and unmanaged, and also by ecosystem type as specified in the IPCC Guidelines. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category*. Countries tend to adopt either the FAO definition, or the Kyoto definition which describes forests[4] as "*a minimum area of lands of 0.05–1.0 hectare with tree crown cover (or equivalent stocking level) of more than 10–30 per cent with trees with the potential to reach a minimum height of 2–5 metres at maturity. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10–30 per cent or tree height of 2–5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest*".

This definition, however, does not capture the forest biodiversity and the vast ecological distance between a single species plantation and a natural forest ecosystem. It was agreed at Cancun that reward for mitigation action under REDD+ should not provide perverse incentive for conversion of natural forests into a stand of trees. The forest definition should therefore distinguish natural forests from plantations.

Moreover, under different ecological conditions the definition of forests could differ remarkably. In arid areas a low density tree cover, say of 10%, could constitute a good forest which may not even be considered a forest in conditions of high rainfall and rich soils. For the purpose of REDD+ it is important to use the same definition consistently over time and the definition used to construct FREL/FRL should be the same as that used for subsequently for monitoring, reporting and verification.

The IPCC definition requires forests to be subdivided into managed and unmanaged since carbon stock changes and greenhouse gas emissions on unmanaged land are not reported under the IPCC Guidelines except when unmanaged land is subject to land use conversion. It

[4] FAO (2006), Forests and Climate Change Working Paper 4, Choosing a Forest Definition for the Clean Development Mechanism, FAO, Rome

is important to clarify what is meant by managed lands and then apply the same consideration consistently over time.

1.14 **Reference levels under various evolving frameworks for REDD+**[5]

At this stage it would be useful to examine the various approaches to the construction of FREL/FRL that have currently evolved. **The Forest Carbon Partnership Facility's Carbon Fund** is currently the largest multilateral fund supporting REDD+ activities around the world and has been developing a methodological framework that supports the construction of FREL/FRL. Another important independent REDD+ standard has been developed by the **Verified Carbon Standard's Jurisdictional and Nested REDD+ (VCS-JNR)** which is a clear preference of the voluntary carbon market. As its name suggests it has created a framework for accounting emission reductions at the jurisdictional level and managing small REDD+ projects "nested" into national or subnational frameworks. The REDD Offsets Working Group set up by the **California's carbon trading system** has also suggested a modified mechanism under which California carbon market may soon begin accepting REDD+ credits. **Germany's REDD Early Movers (REM)**[6] is designed to reward pioneers in forest conservation through performance-based payments for verifiable emission reductions by countries that have begun action without waiting for international REDD+ negotiations to provide funding. The Table below compares the key features of these evolving frameworks.

Elements of REL/RLs	FCPF Carbon Fund[7]	California carbon market[8]	VCS-JNR[9]	REDD Early Movers
Scope – Activities	Deforestation required; degradation required where data is available and such emissions are greater than 10% of total; carbon stock enhancement voluntary.	Deforestation and degradation are mandatory; carbon stock enhancement may be added if deemed appropriate by California and the partner jurisdiction.	Jurisdictions may choose from: Reduced Emissions from Deforestation and Degradation (REDD); Improved Forest Management (IFM); or Afforestation, Reforestation and Revegetation (ARR)	Focus is on deforestation. Over time the scope may be broadened to degradation, but no current intent to support carbon stock enhancement.
Scope - Pools	All significant pools (i.e. pools	Must include carbon pools that	All significant pools (i.e. pools representing more	Not specified

[5] UN-REDD Programme, Background Document to Support the Roadmap for Development of a Reference (Emission) Level for Tanzania, November 2013

[6] Information about REM can be found at: http://www.bmz.de/en/publications/topics/climate/FlyerREDD_lang.pdf

[7] Information based on September 2013 draft FCPF Carbon Fund Methodological Framework, which continues to be negotiated and therefore some elements may change: https://www.forestcarbonpartnership.org/carbon-fund-methodological-framework

[8] Information based on Recommendations of the REDD Offsets Working Group: http://stateredd.org/documents/2013/07/final-row-recommendations.pdf

[9] Information based on VCS-JNR program documents: http://v-c-s.org/program-documents/find-program-document

	representing more than 10% of total); exclusion allowed if conservative	are expected to significantly change when deforestation or degradation takes place.	than 10% of total); exclusion allowed if conservative	
Scale	National or "*of significant scale and aligns with one or more jurisdiction or a national government-designated area (e.g. eco-region)*"	Partner jurisdictions decide what is eligible for crediting: jurisdictional scale efforts only; nested projects only; or both.	National, subnational / jurisdictional, and nested programs / projects	National or subnational / biome level following a jurisdictional approach (methodology applied should be compatible with national strategy and policy goals)
Reference period and number of data points required	10-15 years long; end date is most recent date prior to 2011 for which forest cover data is available; number of points not specified	10-years, chosen between 1995-2010; at least 4 points required; if data not available, a different period may be substituted with justification	8-12 year period for historical average; or 10 years for historical trend; at least 3 points required	Not specified
Monitoring requirement	Activity data must be determined twice in the 5 year crediting period	Verification of GHG reductions must occur at intervals of at least every 5 years	Monitoring and verification must be conducted at least every 5 years	Not specified
Updating procedures	Purchases of ERs are only for 5 years during which no update is expected	Not specified	Jurisdictional baselines are fixed for 5-10 years and subsequently updated with the same periodicity	Not specified
Emission factors	IPCC Tier 2 or higher methods used to establish emission factors; in exceptional cases Tier 1 may be considered	Not specified	Use of Tier 2 or higher methods required, except for pools that represent less than 15% of total carbon stock (default data may be used)	Not specified, but supports use of conservative approaches including carbon content estimates
Representation of land	Approach 3 required for deforestation; other sinks and sources may use alternative methods	Not specified	Approach 3 required for deforestation; degradation/enhancement may be monitored using direct (e.g. remote sensing) or indirect (e.g. timber harvesting data)	Not specified
Uncertainty / Accuracy threshold	Sources of uncertainty are identified and assessed; uncertainties related to activity data and emission	Recommend establishment of a sliding scale discount whereby higher levels of uncertainty would result in fewer	Methodology should provide a means to estimate a 90 or 95% confidence interval. Where a 90% confidence interval is applied and the width of the confidence	Not specified

	factors are quantified. *Under consideration: Whether ERs generated may be discounted for uncertainty*	emission reductions being credited. *Under consideration: An uncertainty threshold beyond which no credits issued*	interval exceeds 20% of the estimated value or where a methodology applies a 95% confidence interval and the width exceeds 30%, an appropriate deduction shall be applied	
Possibility to adjust from historical data?	RLs should not exceed average annual emissions over the reference period. *Under consideration: Whether exceptions may be made (to allow for upward adjustments) for countries with historically low deforestation.*	In certain limited circumstances, the RL may be adjusted from the historical average to account for rigorously-justified predictions that emissions would rise or fall in the absence of a REDD program and must be substantiated with transparent and credible evidence.	Where no UNFCCC baseline has been established, at least two alternative baseline scenarios must be developed: (1) historical annual average emissions or removals over an 8 to 12 year period; and (2) historical trend based on changes over at least 10 years, both ending within 2 years of the start of the baseline period. Modeled adjustments reflecting national or subnational circumstances may also be presented. The jurisdiction must determine the most plausible baseline and justify its selection.	Prefers usage of historical deforestation data (not projections) to ensure transparency and credibility.
Other requirements	Consistency expected with: IPCC guidelines, UNFCCC submissions, national GHG inventory (including forest definition used)	Jurisdictions expected to contribute "own effort" beyond what is credited. Third party verification of results a precondition for crediting	VCS requires independent, third party verification of results	Expects significant "own contribution" based on country capacity

Table 1.2: Comparison of key features related to construction of reference level in important evolving REDD+ frameworks[10]

1.15 **Making choice among the available frameworks**

Of the above four choices the German funded REDD Early Movers would have been a good choice for this project because of its pioneer nature but for the fact that this Early Movers framework is essentially for reducing emissions from deforestation in its current stage of development. The relatively steady and functioning carbon market of the California framework could be an attraction, but this framework does not recognize interim results on the way to measurable climate mitigation benefits and hence is unsuited for this project.

[10] The entire Table is reproduced from UN-REDD Programme, Background Document to Support the Roadmap for Development of a Reference (Emission) Level for Tanzania, November 2013

The Verified Carbon Standard's Jurisdictional and Nested REDD+ (VCS-JNR) is functionally the most suited in that all expected REDD+ activities in this project would be covered by it and the sub-national scale is acceptable. Also, there are existing precedents in which this methodology has already been used which would make the task of developing the project easier and low cost.

The World Bank's FCPF Carbon Fund offers the advantage of advance funding for project development and capacity building. Also it is largely compatible with the VCS-JNR methodology and in specific areas where it is at variance it is possible to adopt the standards expected in FCPF. It would thus be most appropriate to use the VCS-JNR framework for developing FREL/FRL and adopt the FCPF standards wherever necessary so that the project document can be used to access FCPF funding, if available, also besides taking advantage of the more developed VCS methodologies.

Chapter 2: Assessment of National circumstances

2.1 **Introduction**

For the ***assessment of national circumstances*** there are no set guidelines but UNFCCC Guidelines for the Preparation of National Communications for non-Annex I Parties does suggest the outlines of a possible approach for this purpose. Paragraph 3 of this Guideline[11] states that "Non-Annex I Parties should provide a description of their national and regional development priorities, objectives and circumstances, on the basis of which they will address climate change and its adverse impacts. This description may include information on features of their geography, climate and economy which may affect their ability to deal with mitigating and adapting to climate change, as well as information regarding their specific needs and concerns arising from the adverse effects of climate change and/or the impact of the implementation of response measures, as contained in Article 4, paragraph 8 and, as appropriate, in Article 4, paragraphs, 9 and 10, of the Convention".

The description[12] of national circumstances thus provides an opportunity for detailing the development objectives, activities, priorities, and circumstances that make them necessary, and is thus critical for understanding a country's vulnerabilities, capacities and its range of available options for economic development. The information that forms the basis of the assessment of national circumstances includes;

i. Geographical characteristics, including climate, forests and land use
ii. Population: growth rates, distribution, density and other vital statistics
iii. Economy, including energy, transport, industry, mining, tourism, and agriculture
iv. Education, including scientific and technical research institutions
v. Any other relevant information

2.2 **Geographical characteristics, including climate**

The largest country in the mainland South East Asia, Myanmar is located between 9° 32′ and 28° 31′ North latitudes stretching 2051 km north to south; and 92° 10′ to 101° 11′ East longitudes extending 936 km east to west. The country covers an area of 676577 sq km with four distinct agro-ecological regions consisting of the two hill regions of the east along China and west along India, the valley region in the center, and the coastal region in the south west. Tropical monsoon rains feed its four major river systems that crisscross this country of three distinct seasons: the rainy season from the middle of May to the middle of October; relatively cool season till the middle of February, and then hot dry summers till rains arrive. Rainfall varies from the high of almost 4000 mm along parts of the coast to the semi-arid tracts of the central valley with just about 700 mm. Climate is largely tropical to subtropical in the hills, with pockets of temperate climate in high mountains.

[11] UNFCCC Guidelines for the Preparation of National Communications for non-Annex I Parties
[12] UNFCCC (2004) REPORTING ON CLIMATE CHANGE: user manual for the guidelines on national communications from non-Annex I Parties

2.3 **Population**[13][14]

In 2012 Myanmar had an estimated population of about 61.12 million. Children below 14 years of age constitute 32% of the total population while people in the age group 15 to 59 years and 60 years and above constitute 59% and 9% respectively. Young people aged 10-24 years form nearly 30% of the population. The total fertility rate was 2.03 children per woman and the annual population growth rate was 1.1 during 2010-2012. The mortality rate for children below 5 years per 1,000 live births was 62 in 2011. The adult literacy rate was 92.3% in 2010. Population in urban areas in 2011 was 32.7%.

2.4 **Forests and land use in Myanmar**

Myanmar is celebrated for its forest wealth and rich biological and has almost half of its geographical extent still under forest cover despite several decades of significant depletion. The earliest assessment was undertaken in the colonial period in 1925 when two third of the country was under forest cover. Over the past half century a number of comprehensive country wide appraisals of the forest cover status of Myanmar have been made the first of which was based on aerial photographs taken in the 1950s. Two more were conducted using the satellite imageries of the decades of 1970s and 1980s and another one completed in 1997 used the Landsat TM imageries of the year 1989 onwards. The first Forest Resource Assessment (FRA 2005) conducted by the Food and Agriculture Organization of the United Nations (FAO) in cooperation with the Myanmar Forest Department placed the cover at 52.4% while the most recent Forest Resource Assessment (FRA 2010) suggests that forest cover has slipped down rather sharply to 47% now.

Year of appraisal	Forest cover (km^2)	% of total area
1925	445,187	65.8
1955(1st Appraisal)	387,003	57.2
1975 (2nd Appraisal)	356,656	52.7
1989 (3rd Appraisal)	343,701	50.8
1997 (4th Appraisal)	353,747	52.3
2004 (FRA 2005)	354,780	52.4
2010 (FRA 2010)	353,750	46.9

Table 2.1: Forest appraisals over the past hundred years (Source: Thaung et al[15], 2012)

Of the assessed 46.9% forest cover the FRA 2010 places the open forests at 27.1% of the total geographic area and the rest as closed canopy. Another 29.7% of lands are classified as wooded lands that often serve the same economic purpose as the forests for the local people though with reduced ecological spinoffs.

[13] United Nations Population Fund UNFPA Myanmar
[14] Asian Development Outlook 2013
[15] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Myanmar Forest Department

Category	Area (,000 ha)	Percentage
Closed forest	13,445	19.9
Open forest	18,329	27.1
Total forest	31,773	47.0
Other Wooded land	20,113	29.7
Other land	13,869	20.5
Inland Water bodies	1,903	2.8
Total Area of Country	67,658	100.0

Source: Forest Resource Assessment, 2010 (FAO)

Table 2.2: Forest, agriculture and other lands in Myanmar

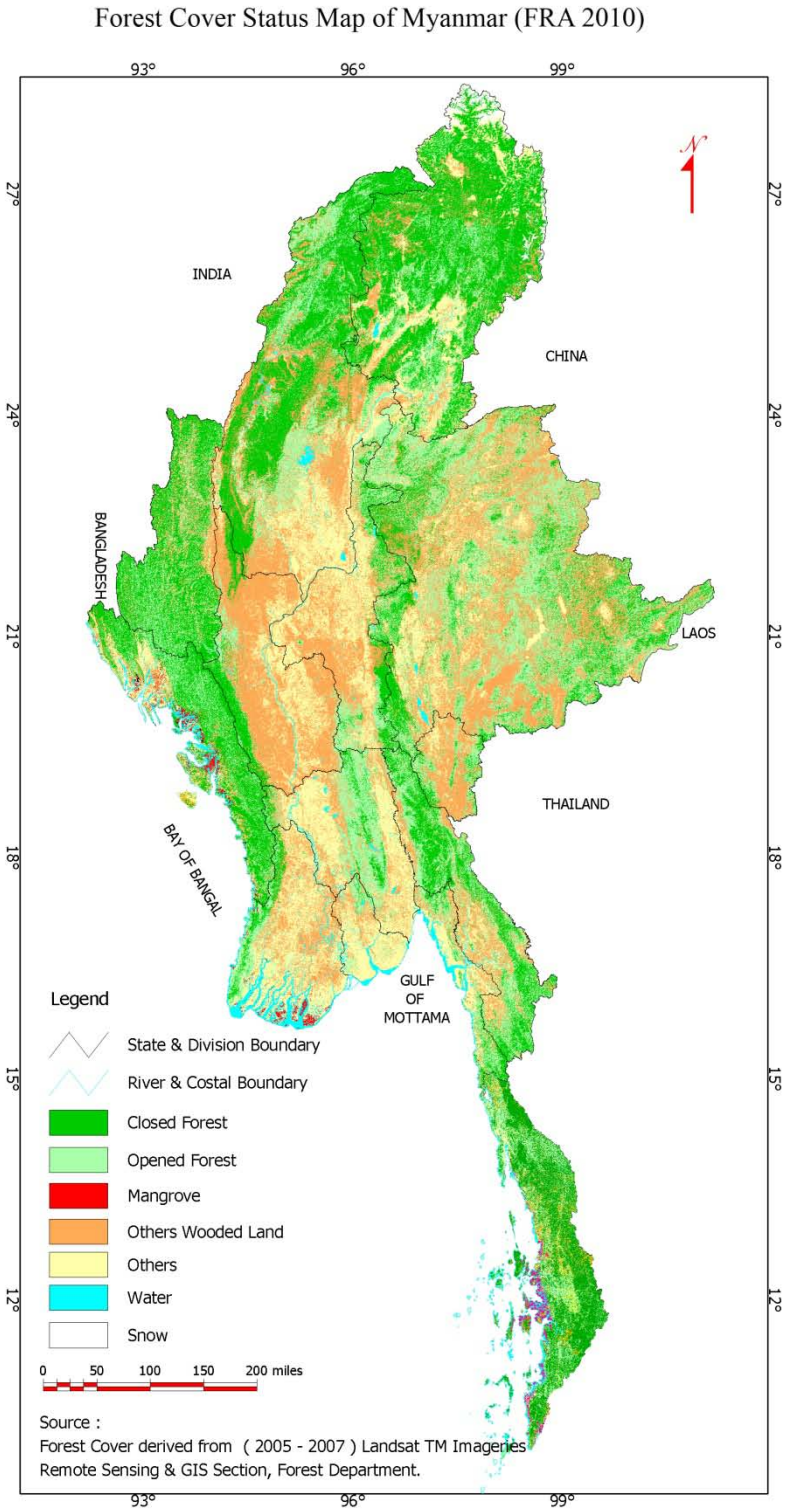


Figure 2.1: Distribution of forest and other land uses in Myanmar

These appraisals, however, suggest an extremely high rate of deforestation in Myanmar which has been called into question by other studies[16] using more extensive data sets and statistical designs better suited to the task. Global Land Cover Characterization (GLCC) map derived using advanced very high resolution radiometer imagery acquired in 1992 suggests

[16] Leimgruber et al, 2005, Forest cover change patterns in Myanmar (Burma) 1990•2000, Environmental Conservation 32 (4): 356•364 © 2005

75% forest cover while the Moderate Resolution Imaging Spectroradiometer (MODIS) Global Land Cover map using imageries from 2000 assesses the country's forest cover at 76%. Another landmark study by the Smithsonian Institute places the forest cover in Myanmar at 65% at the turn of the 20th century. For the purpose of deciding on the deforestation baseline in this study we have used the Smithsonian study by Leimgruber and team.

2.5 **Ecological profile of forests in Myanmar**

Ecologically, Myanmar forests have forest formations that range from teak dominated mixed deciduous forests covering 38% of forest lands, an intimate mix of temperate and semitropical forests in the northern and eastern hills covering a quarter of the forest area, evergreen Dipterocarp forests covering 16% forests, dry forests with Acacias over 10%, deciduous Dipterocarps covering 5% and tidal and swamp forests over 4% of forest lands.

Forest types	Typical rainfall (mm/year)*	Dominant tree species	Area (km^2)	% of total forest area
Tidal, beach, dune and swamp forest	>3,500	*Rhizophora apiculata, Bruguiera gymnorhiza, Heritiera fomes*	13,750	4
Hill and temperate evergreen forest	>3,000	*Pinus insularis, P. khasya, Quercus serrata, Syzygium cummini, Bischofia javanica*	89,378	25
Evergreen forest	2,500-4,000	*Dipterocarp spp., Eugenia spp., Syzygium spp., Credrela spp.*	55,004	16
Mixed deciduous forest	1,250-2,500	*Tectona grandis, Xylia xylocarpa, Pterocarpus macrocarpus, Gmelina arborea, Millettia pendula*	134,068	38
Deciduous dipterocarp forest	900-1,250	*Pentacme siamensis, Shorea oblongifolia, D. tuberculatus, Terminalia tomentosa*	17,187	5
Dry forest	< 900	*Acacia catechu, Tectona hamiltoniana, Terminalia oliveri, A.leucophloea*	34,377	10
Fallow land	-	-	9,983	2
Total			**353,747**	**100**

Table 2.3: Area coverage of the major forest types, dominant species and rainfall range[17]

2.6 **Shifting cultivation**

A 1996 report[18] of the Myanmar Forest Department states that 22.6% of total land of Myanmar is affected by shifting cultivation. This appears an exaggeration now but undoubtedly shifting cultivation is a serious concern in the country. Various forms of this practice with varying fallow periods are in vogue among the tribes spread across northern and

[17] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Myanmar Forest Department

[18] Forestry Fact Sheets, Forest Department, Yangon, 1995, pp 38

eastern parts of the country. While it is primarily aimed at growing food crops there are notable exceptions like the February burning of vegetation in the Chin areas for promoting forage for the semi-wild ox (*Bos frontalis*) or the high importance given to the planting and coppice management of *Alnus nepalensis* tree among the Kachin people of the northern Myanmar touching India.

In the Taungoo district shifting cultivation is confined to its south-eastern parts predominantly inhabited by Karen people. In a study[19] conducted in a village in Karen area of the district it was observed that in 2002 a total of 59 households of the village cleared a total of 60 plots with average plot size of 2.69 ha. In the subsequent year 2003 the number of households increased slightly to 62 who cleared 65 plots with an average plot size of 2.17 ha while 2004 observed a significant increase in both households practicing shifting cultivation and the number of plots with 74 households opening 75 plots with an average plot size of 2.40 ha. The potential maximum numbers of fallow years were 24.6, 28.1, and 22.1 for the three consecutive years beginning 2002 was in sharp contrast with the actual fallow periods of 17.9, 15.1 and 12.8 years during these years suggesting high degree of preference for specific sites for this form of cultivation within the full extents of the lands available to the villagers. *Eupatorium odoratum* covered the fallow lands in the first year before being gradually replaced by *Bambusa polymorpha* and *Bambusa tulda* over several years. Tree species such as *Xylia xylocarpa* also began to establish themselves and by the 12th year they started dominating the fallow lands.

The quickly changing economic scenario in the country with rapid increase in employment opportunities in the past five years seems to have had a huge impact on the extent of lands actively brought under shifting cultivation, the nature of crops grown and the length of fallow periods. While no formal research reports are presently accessible anecdotal evidence suggests steep decline in shifting cultivation practice in the district. However, cultivation practices that have endured for millennia and have a strong cultural roots among the tribal people of the country are unlikely to perish so soon and long term studies are needed to get a good understanding of the real and lasting trends.

2.7 **Forest fires**

Historically, the forest fire reporting system in Myanmar has not been very well organized except in some more intensely managed forests. As a result the available forest fire data is scanty and often not very reliable. The FAO in its Forest Assessment Report of 2010[20] suggests a sharp whittling down of forest area affected by fires from about 4.3 million ha in 1990 to just about 0.43 million ha in 2010. This would be commendable by any measure if it conveys the real trend. However, the fact that the reserved forests affected by fires almost tripled from 76442 ha to 206059 ha during the same period, with a four fold increase within 5 years from 2000 to 2005, infuses a large uncertainty about the veracity of the data. It is not

[19] TAKEDA S , R SUZUKI and M T Hla (Year ?), Three-year monitoring of shifting cultivation fields in a karen area of the Bago mountains, Myanmar, Working Paper, Graduate School of Asian and African Area Studies, Kyoto University, Japan

[20] FAO, 2010, Global Forest Resources Assessment 2010, Myanmar Country Report, FAO, Rome

clear as to why the fires reduced so drastically in non-reserved forest areas that are not particularly well managed when compared to reserve forests. A possible reason could be reduced shifting cultivation which has always been a major source of forest fires outside reserve forests. Yet another reason could be increased collection of non-timber forest produce in reserve forests as a part of government policies.

Year	All Affected Area	Within reserved forest (Ha.)
Y 1990	4,248,247.55	76,442.81
Y 2000	2,452,839.79	63,844.42
Y 2005	1,091,083.90	217,756.23
Y 2008	1,001,663.92	178,755.03
Y 2010	434,687.07	206,059.85

Table 2.4: Forest fires in Myanmar between 1990 and 2000 (Reproduced from FAO, 2010)

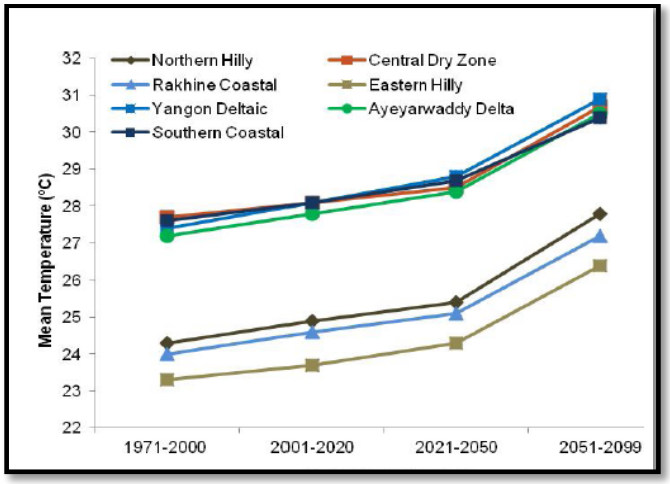
2.8 **Projected impact of climate change**

The National Environmental Conservation Committee of the Ministry of Environmental Conservation and Forestry in its report[21] on NAPA prepared in 2012 uses the model 'Providing Regional Climates for Impacts Studies' (PRECIS) using A2 emissions scenario and 20 km x 20 km resolution for projecting future changes of temperature and precipitation up to the end of the current century for the seven physiographic regions of the country. The core projections suggest;

i. general increase in temperature with the Central and Northern regions experiencing the greatest increases,
ii. increase in clear sky days exacerbating drought periods,
iii. increase in rainfall variability during the rainy season including an increase from March to November and decrease between December and February, and
iv. increase in the frequency and intensity of extreme weather events including extreme high temperatures and drought

The figure below indicates temperature and rainfall changes over Myanmar up to 2099. It can be noticed that in the Eastern Hilly physiographic region, within which the Taungoo district is located, the rise in temperature is projected to be as steep as in other regions but the rainfall increase is likely to be barely noticeable compared to all other regions except the central dry zone. This implies increased evapo-transpiration leading to shift towards more xerophytic conditions and reduced productivity of the teak forests. It is to be noted that since this physiographic region is easily the prime habitat of the best teak in the world, a major change in its defining climatic features would likely have a huge impact on its teak forests.

[21] NECC, 2012, Myanmar's National Programme of Action (NAPA) to Climate Change, National Environmental Conservation Committee, Ministry of Environmental Conservation and Forestry, Naypyitaw, 2012



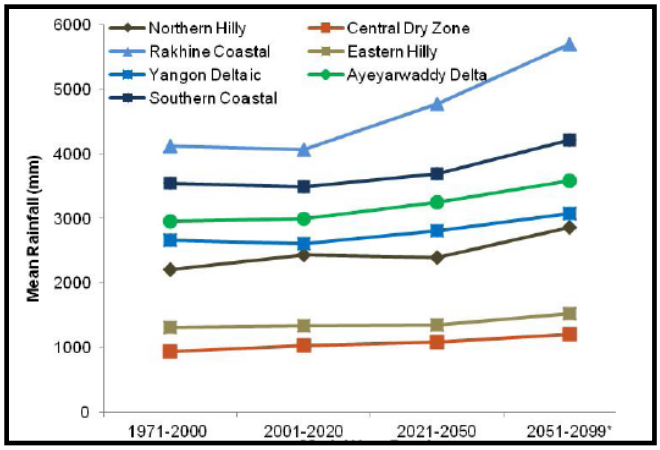


Figure 2.2: Actual and projected physiographic region-wise changes in average annual temperature and rainfall between 1971 to 2099 (Reproduced from NECC, 2012)

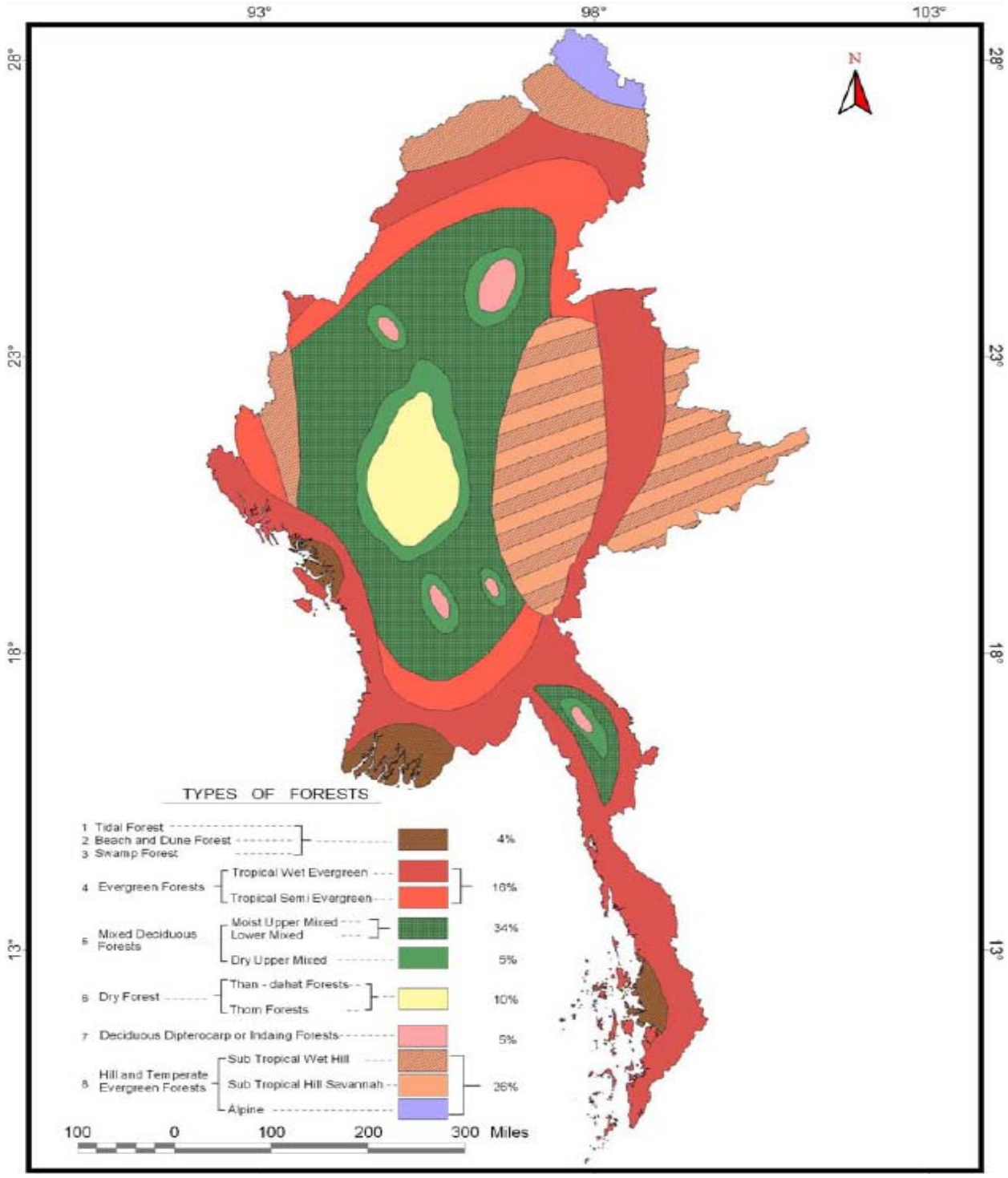


Figure 2.3: Forest types of Myanmar[22]

[22] Reproduced from MYANMAR NATIONAL ENVIRONMENTAL PERFORMANCE ASSESSMENT (EPA) REPORT Prepared by National Commission for Environmental Affairs, Myanmar, and Project Secretariat UNEP Regional Resource Center for Asia and the Pacific, December 2006

2.9 **Forest land ownership pattern**

In Myanmar land belongs to the State and thus the forests of all description are owned by the Government. There have been, however, reforms in management responsibility which, in the case of community forestry, is gradually moving towards the people in partnership with the Myanmar Forest Department under the legal framework created by the new Forest Law enacted in 1992 and the Community Forestry Instructions (CFIs) issued in 1995. More recently in 2005 the Government has also permitted private sector investment in forest plantations which are managed entirely by the private sector investors within the overall ambit of the forestry laws.

2.10 **Government owned forest plantations**

Organized forest plantations began in Myanmar during the colonial period in 1856 with the planting of teak in Taungoo in Bogo Yoma region when farmers were encouraged to plant commercially valuable teak on government forest lands by permitting them to raise agriculture crops for themselves for a few years in the interspaces. This model became hugely successful and was adopted first in India and later in the then British colonies in Africa as the *Taungya* method of teak cultivation.

However, till 1980 plantations were only raised intermittently and on small scale mostly by the efforts of individual officers of the Myanmar forest department spread across the country. Large-scale plantation forestry as a result of policy initiative and governmental support through budget and staffing began only in 1980 and till 2010 a total of 853300 ha of forest plantations have been raised. Government policies do not permit conversion of natural forests into plantations which can be raised only on degraded forest lands and on non-forest lands including lands that were deforested in the past.

Sr.	Year	Area of Plantation (Hectares)				Total
		Commercial	Watershed	Industrial	Village Supply	
1	1981	11493	915	162	6063	18633
2	1982	14706	3553	486	3491	22236
3	1983	16319	4304	769	6219	27611
4	1984	18516	3960	1433	6907	30816
5	1985	18626	4228	2776	10711	36341
6	1986	18917	2615	3446	7968	32946
7	1987	17322	2716	5540	6730	32308
8	1988	16382	2777	4958	5799	29916
9	1989	13812	1165	2448	1304	18729
10	1990	18312	1807	4573	6006	30698
11	1991	18255	1607	3905	7268	31035
12	1992	17335	2232	4128	7892	31587
13	1993	13406	3163	3244	11198	31011
14	1994	6309	2641	890	12742	22582
15	1995	11790	4089	2750	13469	32098

16	1996	13409	3399	2226	13729	32763
17	1997	13871	7305	2206	6803	30185
18	1998	16779	3905	2084	5981	28749
19	1999	17264	7110	1093	5247	30714
20	2000	16847	7450	2086	4335	30718
21	2001	15571	6941	3703	4543	30758
22	2002	15358	7831	3513	4694	31396
23	2003	15344	7386	3318	4393	30441
24	2004	16279	8134	3905	3656	31974
25	2005	17085	8903	2995	4219	33202
26	2006	17094	6712	1922	2600	28328
27	2007	12890	6961	1926	2125	23902
28	2008	15743	6536	4	2003	24286
29	2009	15439	5059	0	1841	22339
30	2010	13861	223	0	917	15001
	Grand Total	**464334**	**135627**	**72489**	**180853**	**853303**

Table 2.5: Area of forest plantation established by year and by type[23]

2.11 **Private Forest Plantations**

With a view to meet the increasing domestic and external demand for teak and other timbers without harming the ecology of natural forests the Myanmar Government has been encouraging private sector investment in forest plantations since 2005. This policy led initiative has led to investment by more than a hundred private companies with almost 30000 ha of teak and non-teak plantations across the country with more than one third in the Bago Yama region alone as indicated in the tables below.

Sr.	**State/Region**	**Area allowed(ha)**	**Planted Area (ha)**					
			2006-07	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**Total**
1	Kachin	3,035	40	295	202	81	40	660
2	Kayah	40	0	0	0	0	20	20
3	Kayin	1,012	0	40	81	180	93	395
4	Sagaing	3262	0	0	945	754	518	2,21
5	Bago (East)	35,089	12	113	194	3,326	3941	7,58
6	Bago(West)	2,995	61	182	283	1,376	243	2,14
7	Magway	2,911	0	101	111	223	674	1,10
8	Mandalay	1,841	0	0	81	121	567	769
9	Yangon	1,760	0	40	0	0	866	907
10	Shan(south)	101	0	20	40	40	0	101
11	Shan(North)	2,347	0	0	81	121	310	512
12	Ayeyawady	2,525	0	202	688	1012	567	2,46
	Total	56,920	113	996	2,707	7,234	7,839	18,8

Table 2.6: Area of private teak plantation[24]

[23] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Myanmar Forest Department

Sr.	State/Region	Planted Area (ha)				
		2007-08	2008-09	2009-10	2010-11	Total
1	Kachin	4,451	338	28	0	4,817
2	Kayah	40	45	20	0	105
3	Kayin	15	138	250	91	495
4	Chin	3	87	60	111	261
5	Sagaing	685	460	440	106	1,692
6	Taninthayi	14	40	48	0	102
7	Bago (East)	421	716	692	512	2,342
8	Bago(West)	72	217	111	0	400
9	Magway	62	474	382	311	1,230
10	Mandalay	390	789	786	0	1,965
11	Mon	0	101	36	0	138
12	Rakhine	29	191	244	399	863
13	Yangon	166	81	141	0	389
14	Shan(south)	45	59	527	0	631
15	Shan(North)	60	166	81	54	361
16	Shan(East)	0	20	29	24	74
17	Ayeyawady	55	105	126	0	286
	Total	**6,509**	**4,027**	**4,004**	**1,609**	**1,6149**

Table 2.7: Private non-Teak Plantations[25]

2.12 **Community forestry program**[26]

With a view to involve people in the management of forest resources in their vicinity the Ministry of Environmental Conservation and Forestry (MOECAF) issued the Community Forestry Instructions (CFI). The main objective is to manage and use national forest resources sustainably, plant trees on barren lands and reforest degraded areas with the active participation of the people, to contribute to the rural economy, create rural jobs, enhance ecological and environmental stability of the country and assist in satisfying the forest based basic needs of the local communities. The CFI stipulates areas where Community Forest (CF) could be established. The CFI defines Community Forestry as forestry operations in which the local community itself is involved for the establishment of woodlots with inadequate supplies of fuel-wood and other forest products for community use, and also the planting of trees and harvesting of forests to enhance rural food security and incomes.

The salient features of CFI are:

i. Any land at the disposal of the State, including reserved forests and village supply plantations, can be alienated as community forests;
ii. Land tenure initially granted for 30 years, is extendable and inheritable;

[24] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Planning and Statistics Wing, Myanmar Forest Department
[25] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Planning and Statistics Wing, Myanmar Forest Department
[26] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Planning and Statistics Wing, Myanmar Forest Department

iii. Forest products harvested from CF for domestic use are tax-free;
iv. No restrictions on the selling and pricing of the surplus forest products;
v. Seeds and seedlings needed for the first rotation and technical assistant provided free of cost by the Forest Department
vi. Forest Department approval to establish CF is easily and quickly obtainable; and
vii. The duties and responsibilities of the user's group are reasonable.

By June 2011 a total of 575 Forest User Groups (FUGs) had already been organized and 43,872 ha of community forests placed under their management across the country as indicated in the Table below:

No.	States/Regions	Area (ha)	No. of FUGs	No. of members
1	Kachin	3,496.8	7	824
2	Kayah	40.5	1	70
3	Kayin	446.6	4	278
4	Chin	1,389.7	17	243
5	Taninthayi	1,725.4	33	1,434
6	Sagaing	180.2	5	118
7	Bago (East)	115.4	3	116
8	Bago (West)	120.4	3	134
9	Magwe	4,094.8	99	2,206
10	Mandalay	4,258.0	38	18,188
11	Mon	66.8	4	59
12	Rakhine	1,665.6	85	3447
13	Yangon	309.7	6	210
14	Shan (South)	2,0621.9	192	10,239
15	Shan (North)	559.5	15	178
16	Shan (East)	2,268.3	14	652
17	Ayeyarwady	2,512.5	49	2,228
	Total	**43,872.0**	**575**	**40,624**

Table 2.8: Status of community forestry as on June 2011[27]

2.13 **Myanmar Economy**

Myanmar's economy[28] has been registering good growth following policy reforms over the past five years after having suffered poor economic growth for decades. In the current Fiscal Year 2013 it is set to grow by 6.5% and is projected to expand to 6.8% in FY2014. This policy reform led growth is also supported by several factors including facilitation of credit to

[27] Thaung et al, 2012, Current status of REDD+ Readiness Preparation in Myanmar, Planning and Statistics Wing, Myanmar Forest Department
[28] Asian Development Outlook (ADO) 2013 Update

the private sector and the reinstatement of duty-free and quota-free market access to markets in the European Union.

Inflation has become something of a problem in the past two years. It rose from a mere 0.76% in June 2012 to 6.0 percent in December 2012 before declining to 4.7% in March 2013. But then it rose again and reached 7.3% in August 2013[29]. Main factors driving inflation are food prices, housing rental costs, and fuel. The increase in rice prices is due to increased exports reducing supplies available to the domestic market. The Government now hopes to stabilize rice prices by selling its buffer stocks in the domestic market. Increased autonomy to the central bank granted under a recent law should also limit the tendency to increase money supply and thus help contain inflationary pressure over the medium term.

Tourist arrivals rose by 36% in the first 2 months of FY2013 and this sector now is geared towards quick growth with big investments in hotel accommodation in the capital Nay Pyi Taw and in Yangon, Mandalay and Bagan, and in other tourism infrastructure. Production and export of natural gas from Shwe and Zawtika gas fields has shown an upward trend and this has become the major source of government revenues. Investment in physical and communication infrastructure is growing sharply with new roads, ports and airports, and the award of telecommunications licenses to two international companies.

Increased earnings from the export of natural gas, foreign direct investment, generous official development assistance, and higher inflows of tourists have led to an easing of restrictions on foreign exchange. There has been a sharp increase in imports also stemming from higher investments but the overall balance of payments is expected to remain in surplus. At the end of FY2013 the foreign exchange reserves rose to an estimated $4.6 billion, sufficient to cover 3.7 months of imports, and are projected to move higher.

Economic Indicator	2008	2009	2010	2011	2012
Per capita GNI, Atlas method ($)	…	…	…	…	…
GDP growth(% change per year)	3.6	5.1	5.3	5.5	6.3
CPI (% change per year)	22.5	2.3	8.2	2.8	3.5
Unemployment rate (%)	4.0	4.0	4.0	4.0	…
Fiscal balance (% of GDP)	(2.5)	(5.2)	(5.4)	(3.9)	(5.4)
Export growth (%change per year)	12.3	(1.4)	25.8	13.3	11.2
Import growth (%change per year)	25.6	1.9	15.8	24.4	22.0
Current account balance (% of GDP)	(3.1)	(2.6)	(1.2)	(2.5)	(4.0)
External debt (% of GNI)	…	…	…	…	…

( ) = negative, … = data not available, CPI = consumer price index, GDP = gross domestic product, GNI = gross national income

Source: ADB. 2013. *Asian Development Outlook 2013*. Manila; economy sources.

Table 2.9: Myanmar Economic Indicators (Reproduced from Asian Development Outlook 2013)

[29] World Bank, Myanmar Economic Monitor, October 2013

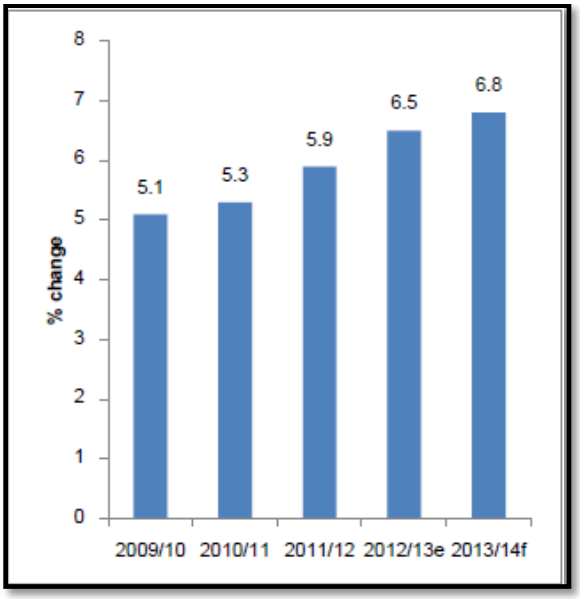


Figure 2.4: Annual Real Economic Growth over five years ending March 2014 (estimates for fiscal 2012-13 and forecasts for 2013-14) Source: World Bank, Myanmar Economic Monitor, Oct 2013

An examination of the above Table of economic indicators would reveal a steady growth in exports of around 12% except for the sharp dip in 2009 and equally sharp increase in 2010, both on account of external trade environment which was first severely affected by domestic turbulence in 2009 and, when the underlying issues were tackled satisfactorily, led to a quick rise again. The unemployment remained at a moderately low 4% throughout the five years unaffected by the temporary turbulence in the export trade which indicates that job creation potential of the present menu of export is not very high. Imports have been rising in value by over 20% annually a significant part of which is for infrastructure development and for transportation.

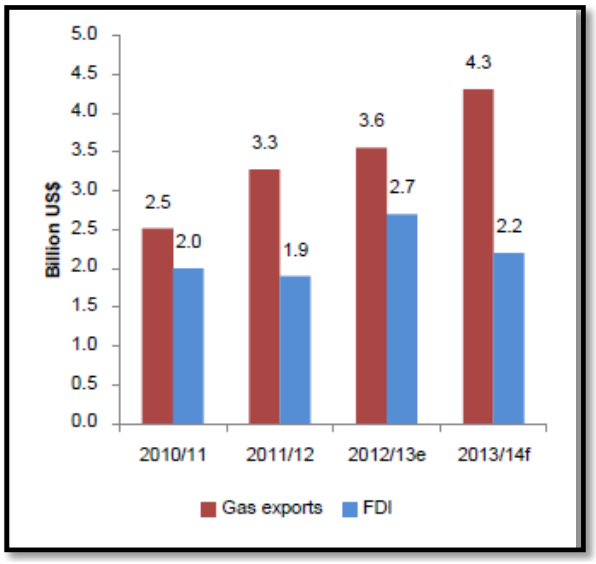


Figure 2.5: Myanmar Gas exports and FDI (estimates for fiscal 2012-13 and forecasts for 2013-14) Source: World Bank, Myanmar Economic Monitor, October 2013

The drivers of strong economic growth are in gas production, construction, as also in foreign direct investment. Construction and services received major boost from the opening up of the country with political and economic reforms that promise to continue. Another major reason of economic growth has been the South East Asia games that Myanmar hosted in December 2013. Foreign direct investment grew from US$1.9 billion in 2011-12 to US$2.7 billion in 2012-13 most of which was in the energy sector, information technology, garment industry, and food and beverages[30].

2.14 **Agriculture economy of Myanmar**

Three agro-ecological zones cover Myanmar that include delta zone with alluvial and swampy soils in the densely populated south predominantly with lowland rice cultivation, dry zone of rain fed crops in middle Myanmar with population mainly along rivers, and the sparsely populated hills with a wide range of rainfed crops including highland rice, maize and pulses along with horticultural crops. Shifting cultivation is practiced by as many as 2 million families over considerable parts of this hilly region[31].

Cultivated farm holdings in Myanmar are estimated to be between 21 and 30 million acres with an additional 14 million acres of cultivable wasteland[32]. This suggests possibilities of further extension of agriculture without deforestation. Most production gains over the past two decades have come from area expansion rather than increased productivity. But the country has also been loosing roughly 1% of its forest land per year over the past 20 years. Roughly half of all rural households are landless in that they have no land use rights to cultivable land. The highest rates of landlessness occur in the Delta region, where estimates of rural landlessness range from 50% to 80%. Elsewhere the share of landless in total rural households ranges between 25% and 45%[33].

2.15 **Tourism and tourism infrastructure**

Due to its immense direct and indirect income and employment generation opportunities tourism creates it has grown globally by leaps and bounds. Myanmar has also laid high emphasis on development of tourism in recent years around its cultural, natural, and historic assets and has seen sharp growth in the past few years. In one year alone, between 2011 and 2012, visitor arrival increased by 29.7% and the country received over one million international visitors.

[30] World Bank, Myanmar Economic Monitor, October 2013
[31] FAO 2005, Myanmar Agricultural Sector Review and Investment Strategy, New York, UNDP
[32] USAID, 2013, Working Paper on A Strategic Agricultural Sector and Food Security Diagnostic for Myanmar,

[33] FAO 2005. Myanmar Agricultural Sector Review and Investment Strategy. New York: UNDP

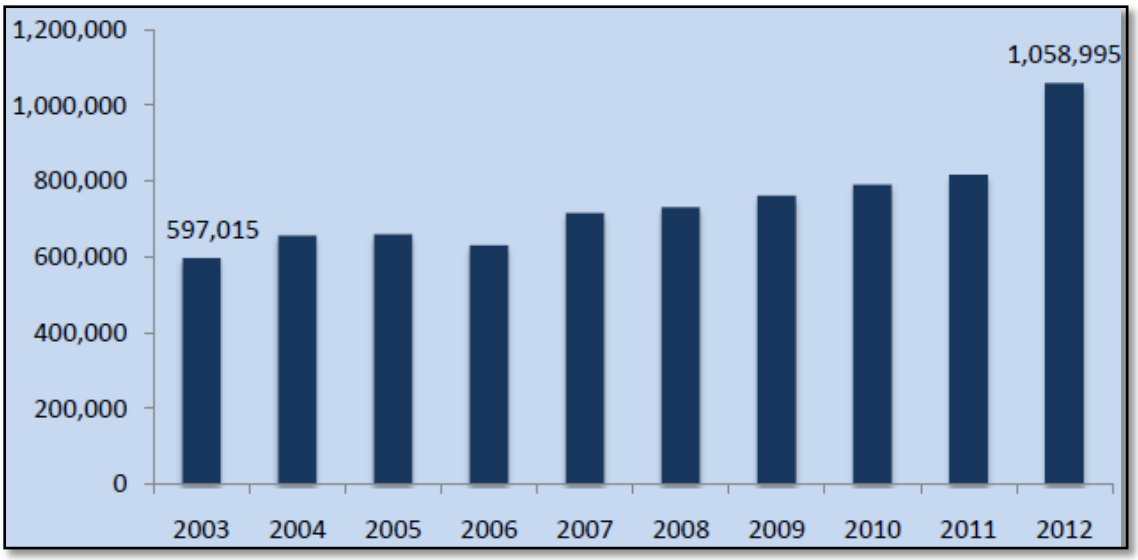


Figure 2.6: International tourism arrival in Myanmar (Reproduced from Myanmar Tourism Master Plan 2013-2020)

Most of this tourism is confined to Yangon, Bagan, Inle Lake, Kyaikhto, Mandalay, and Ngapali Chaungtha and Ngwesaung beaches with almost negligible visitation in the far north and south. With inadequate data keeping accurate estimates of the contribution of travel and tourism sector to Myanmar's GDP is difficult of estimate but a reasonably reliable estimate by the World Travel and Tourism Council (WTTC) places it at $771 million to GDP in 2012. This is set to grow handsomely given the potential steep rise in tourist arrivals in coming years.

The primary attraction of the tourism sector is its high job creating potential since, outside of agriculture, this sector is the most labor intensive sector of national economy with highly dispersed jobs in hotels and restaurants, retail, transportation and recreational services. Within short periods of time adequate training in various aspects of this sector can be extended which can provide life-long satisfactory employment to both rural and urban people many of whom can also become small entrepreneurs with very little initial investments. In 2012 the estimated direct and indirect jobs sustained by tourism was 735000 jobs which formed 2.8% of total employment at least half of whom were women[34]. Seasonality of these jobs is, however, a serious concern since most tourist arrivals are in cooler and drier periods between October to March and it may require well thought out strategies to extend the arrival period significantly.

The 1993 Myanmar Hotel and Tourism Law was rather conservative in its approach and sought to encourage the visitors to observe Myanmar cultural heritage and natural scenic beauty and prevent destruction and damage of cultural heritage and natural scenic beauty due to the hotel and tourism industry. It lays down hotel and transport licensing provisions, prohibitions and penalties. With the projected growth in tourism expected to be very rapid these licensing provisions could prove very restrictive even though the emphasis on cultural and natural heritage, particularly the former, in the development of travel and tourism

[34] Myanmar Tourism Master Plan 2013-2020

infrastructure in Myanmar has not been diluted. These provisions were reviewed in 2011 and might need to be revised again in the light of the new Policy of Responsible Tourism.

Conservative estimates place the tourism arrival in 2015 up by 50% over the 2012 level while more liberal estimates place it 200% higher. Making this increase possible with its incumbent benefits would also entail a certain ecological and environmental cost particularly in the massive expansion of tourism and transport infrastructure that would be needed.

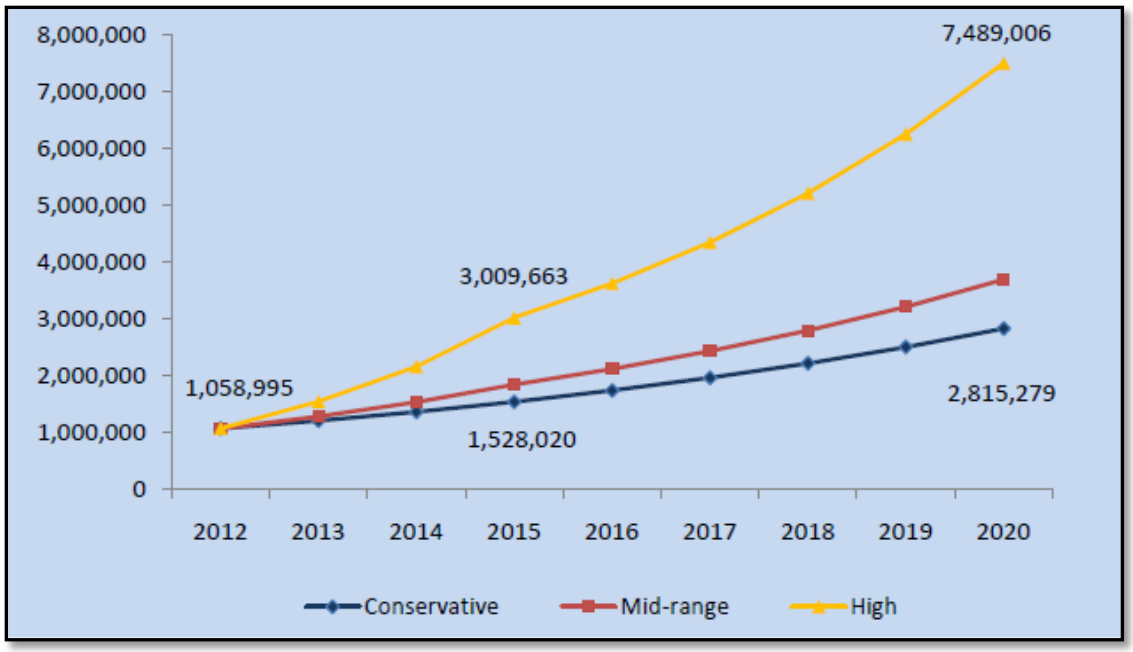


Figure 2.7: Projected tourism arrival in Myanmar (Reproduced from Myanmar Tourism Master Plan 2013-2020)

The challenge before the Tourism Policy is to ensure that the ecological and environmental costs are within the limits of tolerance. The Government of Myanmar has acknowledged this challenge and the Myanmar Tourism Vision states that Myanmar intends "to use tourism to make Myanmar a better place to live in – to provide more employment and greater business opportunities for all our people, to contribute to the conservation of our natural and cultural heritage and to share with us our rich cultural diversity. We warmly welcome those who appreciate and enjoy our heritage, our way of life, and who travel with respect."

For giving practical shape to this vision the Master Plan has adopted nine guiding principles three of which seek to conserve and enhance Myanmar's protected areas and natural environment, promote broad-based local social and economic development and maintain its cultural diversity and authenticity. Some of the niche tourism expected to be developed under this approach would be meditation and religious tourism, adventure tourism, community-based tourism, volunteer tourism, cruise tourism that would center around natural, historical, social and cultural values of the people and the land of Myanmar. Destruction to forests would thus be minimized though the construction of new transport infrastructure and upgradation of the present one across the country would often place demand on the forest land and resources.

2.16 **Mining industry**

Myanmar has a long history of mining particularly in gemstones from the days of the ancient Kings and the country has always been known for its beautiful and rare rubies from the Mogok region. The Myanmar Mines Law of 1994 makes State the exclusive owner of all naturally occurring minerals. The mining policy objective is to immediately boost up the present production fulfilling both the growing domestic needs as also to enhance the national revenues through exports. The country places emphasis on the production of copper, gold, lead, zinc, iron and steel and welcomes foreign participation in the sector. Privatization of the tin and tungsten mines and industrial mines is also being planned both through production sharing and profit sharing arrangements. New areas for mineral prospecting and extraction are on offer as also in the expansion of support infrastructure.

The extremely important, almost central, role that mining plays in the rapidly expanding economy of Myanmar and the fact that most of the new areas for mining as also for infrastructure would require forest lands makes the mining sector very relevant to REDD+ in the country. The baseline should make adequate provisions for this aspect of the country's economy.

2.17 **Road infrastructure**

Myanmar's transport sector, though greatly expanded in recent years, is still very underdeveloped providing sharp contrasts with its neighboring countries. The number of vehicles more than doubled to 2.4 million between 2004 and 2011 with the number of vehicles per 1000 people rising to 38 but it was still very low compared to Thailand's 432 and even Lao's 171.

The country had 150,816 km of roads in 2011 of which only 33,014 km were paved. A number of roads connecting different pars of the country to the neighboring countries of China, India and Thailand are also under construction including the road connecting Yunnan province in China to Assam in India via northern Myanmar and a road linking the city of Dawei with Thailand's province of Kanchanaburi.

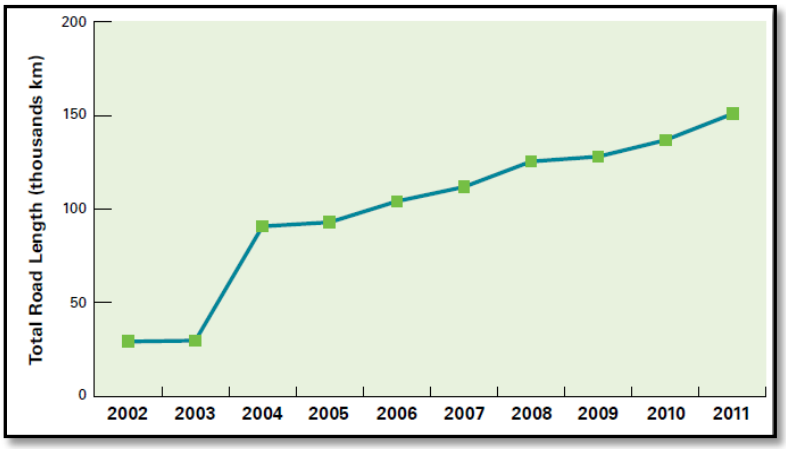


Figure 2.8: Expanding road infrastructure in Myanmar (Reproduced from Infrastructure in Myanmar by KPMG, 2013)

Given the nature and pace of development and the importance of mining, tourism, and agriculture in the future growth trajectory of Myanmar one can expect the road density in Myanmar over the period under consideration would come to resemble like that in Thailand. Construction of these and other new roads would mostly require diversion of forested lands. Also the increased access these roads provide would inevitably lead to greater degradation in some forested areas. Conversely, increased and multifarious economic activities would also lead the poorer section of population, now excessively dependent upon forests, into new economic opportunities and thus reduce pressure on forests. The planned expansion of road work in the region under consideration should, therefore, be necessarily factored in drawing the deforestation and degradation baseline. Also, since the planning of road network is still in progress, it is likely that more roads would be constructed than currently planned and this likelihood should also be examined.

Chapter 3: Construction of reference levels

3.1 **Introduction**

Myanmar forests have faced both deforestation and forest degradation in several parts of the country. The country has also done commendable work in the field of reforestation and afforestation across most parts of the country and has also invested itself deeply in conservation of its forest assets, often at considerable economic cost to itself. These are driven by a varied mix of local, national and international factors that differ greatly in their impacts across the country. The actors, the socio-economic costs and the bearer of these costs, the benefits and the beneficiaries, are also similarly varied. REDD+ in this country would succeed only when the compensations match the costs not merely at the national level but also for the individuals and communities. The reference levels must therefore help in the estimation of both emissions from forests due to anthropogenic reasons, and reductions due to sequestration and the long storage of the sequestered carbon as also their distribution among the communities across the country.

3.2 **Benchmark forest area map**[35]

This is the national or sub-national forest area map within an appropriate administrative territory at the beginning of a formal REDD+ program with reference to which future assessments are to be made. The benchmark map delineates the boundaries within which monitoring is to be done for all the five REDD+ components. Specifically, it makes monitoring of deforestation a simple task of identification of change in forest area within the boundaries. Depending upon the national circumstances, and access to technology and human and financial resources, this benchmark forest map can also present forest cover density and the ecological status of the forests at the beginning against which forest degradation and loss of environmental values can be assessed. Afforestation and reforestation can also be monitored through the conversion of non-forest lands to forests.

Our area of interest is the Taungoo district but since attempts to reduce deforestation and forest degradation in this district alone through a top down government directed program can easily lead to leakages spilling beyond the district boundaries it is important to extend monitoring to all those areas such spillages are possible. However, the economic costs of monitoring are considerable and for reducing these costs we decide to limit the zone of monitoring up to 20 km beyond the district boundaries only. In other words, physical leakage monitoring shall be confined to a 20 km wide belt all along the Taungoo district boundary.

[35] GOFC-GOLD Source Book

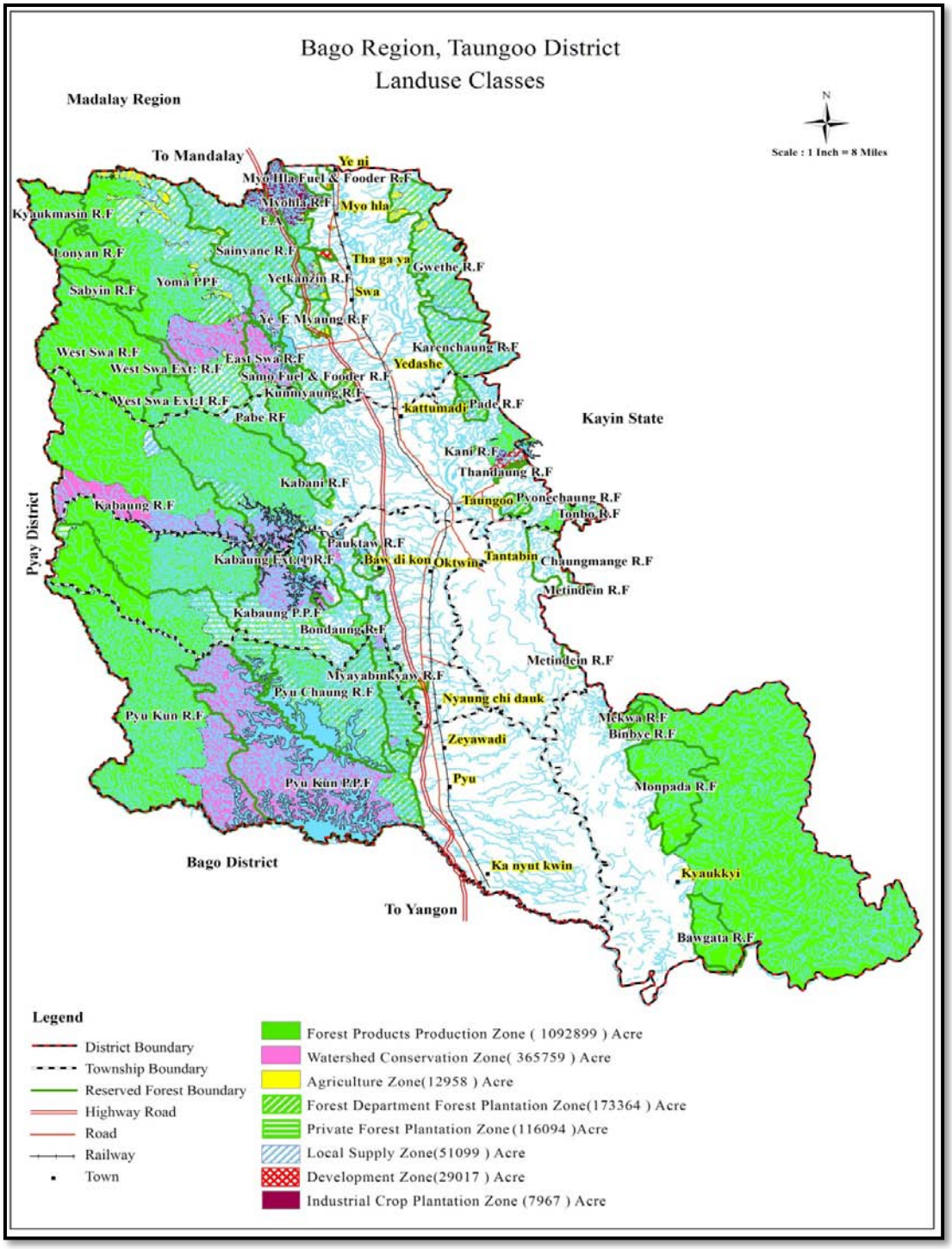


Figure 3.1: Baseline forest map of Taungoo district[36]

3.3 **A bottom up approach for constructing FREL/FRL**

REDD+ has five distinct components of reducing emissions from deforestation and forest degradation, enhancing forest carbon stock, conservation of forests and sustainable

[36] This is the most recent Myanmar land classification map prepared by the Myanmar Forest Department (Source: Dr Thaung Naing Oo)

management of forests. These five components will often have different drivers but they have obvious overlaps as they produce only three different outcomes, namely, reduction of emissions; enhancement of the rate of sequestration and maintenance of existing forest reservoirs[37]. The project area is divided into distinct zones where one or the other of these components predominates. Each such zone is then studied intensively to decipher the causal factors like dependence of the local communities on forest for various activities like fuel wood collection, NTFP collection, unregulated livestock grazing, agriculture, illegal mining, etc. A comprehensive plan is then prepared for the district on the basis of these reports which would be supplemented by micro plans at the village level.

In the context of the ongoing REDD+ negotiations a single FREL and FRL would appear appropriate for a future market oriented REDD+ in which a country's aggregate mitigation achievements in the forestry sector, the carbon credits expressed in tCO_{2e}, would become tradable in the market. But in the result based payments for REDD+ agreed at Warsaw 'results' refers to the outcomes of successive steps that would lead to effectively addressing the causes of deforestation and forest degradation over an agreed period of time in addition to measurable achievements in enhancement of carbon stocks, conservation of forests and sustainable forest management.

In the case of market based approach, with carbon credits acting as the currency, the tree grower who holds the credits earns its equivalent monitory value by sale in the market. But in the result based payment the flow of incentive money must relate to the costs of achieving the agreed series of interim results measured against local baselines incurred by various actors including the individuals, communities and the government agencies like the forest departments. These local baselines, therefore, assume crucial importance in result based payments.

This would necessitate a bottom up approach for the construction of FREL/FRL in which the first step would be to construct local baselines for the relevant REDD+ component(s) followed by aggregations over a forest district. The component-wise baselines for the districts would then be aggregated over a province and, finally, for the country as a whole. The final outcome would be a single reference level, which will represent the net impact of all five REDD+ components on the forest carbon stocks.

The following are the steps in designing FREL/FRL:

3.4 **Deforestation reduction zone**

The first step is to identify forest lands in Taungoo district that are currently exposed to significant degree of deforestation and place them in the Deforestation reduction zone and marked on the map. For getting historical trend annual deforestation figures for the last 10 years are needed and a minimum of 3 points are required for intrapolation and extrapolation of the trend.

[37] GOFC-GOLD Source Book

3.5 **Conservation of forests zone**

Similarly, forest areas in the district that are formally under conservation by way of official notification and those that are placed under strict conservation on account of vicinity to habitations, streams and other water bodies, steep slopes, and other topographical or ecological reasons are identified and placed under the Conservation zone and marked on the map. The entire Conservation zone is then stratified in homogenous strata to make statistical assessment of the carbon content possible.

No decrease in these areas is expected as the conservation zone is largely guided by government and departmental policies and conventions where no change is likely. However, some forest lands in the conservation zone could be lost to deforestation for priority activities like mining, tourism, urban settlements and road construction which would however be covered under the preceding category of deforestation.

Monitoring of this zone shall be primarily satellite imagery based resorting to ground survey assessment of carbon losses where disturbances are noticed in imageries.

3.6 **Sustainable management of forests zone**

Under the decisions of the UNFCCC it is left to the countries to decide what constitutes sustainable management of forests. Since one of the most important objectives of the forest department is to manage all forest areas sustainably it is difficult to decide the forest lands that could be placed under this component. One possibility is to treat the areas where local communities play central role in management of forests for producing forest goods and services for local consumption as the zone for sustainable management of forests by local communities. Since a separate demarcated area for this purpose would facilitate the development of good practices for flow of funds to the local communities it would be best to treat all forest lands under the full or partial control of Forest User Groups (FUGs) as the lands under this component. Accordingly the forest lands under the control of FUGs should be demarcated on the map and placed under this category.

More areas are likely to be added to this zone as more FUGs are formed to ultimately cover all communities living adjacent to forests. The number of these communities and the average size of forest lands placed under each FUGs will decide the total extent of lands in this zone. Management of these forest areas is expected to be highly intensive with intense yearly harvesting that removes the annual increments accrued in the preceding year.

Carbon content in this zone would be assessed in a manner similar to the one described above for the Conservation zone. Monitoring of this zone shall be satellite imagery based and supplemented by community monitoring.

3.7 **Degradation reduction zone**

The rest of forest lands would be placed under the Degradation reduction zone and marked on the map. The causes of degradation here could be a combination of harvesting practices,

illegal removals, grazing, forest fires, insect and pest attacks and fire wood collection, among others.

Presently there is no past data based on which a baseline representing historical forest degradation could be constructed. In its absence we would adopt the current carbon contents assessed through sample survey of the project area as the reference level carbon content.

Carbon content in this zone would be assessed in a manner similar to the one described above for the Conservation zone. Monitoring of this zone shall be highly intensive based first on satellite imagery and supplemented by ground assessment.

3.8 **Enhancement of carbon stock zone**

This zone would include all non-forest lands where tree plantations have been raised in the past 10 years along with those that are planned, or are likely to be taken up, under farm forestry, social forestry or village forestry schemes, and mine reclamation areas, and placed under the Enhancement of carbon stock zone and marked on the map.

Monitoring of this zone shall be highly intensive based first on satellite imagery and supplemented by reporting by forest plantation owners and verified through ground assessment by REDD+ Project Monitoring Staff.

3.9 **Available data insufficient for this zone-wise FREL/FRL**

However, the data presently available is insufficient for the construction of the above described zone-wise reference levels and the limited time for this project does not permit the detailed data collection needed. We would, therefore, limit this exercise to the data available and assess the reference levels for deforestation and degradation and enhancement of carbon stocks alone as below.

3.10 **Deforestation in Myanmar in recent years**

Myanmar has been cited in some of the FAO reports as one of 10 tropical countries with the highest annual deforestation rate assessed at 1.3% in the last decade of 20th century mostly on account of agricultural expansion, fuelwood consumption, charcoal production, uncontrolled logging and plantation development. But these now appear to be somewhat erroneous probably because most of these reports were based on data samples derived from small geographic areas and small sample of satellite images and relied on extrapolations assuming similarity in causative factors. A more judicious assessment appears to be by Peter Leimgruber and team of Smithsonian Institute[38] who offer the following three possible reasons for the large errors in FAO estimates:

a) Previous estimates were based on small samples of satellite imagery combined with the skills of the Experts used for extrapolation to the rest of the country. The

[38] Leimgruber et al, Forest cover change patterns in Myanmar (Burma) 1990•2000, Environmental Conservation 32 (4): 356•364 © 2005

Smithsonian team used wall to wall Landsat coverage for Myanmar thereby eliminating errors that arise from random selection of a few images and extrapolation of deforestation rates to the country scale.

b) Unlike FAO assessments, possibly using government classification of open canopy tropical forests in several parts of the drier regions as non-forests, the Smithsonian assessment included these open-canopy dry forests with sparse tree cover falling within the internationally acceptable definition of forests in its assessment.

c) Earlier assessments may have also been hindered by confusion between seasonal changes in canopy cover with anthropogenic forest degradation and deforestation which becomes particularly difficult to tackle in deciduous and other open-canopy forests. The Smithsonians reduced this error by using images acquired immediately after the Monsoons minimizing problems caused both due to excessive cloud cover during rainy season and misclassification of leafless deciduous forests in pre-Monsoon period.

The Smithsonian team used complete wall to wall coverage by Landsat-5 Thematic Mapper (TM) for 1989-1992, and Landsat-7 Enhanced Thematic Mapper (ETM-h) for 2000-2001 using 43 images for each date distributed in discrete image tiles designated by a unique row and path number of the World Reference System II. This allowed these images to be overlaid for change detection based on these unique row and path numbers. These images were subjected to the NASA's Geocover orthorectification process that uses Global Positioning System (GPS) data and accounts for elevation to produce an image set with a root mean square error lower than 50 m. The orthorectified discrete image tiles were mosaicked into a single forest map for the whole country and used to calculate countrywide and divisional forest cover and deforestation rates. Forest cover and deforestation rate was also analysed for each image tile separately for more localized assessments and identification of deforestation hotspots.

Mapping accuracy was evaluated comparing these change maps with raw images collected between 2000 and 2002 from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) acquired from the Land Processes Distributed Active Archive Center (LPDAAC) of US Geological Survey. ASTER images have better spatial resolution of 15 m providing greater accuracy in delineation of forest and non-forest cover. This was crucial to distinguish low canopy cover degraded forests from the seasonal low canopy covers in dry dipterocarp forests. These ASTER generated 1558 control points spread across the country, and well distributed among forested, non-forested, reforested and afforested landscapes, showed that the forest cover map for the year 2000 produced by the Smithsonian team in 2000 had an overall accuracy of 86%.

According to their assessment Myanmar's forest cover went down from 442 000 km^2 (67% of land area) to 430 000 km^2 (65%) over a decade between 1990 to 2000 with an annual rate of 0.3% decline primarily due to anthropogenic factors. During the same period there was an accretion of about 3000 km^2 of forests thus reducing the net deforestation to about 0.2% per annum. The specific causative factors, and their severity, varied from region to region as a

result of which the change in forest cover also varied considerably across the country with the highest rate of deforestation of 1.2% being in the Ayeyarwady delta region. Deforestation in the heavily populated regions of Mandalay and Sagaing divisions were also more than double the national average. The regions that showed no decline were the Karen and Kaya states with a negligible rate of deforestation. It needs, however, to be noted that shifting cultivation was the severest in these two states with significant area of vegetation regrowth being cleared annually for cultivation.

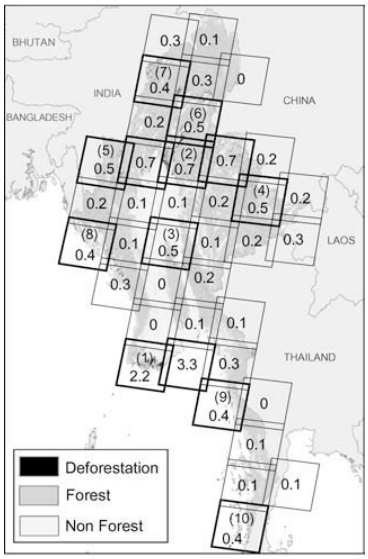


Figure 3.2: Annual forest loss 1990-2000, numbers inside tiles give yearly % deforestation, thick black lines indicate higher than average deforestation (Reproduced from Leimgruber et al, Environmental Conservation 2005)

The rate of deforestation was higher in states with lesser forest cover. The Ayeyarwady and Mandalay Divisions were among the four of the country's Divisions and States that had less than 35% forest cover while the annual losses in the Divisions and States that had over 70% forest cover were well below the average annual rates estimated for the whole country.

Divisional State	Total area (100 km^2)	Forest cover (100 km^2)	Forest cover (%)	Average annual deforestation rate (%)
Ayeyarwady Division	34	9	26	1.2
Mandalay Division	37	11	31	0.5
Sagaing Division	96	62	66	0.4
Yangon Division	10	1	13	0.2
Rakhine State	35	25	74	0.2
Shan State	157	116	76	0.2
Magway Division	44	14	31	0.2
Kachin State	89	76	89	0.2
Tanintharyi Division	42	31	75	0.1
Bago Division	38	18	47	0.1
Chin State	37	31	87	0.1
Mon State	11	5	45	0.1
Karen State	30	24	78	0.0
Kayah State	12	8	74	0.0
Total	671	430	65	0.2

Table 3.1: Region-wise deforestation rate in Myanmar between 1990-2000[39]

[39] Table reproduced from 'Forest cover change patterns in Myanmar (Burma) 1990•2000, Leimgruber et al, Environmental Conservation 32 (4): 356•364 © 2005'

3.11 **Deforestation hotspots:**

Among the local patterns of forest cover and losses described in the Table above the forest losses were clearly concentrated into 10 deforestation hotspots named below

a) Ayeyarwady delta region (2.2-3.3%),
b) Northern edge of central dry zone and Ayeyarwady valley (0.7%),
c) Northern Bago Yoma and Sittaung valley (0.5%),
d) Shan plateau (0.5%),
e) Northern Chin State and Myitha River (0.5%),
f) Eastern Sagaing and East bank of Ayeyarwady River (0.4%),
g) Nagaland, Northern Sagaing Division and Uyu River (0.4%),
h) Northwestern Rakhine State (0.4%),
i) Border region between Mon State and Tanintharyi Division (0.4%), and
j) Southern tip of Tanintharyi Division (0.4%)

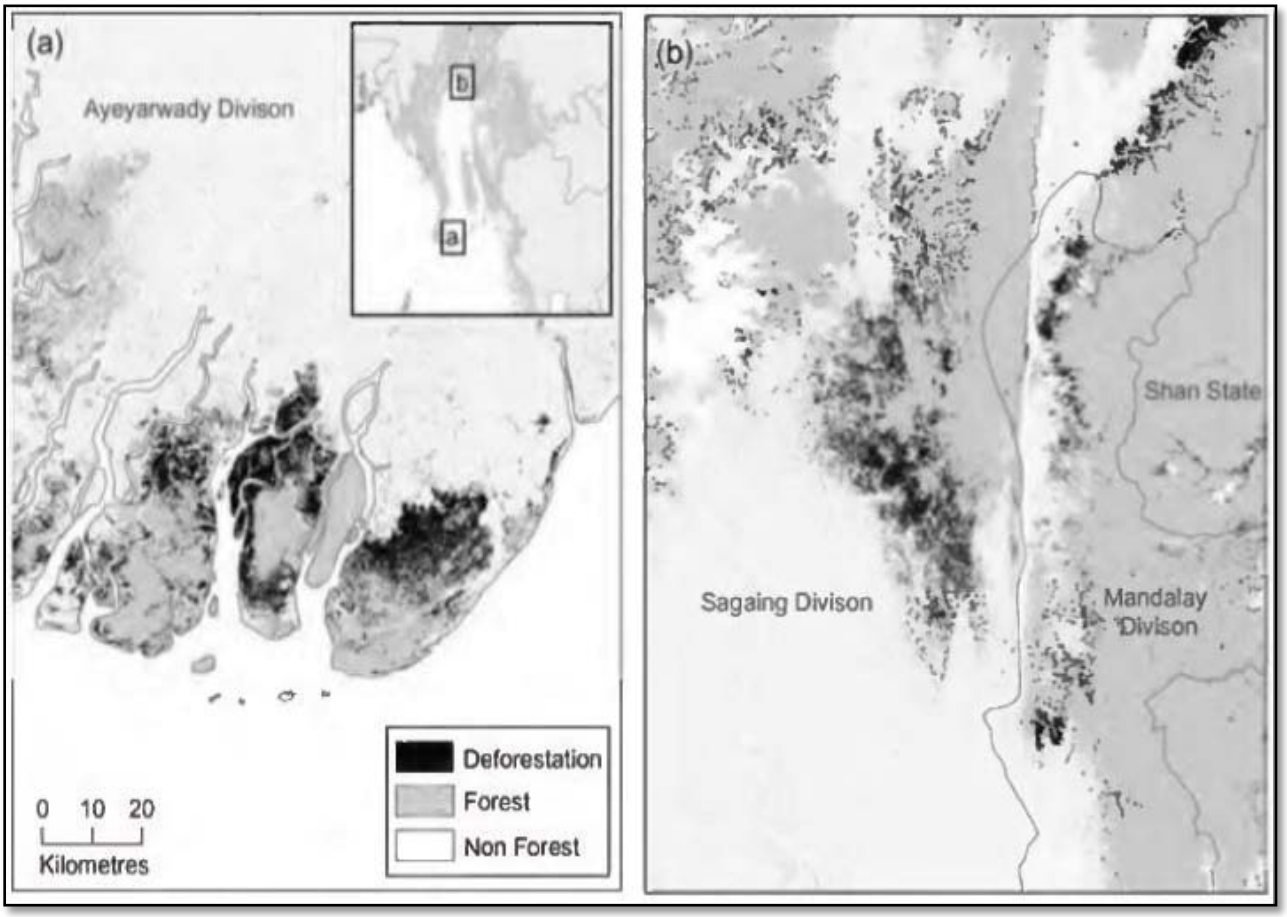


Figure 3.3: Deforestation due to agriculture expansion in (a) Ayeyarwady delta , (b) at the northern edge of the central dry zone along the Ayeyarwady valley (Reproduced from Leimgruber et al, Environmental Conservation 2005)

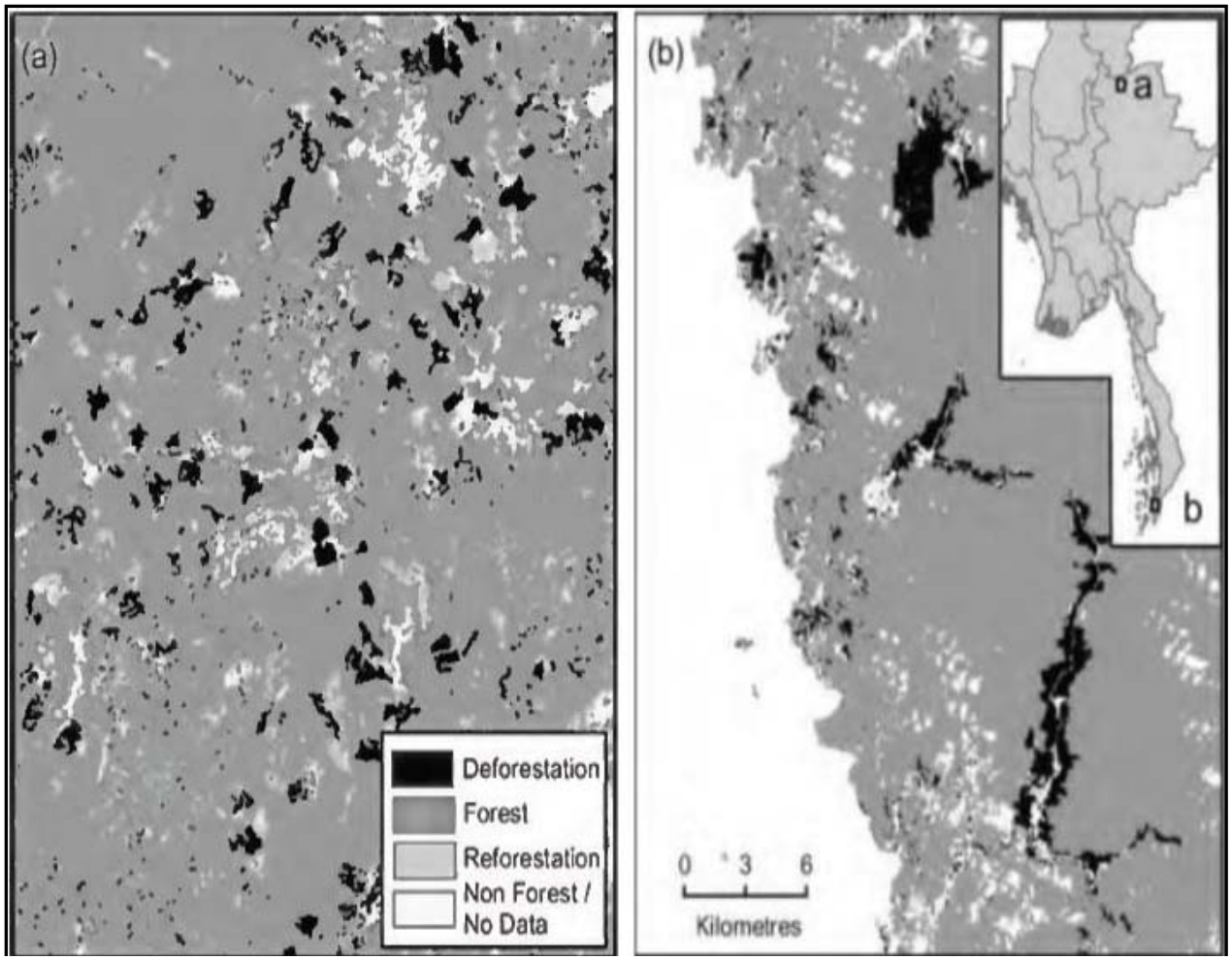


Figure 3.4: Deforestation due to (a) shifting cultivation in Chin Hills and (b) oil palm cultivation in low-land rainforests of southern Tanintharyi Division (Reproduced from Leimgruber et al, Environmental Conservation 2005)

The rate of deforestation during the decade ending 2000 has been the severest in the Ayeyarwady delta region, primarily for meeting the wood energy needs of Yangon metropolitan area and to a lesser extent for expansion of agriculture. Next in line of severity is the northern edge of central dry zone and Ayeyarwady valley with loss of forest lands to agriculture and other uses for urban and transport infrastructure. Another hotspot for deforestation was the northern parts of Bago Yoma region which also faced significantly higher than average loss of forests at 0.5% per year as indicated above. No specific data is available for Toungoo district in this region in the absence of which we will assume the same rate of deforestation as in the northern parts of Bago Yoma in the decade ending 2000.

In the decade 2001-2010 deforestation has slowed down somewhat across the country with increased awareness and action on the part of the government. Only anecdotal evidence is available for this reducing trend with little hard data. The FAO estimates are not usable for reasons already mentioned. We shall, therefore, assume that the rate of deforestation reduced very modestly from 0.5% in 2000 to 2010.

3.12 **Impact of present growth patterns on deforestation since 2010**

In the Toungoo district the main causes of deforestation so far have been agriculture expansion, increase in shifting cultivation, road construction, mining and tourism infrastructure. Increasing investments in agriculture sector, particularly in horticulture and floriculture, would place increasing demand for land. Combined with the high degree of rural landlessness in Myanmar this could potentially become a serious threat to forests in the coming years. However, the availability of cultivable wastelands of almost 14 million acres, owned by the state and distributed across the country, offer a degree of protection against forced deforestation on this account. This is particularly so in view of the determination of the Government in recent years to discourage diversion of forests lands for agriculture.

Shifting cultivation has traditionally been confined to the lands with the Karen people mostly in the south-eastern part of the Toungoo district and, as discussed in details in the preceding chapter, it is apparently in decline though a definitive finding is yet to emerge. But even if decline is not assured we can safely assume that no new forest lands are likely to be exposed to shifting cultivation and thus it would not contribute to loss of forests in future. We, therefore, do not see increased investments in agriculture sector in the coming years causing an increase in the rate of deforestation in Myanmar in general and in Taungoo district in particular. On the other hand, this sector is likely to contribute progressively more to afforestation in the coming years in this district where the main land based activity is in raising teak plantations.

Mining, tourism, urban settlements and roads are likely to become significant causes of deforestation in the country in the coming decade as these activities are increasing at a fast pace. We estimate that for the country as a whole any reduction in deforestation due to agriculture expansion would likely be compensated by increased losses due to these activities and, therefore, continuance of the past rate of deforestation in Myanmar into the coming decade is a likely course.

But in the case of Taungoo district we do not see any of these drivers, while present, becoming an overwhelming cause of deforestation. The government plans for the immediate future for mining, urban expansion, tourism and road construction activities falling within this district are all on a moderate scale. The loss of forests due to these activities is therefore projected to be at lower rate in the coming years.

The overall projected rate of deforestation in the baseline scenario, without any focussed REDD+ efforts, is expected to resemble the graph below. Monitoring of this zone, expected to be very small, shall be exclusively satellite imagery based.

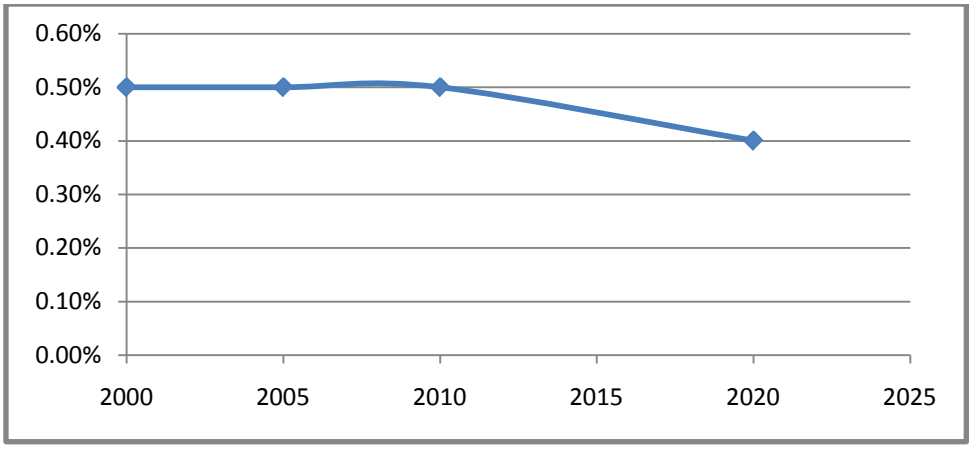


Figure 3.5: Baseline deforestation showing projected deforestation trend in Taungoo district

3.13 **Forest degradation in recent years**

Forest cover density (FCD) estimations of forest degradation based on field data collection are time-consuming and very expensive, and are not economically justifiable in the face of limited extent of benefits likely from REDD+. Estimates using remotely sensed data are the only possible option as they are more cost-effective for assessing large areas. FCD Mapper is a system developed for this purpose with the support of the ITTO which utilizes vegetation index, bare soil index, shadow index and thermal index derived from remotely sensed data. The vegetation index has a positive relationship with the quantity of vegetation (a measure of degradation) and, therefore, increases from grasslands to forests. When there is more tree vegetation there is greater shadow and the shadow index also increases with tree density. The thermal index decreases with increasing vegetation index and decreasing bare soil index.
Using FCD Mapper for assessing forest degradation in the Bago mountains Dr Myat Su Mon with a team of researchers from Kyushu University found that an increase of 1 km in distance to the nearest town and distance to the nearest village decreased the odds of forest degradation by 15.3% and 19.4% respectively while an increase of 50m in elevation would decrease the likelihood of forest degradation by approximately 37%. Increased logging was the most important variable linked to forest degradation with an increase of harvesting by 5 m^3 ha^{-1} increasing the likelihood of forest degradation by approximately 66%.[40]

The team studied[41] forest degradation in Khapaung, Middle Nawin and South Nawin Reserve forests of the Taungoo district. They categorized forest cover density in four categories and defined forest degradation as follows:

NF: Non forest
OCF: Open canopy forests
MCF: middle canopy forests
CCF: Closed canopy forests

[40] Myat Su Mon et al (2012), Forest Ecology and Management 267 (2012) 190–198
[41] Myat Su Mon et al (2010), Monitoring deforestation and forest degradation in the Bago mountain area, Myanmar using FCD Mapper, J.For.Plann. 15:63-72(2010)

Gross forest degradation (GFD): total number of pixels converted from a higher to lower forest canopy
Gross forest improvement (GFI): total number of pixels converted from a lower to higher forest canopy
Net forest degradation (NFD): Gross forest degradation - Gross forest improvement

Annual rate of forest degradation (%) = 100 x (NFD/total forest area at the beginning of assessment)/assessment period

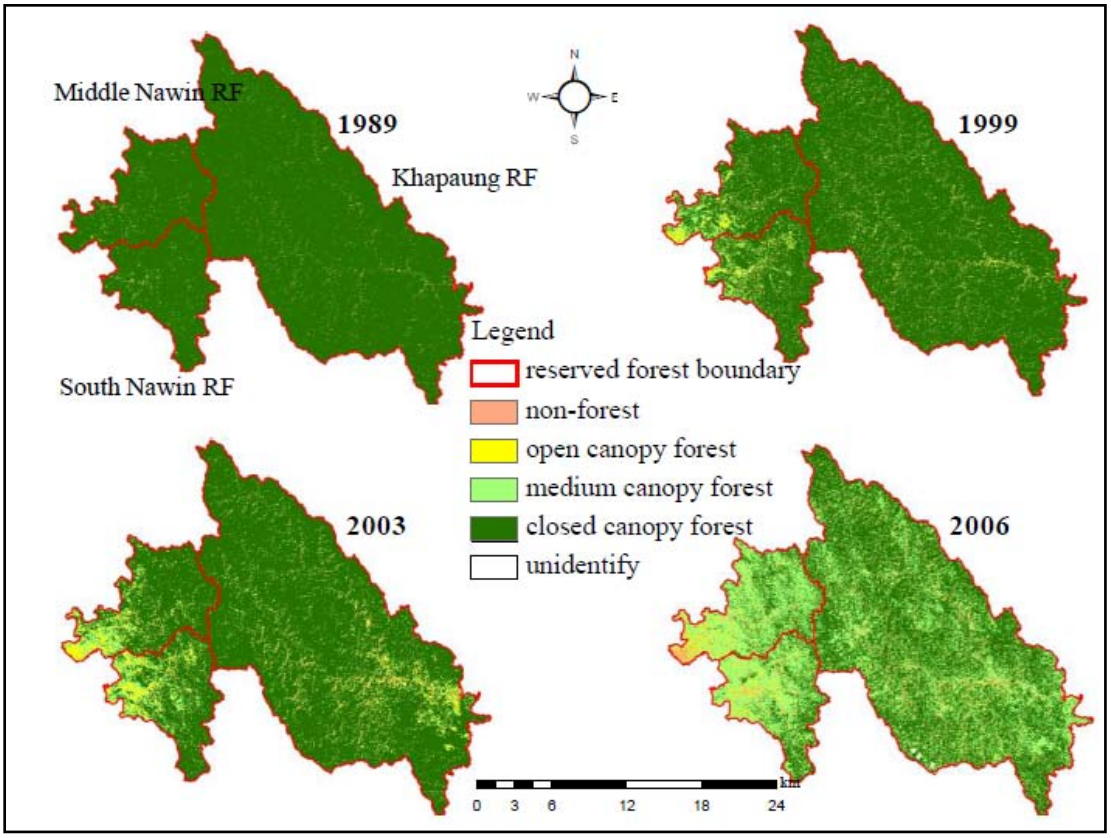


Figure 3.6: Increase in forest degradation in three reserved forests of Taungoo district between 1989 to 2006 (Reproduced from Myat Su Mon et al, 2010)[42]

The annual rate of net forest degradation (%) in these three reserve forests assessed by Dr Myat Su Mon is shown in the table below:

Reserve forest	**1989-1999**	**1999-2003**	**2003-2006**	**1989-2006**
Khapaung RF	0.42	0.82	8.96	1.99
Middle Nawin RF	1.72	1.47	16.10	3.88
South Nawin RF	1.58	3.51	11.35	3.66
Total	0.76	1.27	10.35	2.50

Table 3.2: Annual net forest degradation rate (%) of three Reserved Forests in the Taungoo district (Reproduced from Myat Su Mon et al, 2010)

[42] Myat Su Mon et al (2010), Monitoring deforestation and forest degradation in the Bago mountain area, Myanmar using FCD Mapper, J.For.Plann. 15:63-72(2010)

Among the available data the table above for the three reserve forests of Bago hills gives the closest representation of the reality of Taungoo district in the context of forest degradation. No data are presently available for the period beyond 2006 and it would be necessary to construct the scenario between 2006 to the present and then to 2020. Beginning 2009 the country has witnessed high economic growth that is expected to touch 6.8% in fiscal 2014. This period of opening economy with highly increased domestic and international demand for teak and other forest products has also been accompanied by increased political opening and, expectedly, a certain measure of lowering of discipline in the management and utilization of natural resources as governance transits into a political and economic future of which it has limited experience.

It would thus be reasonable to state that the annual net forest degradation rate in Taungoo district remained at least at the same high rate of 10.35% in the years beyond 2006 until 2012. We assume 2012 to be the year in which the degradation began attracting serious attention from the Government because this was the year when the high powered National Environmental Conservation Committee set up by the Government in the Ministry of Environmental Conservation and Forestry became functional and several key activities were initiated across the country with environmental focus. Teak harvesting by Myanmar Forest Department has turned very conservative and communities are being encouraged to undertake planting on a large scale. So we assume a small but significant decline in forest degradation in the years beginning 2013 with the same but slightly steeper trend continuing into 2020.This graph below, therefore, represents the baseline net forest degradation rate in the Taungoo district using the available data and the above justification.

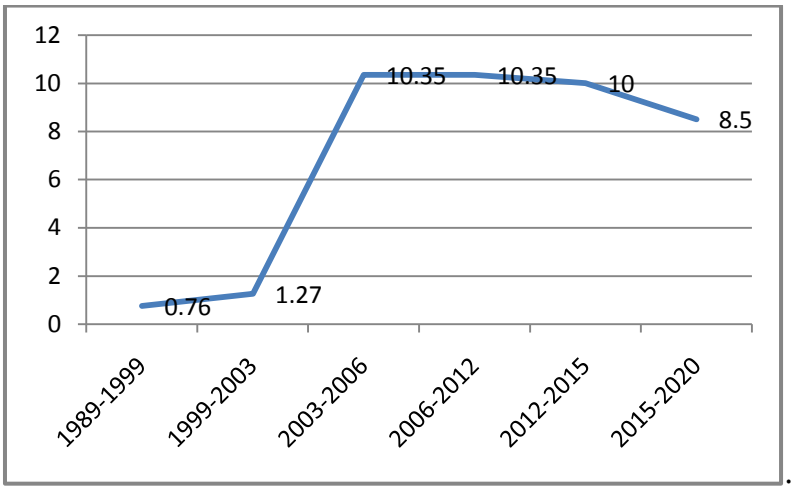


Figure 3.7: Baseline for forest degradation . Y-axis shows percentage forest degradation

3.14 **Baseline for afforestation in Taungoo district**

In the recent years considerable extent of afforestation has been undertaken on non-forest lands by private entrepreneurs. The Figure 3.10 below shows the trend of afforestation on non-forest lands between 2006 to 2010 in the Taungoo district.

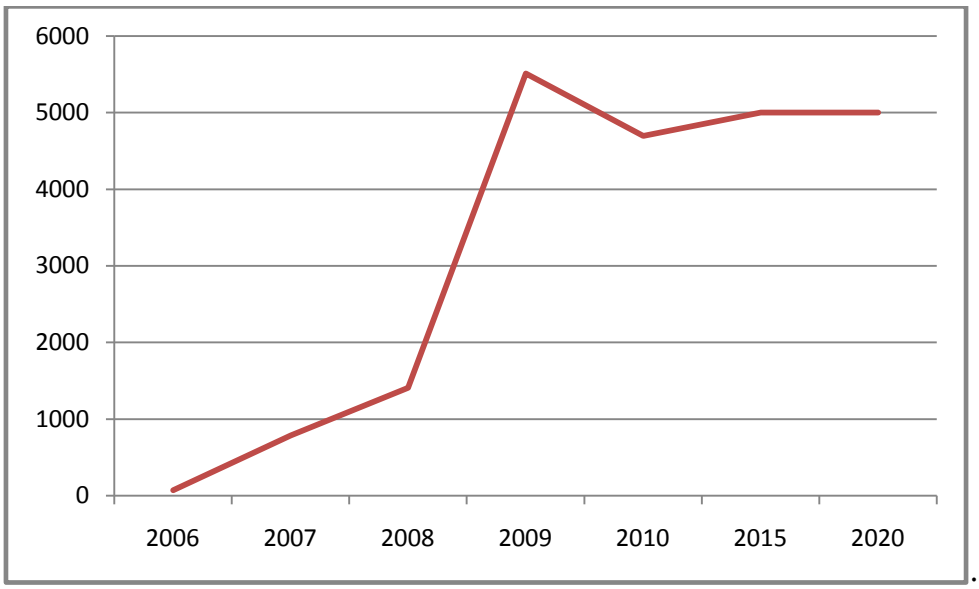


Figure 3.8: Baseline for afforestation in Taungoo district

The afforestation peaked at about 5510 ha in the year 2009 and before declining to about 4700 ha in 2010. Data for later years is not available yet. Data for later years is not available yet. There is an increasing thrust on planting of trees, particularly teak, on private lands by plantation companies as the profitability of these ventures increases. But the limited availability of suitable lands, and the increasing opportunity costs of lands, is likely to limit the annual planting to just about 5000 ha in this district in the baseline scenario. It would require major interventions through policies and measures by the government to take the afforestation of non-forest lands in the Taungoo district to higher extents under REDD+.

Chapter 4: CONCLUSIONS

The Warsaw Climate Conference, a limited success otherwise, is rightly considered an important landmark in the long road to the implementation of REDD+. One of the most critical issue that has held up implementation of REDD+ is the difficulty in deciding on the way to measure achievements so that the rewards can be pegged to the results. A prime requirement in the construction of FREL/FRL for REDD+ is the pursuit of environmental integrity and avoidance of perverse incentives in mitigation achievements while accommodating national circumstances and capabilities. A step-wise approach to the development of national FREL/FRL is permissible wherein countries could begin with sub-national FREL/FRL for geographically smaller areas than their entire national territory while transitioning to a national FREL/FRL. But, since it is only an interim measure, the development of sub-national reference levels should be done so as to facilitate scaling up to a national level at an appropriate time in future.

The preceding chapters have described such an attempt in which sub-national FREL and FRL has been constructed for the Taungoo district in the Bago Yoma region of Myanmar. In view of the very short period in which this project had to be executed it was necessary to use the data already available. The forest department has been conducting a prolonged field estimate, beginning 2010 and not yet completed, of the biomass of trees and bamboo in predefined sample plots in the district that number several hundreds. But the data generated cannot be used for the construction of baselines because there is no similar data from preceding decades that could lead us to a trend. Its utility is also limited by the fact that it is not appropriately organized in homogenous strata and sample plots are not randomly selected. We, therefore, used published data for the purpose of construction of baselines.

REDD+ has five distinct components of reducing emissions from deforestation and forest degradation, enhancing forest carbon stock, conservation of forests and sustainable management of forests. These five components will often have different drivers but they have obvious overlaps as they produce only three different outcomes, namely, reduction of emissions; enhancement of the rate of sequestration and maintenance of existing forest reservoirs. A subnational REDD+ project in Taungoo district will have all these five distinct components. An acceptable approach could be to divide the project area into distinct zones where one or the other of these components predominates and decipher the causal factors.

The result based payment agreed at Warsaw need this bottom up approach because the flow of incentive money to the communities and organizations involved in REDD+ activities must relate to the costs of achieving the agreed series of interim results measured against local baselines incurred by various actors including the individuals, communities and the government agencies like the forest departments. These local baselines, therefore, assume crucial importance in result based payments. But lack of data restricted us to confine the reference level assessment to only deforestation, degradation of forests and afforestation over non-forest lands for which published data was available as discussed above.

FAO reports list Myanmar as one of 10 tropical countries with the highest annual deforestation rate assessed at 1.3% in the last decade of 20th century mostly on account of agricultural expansion, fuelwood consumption, charcoal production, uncontrolled logging and plantation development. But these now appear to be somewhat erroneous probably because most of these reports were based on data samples derived from small geographic areas and small sample of satellite images and relied on extrapolations assuming similarity in causative factors. A more judicious assessment appears to be by Peter Leimgruber and team of Smithsonian Institute who have addressed these shortcomings in the FAO assessment.

The Smithsonian team used complete wall to wall coverage by Landsat-5 Thematic Mapper (TM) for 1989-1992, and Landsat-7 Enhanced Thematic Mapper (ETM-h) for 2000-2001 with the images subjected to the NASA's Geocover orthorectification process allowing these images to be overlaid for change detection. The orthorectified discrete image tiles were mosaicked into a single forest map for the whole country and used to calculate countrywide and divisional forest cover and deforestation rates. Forest cover and deforestation rate was also analysed for each image tile separately for more localized assessments and identification of deforestation hotspots.

Mapping accuracy was evaluated comparing these change maps with raw images collected between 2000 and 2002 from the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) that have better spatial resolution of 15 m providing greater accuracy in delineation of forest and non-forest cover. This was crucial to distinguish low canopy cover degraded forests from the seasonal low canopy covers in dry dipterocarp forests. These ASTER generated 1558 control points spread across the country, and well distributed among forested, non-forested, reforested and afforested landscapes, showed that the forest cover map for the year 2000 produced by the Smithsonian team in 2000 had an overall accuracy of 86%.

According to their assessment Myanmar’s forest cover went down over a decade between 1990 to 2000 at an average annual rate of 0.3%. The specific causative factors, and their severity, varied from region to region as a result of which the change in forest cover also varied considerably across the country with the highest rate of deforestation of 1.2% being in the Ayeyarwady delta region. Deforestation in the northern parts of Bago hills was also higher than the national average at 0.5%. We adopted this as the closest estimate for the Taungoo district and, taking the improving national circumstances in consideration, arrived at the deforestation FREL (shown in chapter 3) for the Taungoo district against which achievements have to be measured as the REDD+ project progresses.

For the purpose of assessing baseline for forest degradation we used the excellent work done in three reserve forests of the Bago Yoma region using FCD Mapper by Dr Myat Su Mon and published in a series of papers in reputed international journals. The result (shown in the previous chapter) suggests a steep increase in forest degradation in recent years. This baseline also matches well with the anecdotal evidence we gathered during our field visit in December 2013.

We did not rely upon the deforestation profile drawn by Dr Myat Su Mon in the same work along with the forest degradation profile because her work on the assessment of deforestation suffered from the same limitations as the FAO estimates as the LANDSAT data used with 30m resolution is inadequate for correctly distinguishing seasonal leaflessness in a teak dominated open canopy forest form a non-forest.

The baseline has been expressed in area rather than carbon tonnage as is the norm in climate change projects. The reason lies in the result based finance for REDD+ agreed to under the Warsaw Framework under which the finance for REDD+ is to be provided based on the planned measurable, reportable and verifiable interim achievements on the path towards reduced emissions from deforestation and forest degradation. The forest department has been conducting a prolonged field estimate, beginning 2010 and not yet completed, of the biomass of trees and bamboo in predefined sample plots in the district that number several hundreds. But the data generated can not be used for the construction of baselines because there is no similar data from preceding decades that could lead us to a trend. Its utility is also limited by the fact that it is not appropriately organized in homogenous strata and sample plots are not randomly selected and are permanent. Also for almost three fourth of the sample plots for which the data has been collected prior to 2012, it does not give a correct picture of the status of forest degradation in 2014. It is for this reason that all activities for which baselines have been proposed in this report, namely reducing deforestation and forest degradation and undertaking afforestation, have been expressed in terms of area which is easily measurable, reportable and verifiable and can also be effortlessly converted to carbon once the average carbon storage in various parts of the forests is known.

It needs to be emphasized that this attempt at REDD+ baseline construction for Toungoo district is just a beginning of this very important and highly complex task and it would require continuous improvements to make it more accurate.

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