Review of methodologies for the establishment of Reference Emission Levels and Reference Levels for REDD in Viet Nam

Final Report

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1 Introduction

This report provides an overview of the options that Viet Nam has for the establishment of reference levels[1] for reduced deforestation and forest degradation and enhanced carbon stocks under the REDD mechanism of the UNFCCC. The options are primarily based on current discussions at the UNFCCC and its supporting bodies and guidelines from the IPCC. However, since there is no prescription of important elements of reference levels, in order to account for "national circumstances", Viet Nam has much liberty to establish reference levels that are both adequate and appropriate. With this liberty comes the responsibility to make the right choices: If the reference levels are too lenient for historical deforestation estimates and not ambitious enough for future emission reductions or carbon stock enhancements, the international community may not accept the reference levels suggested by Viet Nam. Inversely, if the reference levels are too tight or overly ambitious, Viet Nam is limiting its scope for generating carbon emission rights from REDD. This report outlines some of the options that Viet Nam has in making the right choices in establishing reference levels.

Many proposals for the establishment of reference levels have been made in submissions by Parties and observers to the UNFCCC and in the scientific literature. To date there is no formal decision by the Conference of the Parties (CoP) to the UNFCCC and countries are encouraged to evaluate the various proposals to assess their applicability at the national level. Of all the proposals made, only a few apply to the Vietnamese context if a few basic assumptions are made:

- Viet Nam has sufficient forest inventory data to base the reference level on it.
    - The scale of the reference level is national.
    - A historical reference level will be constructed.
- Viet Nam has seen much deforestation in the past and it has sufficient human resources and capacity to observe these processes using modern technologies.
    - A Development Adjustment Factor is not applicable.

This report does not aim to give full account of all of the available proposals. Some of the more applicable proposals are briefly discussed, though. Instead, emphasis is placed on capacities, data and options that Viet Nam has in establishing reference levels in accordance with UNFCCC current status and available IPCC guidance.

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1 The term *reference level* is here used in its generic form. It includes all variants of it, in particular also *reference emission levels*, whether they are retrospective or prospective. Section 2.2 gives an overview of the different contexts in which a reference level can be used.

2 Reference Levels under the Convention

Reference levels are an important concept in the operationalization of REDD at the country level. Reference levels establish the yardstick against which the achievements of national REDD policies and interventions are measured. Setting objective and correct reference levels will ensure that emission reductions or removals are real and verifiable and the buyers of emission credits will have confidence in the supplier of the credits.

The requirements and characteristics of reference levels are under the purview of the Conference of the Parties to the UNFCCC. Given the wide variety in ecological conditions and country-specific circumstances, these requirements will be rather global and every country will have a range of options in its definition of reference levels within its territory. The expected requirements emanating from the UNFCCC and its supporting organisms are presented in this chapter.

2.1 Official status

At its 30th session, the Subsidiary Body for Scientific and Technological Advice (SBSTA) of the UNFCCC discussed REDD in detail. This has resulted in a Draft Decision which has been presented to the Conference of the Parties to the UNFCCC at its 15th session in Copenhagen, December 2009. The text of the Draft Decision is reproduced in Appendix 2. The most relevant article in the Draft Decision, to this study, is Article 5:

> 5. *[Recognizes* that [developing countries, when establishing] [methodologies to establish] [national] reference emission levels and reference levels [should] take into account, [inter alia,] national circumstances; respective national capabilities and capacities; historical data; [if necessary adjustments for expected future emission trends]; relevant socio-economic factors; drivers of deforestation; and existing domestic legislation, policies and measures[, or those under development], as appropriate;]

The first thing that this text reveals is that there is no agreement on the issue of reference levels (the entire article is placed in square brackets). After that, the text is relatively clear: reference emission levels and reference levels are based on national circumstances and include historical data, socio-economic factors, drivers of deforestation and the national policy context.

2.2 Terminology

Different publications use several related terms in different contexts (see, for instance, Angelsen, 2008). In order to avoid confusion, an overview is given of the processes and the associated terminology.

A *reference level* (RL) is a sequence of amounts over a period of time. These amounts can be different things, but for REDD purposes the amounts are typically emissions of CO_2-equivalents (CO_2e), biomass or forest area. If the amounts are emissions, the reference level becomes a *reference emission level* (REL). Reference levels are based on a *scope* – what is included? – a *scale* – the geographical area from which it is derived or to which it is applied, typically the national or the sub-national level – and a *period* over which the reference level is calculated. The scope, the scale and the period can be modified in reference to *national circumstances*: specific conditions in the country that would call for an adjustment of the basis from which the reference levels are constructed. A reference level can be based on observations or measurements of amounts in the past, in which case it is *retrospective*, or it can be an expectation or projection of amounts into the future, in which case it is *prospective*.

A retrospective RL – commonly referred to as *historical reference level* – is a RL of observed amounts in the past, for instance from past forest inventories. The observed trend in the historical RL is often projected into the future to create the *business-as-usual* (BAU) RL, the expectation of emissions or loss of biomass or forest area when past conditions continue to prevail into the future without a REDD programme[2]. The BAU RL can be adjusted in two different ways. A *development adjustment factor* (DAF) may be applied to account for specific country conditions that reduce the scope for generating emission reduction credits under REDD. Such conditions include low deforestation in the past and low technical capacity within the country – it is unlikely that Viet Nam will be eligible for a DAF[3]. Secondly, in order to meet the primary objective of the Convention, greenhouse gas emissions into the atmosphere have to be reduced and it is therefore proposed to introduce a "discount" in the amounts of emission reductions that can be claimed. This leads to a *crediting reference level*, the RL against which the actual emission reductions and removals are compared.

RELs apply only to situations where emissions can be reduced, such as in reducing deforestation or forest degradation. In other situations, particularly enhancement of carbon stock, a removal of greenhouse gases takes place through regeneration of forests. In such cases, when there are no reductions in emissions, a RL must be used. A consequence is that separate RLs have to be developed for reductions in emissions and removals.

In the remainder of this document the term *reference level* will be used consistently according to the definitions above. This term may be qualified to denote a specific context, as introduced above and in conformance with use at the UNFCCC.

2.3 IPCC methodologies related to reference levels

Reference levels can be constructed in various ways, see Chapter 3 . All methods apply, in different ways, locally measured data on (above-ground) biomass at different epochs. IPCC (2006) defines two methods for the assessment of biomass change in managed forests:

2 The term *baseline* is often used in this context, but its use is not correct for REDD. Official texts on REDD use the term *reference level* exclusively in order to avoid confusion with other uses of the term *baseline*, in particular with reference to the Clean Development Mechanism of the Kyoto Protocol.

3 The Development Adjustment Factor was initially designed to address the fears of countries will low historical deforestation rates and thus little potential for emission reductions. Later, the lack of national capacity to establish an effective national REDD programme was added (for instance, due to lack of suitably trained staff, lack of forest inventory data). Consequently, countries that apply a DAF are expected to report at IPCC Tier 1 level, which negatively impacts confidence in the national estimates and thus the potential for generating credits.

1. The **gain-loss method**, in which annual increments and reductions in the biomass are calculated.
2. The **stock-difference method**, in which periodic changes in biomass between two observations of stand volume are calculated.

While neither of these methods are specific to the establishment of reference levels they are useful given that reference levels require an assessment of carbon stock in the forest, which these methods are developed for.

The gain-loss method is a process-based method in which all changes in the carbon pools in the forest are accounted for: growth of trees, transfers from one pool to another (e.g. leaf shedding, falling branches, decomposition) and removals (harvesting of timber and non-timber products). In its basic form the gain-loss method is quite simple:

$$\Delta C = \Delta C_G - \Delta C_L \quad (1)$$

where ΔC is the annual carbon stock change in the forest and the subscripts refer to gains and losses, respectively. This formula is deceptively simple and the devil is in the detail. In order to apply this formula, all the gains and losses have to be individually identified and quantified. It is unlikely that such data is available with sufficient detail in Viet Nam. For instance, estimating the annual gain in biomass requires knowledge of the *average net annual increment for specific vegetation type* for every climatological and ecological zone (IPCC, 2006; section 2.3.1.1). For losses, separate estimates have to be made for wood removals (timber harvesting), fuel wood collection (as whole trees and as tree parts) and disturbances (due to fire, by fraction of biomass affected).

The stock-difference method, on the other hand, appears more complex but is more compatible with the Vietnamese context:

$$\Delta C = \frac{C_{t_2} - C_{t_1}}{t_2 - t_1} \quad (2)$$

where C_* refers to the carbon stock in the forest at time t_2 and t_1, as indicated. This method is quite easily implemented with the available forest inventory data. This does require, though, that the inventory data are of sufficient quality to be acceptable to the international community for the purpose of reference level establishment.

Both of these methods are considered to be Tier 1 methods when applied with standard data: using default values for certain forest properties and assumed to have large uncertainties. If the stock-difference approach is applied with fine-grained, locally measured data it can be considered to be of a higher tier with lower associated uncertainty. IPCC suggests to use higher tiers where possible, with higher tiers requiring more locally measured data and more advanced methods, such as species-specific allometric equations or dynamic models. Figure 1 provides a decision tree to select the appropriate tier for biomass assessment. Assuming that accurate biomass data can be extracted from the FIPI inventory data but without advanced methods (e.g. locally derived, species-specific allometric equations for the various types of forest), Viet Nam should be able to report biomass at Tier 2 level.

IPCC explicitly indicates that the methods are for managed forests, i.e. forests subject to some form of intervention that typically requires or yields information on forest resources (e.g. harvested volume, mean annual increment). However, the methods are defined so generically[4] that they can also be applied to unmanaged forests, if some estimate of the required parameters can be made.

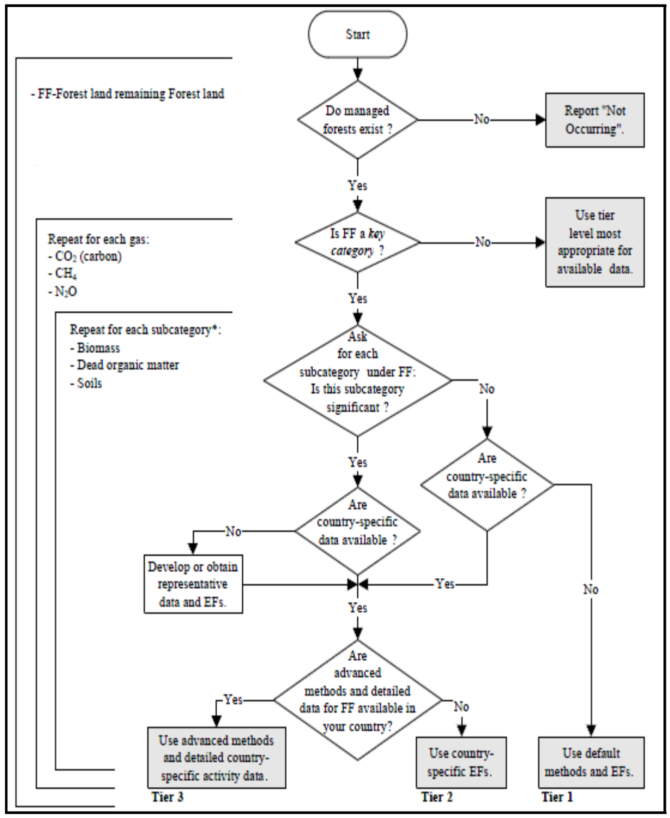

Figure 1: Tier selection tree (IPCC, 2006).

IPCC recognizes five pools of carbon in the forest:

1. Above-ground biomass
2. Below-ground biomass
3. Litter
4. Dead wood
5. Soil organic matter.

Data on all of these carbon pools has to be included in the reference levels. However, spatially-explicit data is usually only available for the above-ground biomass. Other carbon pools then have to be estimated using a conservative approach, which for reduced deforestation and forest degradation means that the other carbon pools are assumed to have a constant value, a Tier 1 approach. Measurement of especially litter and dead wood is advisable because that will increase the confidence in the estimate of total carbon in the forest while they are relatively easily collected in the field. Below-ground biomass and soil organic matter may be determined by professional forest inventory specialists on a coarse sampling basis.

With both methods, two primary obstacles in generating estimates of emission reductions in the entire national forest estate with sufficient accuracy are encountered:

1. The forests are heterogeneous, being an expression of ecological condition determined by environmental factors such as elevation, soil type, (seasonality of) precipitation, etc. For each of the resulting forest types specific parameters have to be derived. Impacts from anthropogenic sources vary by population density, regional socio-economic development status and accessibility to the forest and markets for forest products. In combination, these make for a very diffuse picture, which has important implications for the gain-loss method in particular (since different approaches may be necessary to account for different growth and extraction scenarios). The heterogeneity needs to be addressed by stratifying the forest into more homogeneous sub-units in terms of eco-type and management

4 They are defined to be applicable to any of the defined land use categories.

regime. Obviously, this requires substantial effort from experts in FIPI and FSIV. Such stratification is considered *good practice* by the IPCC.

2. The measurements have to be fine-grained in space and time and accurate in terms of biomass, to capture relatively small changes in emission reductions, as this will lower the uncertainties in the estimates and thus raise the credibility of the national emission reduction claim and hence the (potential) revenue through sale in the international carbon market. In addition, small local emission reductions could generate substantial revenue for individual land owners, communities or local governments, and attribution of emission reductions to such individual actors requires localized estimates.

3 Proposals for the establishment of reference levels

There is not a prescribed methodology for the establishment of reference levels. Under the principle of subsidiarity under the Convention, and in recognition of the multitude of ecological and socio-economic conditions shaping the world's forest resources, countries are free to establish their own reference levels, within the scope set by the Convention and following guidance from the IPCC. This gives the individual countries, including Viet Nam, the opportunity to establish a reference level that is appropriate to its national circumstances – forest ecology and condition, socio-economic development, technological capacity, policy context – but it also places the burden on these countries to develop a reference level that is realistic for the national situation and acceptable to the Convention.

At the level of the UNFCCC there are discussions about the scope and the scale of reference levels. These discussions, however, relate mostly to how countries communicate their reference levels to the UNFCCC. Within the countries there is much freedom to arrive at a nationally acceptable and appropriate reference level. Viet Nam may elect to have multiple reference levels, e.g. one for each major ecological zone, or sub-national approaches, e.g. specifically aimed at shifting cultivation, or both. The information submitted to the UNFCCC then becomes an aggregation of the different reference levels developed throughout the country.

Many proposals have been made for the establishment of reference levels, both as submissions to the UNFCCC by Parties and observers and in publications in scientific literature. A complete overview can be found in "The little REDD+ book" by the Global Canopy Programme (Parker et al., 2009) and online at http://www.theREDDdesk.org/. In all cases, these reference levels apply to deforestation and they can be subdivided into retrospective reference emission levels based on historical observations of forest cover and prospective reference emission levels based on some type of modeling.

3.1 Retrospective reference emission levels

Retrospective RELs are almost all based on analysis of historical observation of forest cover over a period of at least 10 years (although the time period is still widely debated). Forest cover activity data is multiplied by an emission factor to arrive at an annualized net emission of greenhouse gases due to deforestation.

In its simplest form, also referred to as Simple Historical Approach (SiHA) (Huettner, 2009) use is made of FAO Forest Resources Assessment activity data and IPCC default values for emission factors. There are a variety of modifications to the SiHA method. These refer to the period (anywhere between 5 and 20 years), the source of basic forest cover data (global estimates, satellite imagery of varying characteristics) and scale (global, nation or sub-national).

For Viet Nam, use can be made of the existing FIPI inventory data, if the accuracy can be established with sufficient accuracy, for activity data and possibly for the emission factor(s) as well. This automatically leads to a preference for a Tier 2 approach for the REL, without relying on international or external data on forest cover and biomass content, as this will have higher credibility internationally. The sub-national approach, as suggested by CATIE (Pedroni et al., 2008) and also represented in the proposed standard for Mosaic Deforestation (BioCarbon Fund, 2008), could be interesting for Viet Nam in the sense that it allows for sub-national RELs on a project basis, which are later integrated into a national REL. While the project scenario may or may not be relevant for Viet Nam, the mechanism of local establishment of RELs (e.g. at provincial level) that are later merged into a national REL may be useful for Viet Nam.

3.2 Prospective reference emission levels

Prospective RELs are typically based on an extrapolation of a historical trend, e.g. the retrospective REL, applying some knowledge, understanding or expectation of the future. It is also possible to construct a prospective REL on the basis of policy and intervention strategies alone, but all proposals so far use hard evidence in some form or another. Given that Viet Nam has substantial data on which to base the retrospective REL, it is only natural to base the prospective REL on the same evidence.

There are three distinct procedures to arrive at a prospective REL:

1. Extrapolation of the historically observed forest cover data, possibly with reference to secondary data sets.
2. Econometric modeling, whereby the formal and informal forestry sector are considered as operating in the national economy and responding to impulses (e.g. market prices for tree-based products).
3. Dynamic land use modeling, accounting for drivers of land use change and using historical spatial data of forest cover, other land uses and deforestation.

3.2.1 Extrapolation of historical data

One of the more straightforward ways to establish a prospective REL is to take the same historical forest cover data that was used to establish the retrospective REL, derive a mathematical relationship through regression analysis and project that relationship into the future. The functional form of the regression function can be any type that corresponds to the data, but a logarithmic, inverse exponential or low-order polynomial would be most appropriate in this context. The regression analysis can be based on forest cover data only, or it can include secondary variables that help reduce the variance in the data (Hirata, 2009). Examples of such secondary variables are: expansion of the agricultural area, labour markets, etc.

An important quality indicator of extrapolated mathematical models is the residual error or variance in the regression analysis (which is based on observed data). The variance in the data, that part of the observed phenomenon that can not be "explained" by the mathematical model should be reduced to the extent possible, for instance through the inclusion of secondary variables. Judging from guidance on other methods under the UNFCCC (e.g. IPCC documents), the variance should be kept under 10% to be acceptable.

Mathematical models are typically easy to understand and since they are based on observed data they are also easily accepted. A problem with mathematical models is that the mechanism of the underlying processes (population pressure, poverty, inadequate management) leading to the observed feature (declining forest cover) is not very clear. Changes in these processes can therefore not be included in the REL. If the National REDD Programme is successful in reducing deforestation, it will be because some of these processes are changing, thus invalidating a further extrapolation of the mathematical model in time. Also, changes in the resource itself (less forest available due to deforestation) may make an extrapolation based on forest cover alone not realistic. However, mathematical models are very powerful in demonstrating trends due to their simple structure and they will therefore not easily generate debate or controversy on the relative merits of decisions made in their elaboration.

3.2.2 Econometric modeling

In econometric modeling the assumption is made that all decisions by land managers (e.g. forest companies, households with leases) are rational and made in response to market prices for tree-based and other products.

Kerr et al. (2002) developed a model for Costa Rica that includes the carbon balance of the landscape (other land uses in addition to forests). The model includes the dynamics of the ecological system, the human land-use system and the interactions between the two. The central assumption is that the land manager chooses that land use, including that in forests, that yields the highest economic return. The return from a certain land use depends on current and expected future economic and ecological conditions. His choices might alter internal ecological and economic conditions by changing accessibility, market conditions and ecosystem behaviour. Clearing of forest land will only take place if the present discounted benefits from forest conversion will more than compensate the land manager for the lost returns from forestry uses, including carbon benefits under a REDD mechanism, and the land conversion costs for different points in time. Economic and ecological conditions can be exogenous (e.g. national policies, not under the influence of the land manager) and endogenous (under the influence of the land manager).

Other econometric models have been suggested as well, with similar emphasis on relative merits of deforestation within a larger context of alternative choices and markets with prices of which the land manager has knowledge. In other words, deforestation is a choice governed by the market.

This approach has merit for Viet Nam since the availability of information on markets for agricultural and forest-based products and commodities is relatively good. On the other hand, the economic system of Viet Nam is not fully based on free markets and individuals, independent actors having free access to and control over resources, in particular related to deforestation. Also, these models only work well at a local scale and national implementation may be cumbersome, if not impossible, if market data from past years are not available at a sufficient level of regional disaggregation (e.g. to many households, the "market" is at the level of the district).

An additional complication with this approach is that many of the assumptions underlying the econometric models are debatable in general and especially so in a specific context such as Viet Nam. This means that any REL based on this approach will be under close scrutiny.

3.2.3 Dynamic land use modeling

Dynamic land use modeling is an approach based on spatial analysis in combination with expected effects or impacts of policies and other drivers on land use. Many such models have been developed and reported upon in scientific literature. For the establishment of prospective RELs two models are of specific interest, GEOMOD and CLUE-S (both, incidentally, originally developed for application in Costa Rica), as both have been suggested for this purpose in submissions to the UNFCCC.

GEOMOD

The GEOMOD2 model (Pontius et al., 2001) is a grid-based model that determines the "demand" for a certain land use type and then identifies which areas in other land use classes are most likely to be converted to the land use class in demand. GEOMOD2 selects the locations of land to be converted according to three decision rules:

1. The nearest neighbour principle, which restricts land-use conversion to those areas that are on the border between closed-canopy forest and disturbed land.
2. Regional stratification. The model can use maximum annual amounts of land-use change within a series of regions, as specified by the user.
3. Biophysical attributes. The model predicts future disturbance at locations that have attributes that are similar to the attributes of previously disturbed areas, on the basis of a “suitability” map created from the land-use map and some secondary data, such as slope or accessibility.

The output of the simulation, at any point in the future, can be evaluated to determine the amount of remaining forest cover cover and thus deforestation over the time step.

The GEOMOD-2 model is incorporated in more recent versions of the IDRISI raster GIS software and is therefore quite easy to implement.

Clue-S

The CLUE-S model (Verburg et al., 2002) intends to make a spatially explicit, multi-scale, quantitative description of land use changes through the determination and quantification of the most important bio-geophysical and human drivers of land use on the basis of the historical and actual land use. Results of this analysis are incorporated into a dynamic model, which describes changes in the area of the different land use types. Land use changes in the near future under different development scenarios can be predicted, with a time horizon of about 20 years. The concepts implemented in the CLUE methodology are:

- Connectivity: locations that are spatially nearby influence each other.

- Hierarchical organization: higher level processes can steer and constrain lower level processes, while higher level features might emerge from lower level dynamics.
- Stability and resilience: land use systems are able to absorb disturbances before the structure of the system is changed.
- Driving factors: a large set of socio-economic and biophysical factors can be seen as the drivers of land use change, steering the rate and/or location of change.

In the CLUE method this complexity is captured by a combination of dynamic modeling and empirical quantification of relations between land use and its driving forces. Economic models are used to calculate the area of change demanded for by the different sectors of the economy. These "demands" are then allocated to different locations within the study area. For each location the possibilities for change are evaluated based on the actual land use and the competitive strength of the different land uses. Furthermore, the user can specify fixed sequences of land use conversion or indicate areas where spatial land use policies apply. Scenarios can be calculated to evaluate different land use change situations cause by differences in demographic change, land use requirements and spatial policies.

The CLUE-S model is supported by the CLUE Project, which also provides support for the development of national or local models. The CLUE-S model has been applied in Viet Nam before, in a project to evaluate the loss of biodiversity in MPI.

Use in REL establishment

As with the econometric models, the dynamic land use models have many in-built assumptions that allow great flexibility to the modeler and the consequent great need to explain why and how these assumptions are relevant to Viet Nam. Furthermore, the dynamic land use models require certain expertise which is not easily created in Viet Nam, especially for the CLUE-S model. For both models Vietnamese staff will have to spend considerable time abroad with the model developers in order to master the models and their intricacies. GEOMOD2 is preferable from this perspective as it is more focusing on forestry and deforestation, but it is not as comprehensive as CLUE-S. GEOMOD2 will be applied for REL establishment in the COMIFAC countries of Central Africa.

3.3 Other proposals

Very many proposals for RL/REL establishment have been published. Many of these are not applicable to Viet Nam, because of an incompatible scope or scale, or because they do not apply to the knowledge and capacity available in Viet Nam.

Most proposals have been submitted to the UNFCCC and are published on their web site; see the REDD platform at http://unfccc.int/methods_science/redd/items/4531.php.

4 Forest dynamics in Viet Nam

This chapter contains a brief overview of the availability of forest inventory data in Viet Nam that could be useful for the establishment of reference levels. In addition, some relevant additional issues related to forestry and inventory are presented. This chapter is in no way intended to provide a complete picture of forest inventory in Viet Nam; rather it focuses on those issues relevant to reference levels.

4.1 Forest cover and forest cover change

The Forest Inventory and Planning Institute (FIPI) has the formal mandate to undertake the national forest inventory since 1981. Four cycles of forest inventory have been completed to date. All of the cycles consisted of inventorying a large number of permanent sampling plots (2000 - 4000) for correlation to imagery of varying characteristics.

- **1991 - 1995:** This first cycle was based on visual interpretation of hard-copy Landsat images. Emphasis was placed on areas managed by the State Forest Enterprises and large forested areas were therefore not included.
- **1996 - 2000:** The second cycle used digital Landsat and SPOT-4 imagery, but the interpretation was still visual. Coverage was extended, but some gaps still exist in the data.
- **2001 - 2005:** The third cycle used Landsat ETM+ data with digital image classification using standard supervised classification algorithms. This inventory was started in 1997, completed in 1999 and approved in 2001. This data set has been widely distributed to provincial forest management authorities.
- **2006 - 2010:** The fourth cycle has nearly been completed. SPOT-4 and SPOT-5 data have been used, with digital image classification. A new classification scheme was employed, making it awkward to compare against the earlier inventories.

Problems exist with the variety of data sources that has been used, the quality of the analysis and the lack of information to independently verify the inventory results[5]. It is particularly unclear whether the data from the subsequent inventory cycles can be compared. The classification systems between the first three cycles and the fourth cycle differ considerably, particularly in the descriptors of the natural forest classes.

In addition, in 2001 the definition of a forest has changed to the extent that minimum cover was reduced from 30% to 10%. In circular 34/2009/TT-BNNPTNT from MARD a new classification system was introduced which differs slightly from the fourth cycle classification system. This latter classification appears to be the basis for the next inventory

5 FIPI has been guarding the inventory data jealously. Some independent research work has been conducted on the inventory data from the permanent sampling plots and the results have been mixed, in particular with respect to establishing plot biomass and for development of allometric equations. Recent efforts to evaluate the inventory and mapping data for application in REDD have opened possibilities for two external parties to work with the data, even though most of the actual work is performed by FIPI staff.

cycle. It appears to be quite suitable for REDD purposes such as reference level establishment, monitoring and as a basis for intervention strategies. However, it is not based on some ecological stratification principle, which limits its use in several aspects (see sections 5.1.5 and 5.2.3 , for example).

While some of the methodological deficiencies are recognized, the inventory data are widely used in official reports (e.g. Initial National Communication to the UNFCCC (Viet Nam, 2003), FAO Forest Resources Assessment reports) and scientific literature (e.g. Meyfroidt & Lambin, 2008)) and government policy is based on it.

4.2 Assessment of national circumstances

In establishing reference levels countries can include national circumstances to justify certain decisions or choices. These national circumstances can relate to the capacity of the country to benefit from REDD (not applicable since Viet Nam has seen considerable deforestation in the past), technical ability of national staff (not applicable since Viet Nam has many excellent forestry institutions and trained staff), environmental conditions (not applicable) or policies related to the forestry sector. This last option can be very interesting to Viet Nam.

In 1998 Decree 661 established the 5 Million Hectare Reforestation Project (5MHRP). This project has been very important in realizing the upward trend in forest cover that Viet Nam has experienced since the late 1990's. At the end of 2006, the 11th National Assembly amended the original plan and decided:

> **Article 2:** Adjustment of the project targets and tasks in 2006 – 2010 as follows:
>
> 1. Effective protection of the total existing forest areas, especially natural forests, for which annual protection contracts are issued annually for 1.5 million ha of protection and special-use forests.
>
> 2. Afforest 1,000,000 ha including 250,000 ha of protection and special-use forests (with an average plantation of 50,000 ha each year), and 750,000 ha of production forests (with an average plantation of 150,000 ha each year).
>
> 3. Carry out zoning for regeneration of 803,000 ha of protection and special-use forests, including ongoing regeneration of 403,000 ha and new regeneration of 400,000 ha.
>
> 4. The total estimated investment is 14,653 bil. VND, including 4,515 bil. VND from the state budget and 9,000 bil. VND from loans and other funding sources for production plantations.
>
> 5. After completing the revised targets and tasks in 2006–2010, the Government will further allocate funding sources and implement the forest protection and development program in line with the mechanism of national target programs in order to meet the target of afforesting 5 million hectares of forests.

(FSSP, 2007)

Viet Nam is obviously making a very deliberate attempt at increasing the forest cover in the country at great cost and without any economic direct benefit, creating a large carbon sink in the process. In elaborating the reference emission levels, Viet Nam can elect to exclude these new forests and base the RELs on forest areas not falling under the 5MHRP, considering the 5MHRP areas for enhancement of carbon stock or Sustainable Forest Management (SFM) only. This might lead to net deforestation on the other forest areas and thus create a scope for reducing emissions under REDD (see chapter 5 for more details).

Other government policies may likewise be introduced as national circumstances. Decree 327 on the reclamation of barren lands and forest land allocation would be a possibility in this regard.

4.3 National capacity for forest monitoring and assessment

Forest monitoring and assessment is implemented by a few state organizations. The two principal organizations for data collection, analysis and reporting are FIPI and the Forest Science Institute of Viet Nam (FSIV).

FIPI is responsible for the national inventory. It is headquartered in Ha Noi and has a number of regional offices throughout the country. FIPI staff are experienced in forest inventory and specialized units exist for data management and image analysis. However, there is still a lack in institutional capacity with regards to quality assessment and control. This is evidenced by the absence of proper documentation and independent review of the existing forest inventory data. FIPI has worked with external partners for many years, such as FAO, and current collaborations emphasize some of the weaknesses in conducting and managing forest inventories.

FSIV undertakes basic forest research in ecology, silviculture, forest industries, forest economics and other areas. FSIV has a system of permanent sampling plots for ecological research and it is collaborating with external partners (e.g. Utrecht University, The Netherlands) in strengthening its capacity in this area. FSIV could play an important role in REDD as analyst of forest ecology and environmental conditioners for stratification of the Vietnamese territory and as independent assessor of the reference levels.

5 Reference Levels for Viet Nam

On the basis of the Vietnamese context described in Chapter 4 , the current (draft) proposals and the expressed preference of the Department of Forestry[6], the following recommendations are made with regards to the establishment of reference levels:

- Any reference levels that are developed should be made for forests stratified at the first level ecological regions present in the territory of Viet Nam, leading to approximately 13, mutually exclusive zones. In combination, these zones form the national reference level. The stratification should be established by the Department of Forestry. (See section 5.1 .)
- Separate historical reference levels must be established for deforestation and forest degradation. (See section 5.2 .)
- The emission factors due to deforestation may be determined from FIPI forest inventory and FSIV forest research data for all the major forest types in each of the ecological regions. The emission factors have to be established through rigourous statistical analysis of all available data from undisturbed inventory plots and full account must be given of the procedures and data applied in the determination of the individual emission factors. (See section 5.3 .)
- The initial activity data of deforestation can be based on the full available record of satellite imagery for Viet Nam at medium spatial resolution and the highest possible temporal resolution, using data sources such as NOAA AVHRR and MODIS. While this data is not suitable to detect some of the smaller intensity deforestation processes that were prevalent in many areas of Viet Nam, it is the only viable source of satellite imagery that dates back to the 1980's. Much of the lower intensity deforestation is captured, though, because of the long time-series that can be constructed from the imagery, in particular the NOAA AVHRR data. Given that the objective of the time-series is to establish the trend over a long time and over relatively large areas, the omission or commission of deforestation in individual locations in any individual image is not relevant.
- The initial activity data of deforestation can be supplemented with existing forest inventory data from FIPI, dating back to 1990, using both the digital maps and the ground-truth data from the permanent sample plots. The inventory data can be used (1) to test the strength of the initial activity data from medium resolution data through statistical sampling; and (2) to refine the activity data at the higher spatial resolution of the inventory data to the extent possible vis-a-vis the quality and spatial coverage of the inventory data.
- The historical reference level of forest degradation is very difficult to establish. Activity data can possibly be extracted from high-resolution satellite imagery (better than 2.5m), but such imagery is not available for the entire territory of Viet Nam. This situation is compounded by the variability in the level of forest

6 Statement by Mme. Pham Minh Thoa, Department of Forestry, at the conclusion of the third meeting of the REDD Working Group, Ha Noi, 21 January 2010.

degradation over time and space and the determination of emission factors is therefore cumbersome and intrinsically inaccurate. A few options exist:

    - Emission reductions from forest degradation are disregarded; only carbon stock enhancements are calculated in the prospective reference level(s). This implies a potentially substantial loss of revenue[7], but it is also conservative leading to other emission reduction claims being more easily accepted. Furthermore, there is no effort involved in this option, so there are no resources required to determine the historical reference level or to defend its properties.
    - Emission reductions are calculated from activity data extracted from high-resolution satellite imagery and emission factors from the FIPI and FSIV inventory data. The data are extrapolated to the territory not covered by these data sources. The associated uncertainty will be high.
    - A spatial modeling approach based on available proxy data (e.g. population distribution (by commune), road network, markets for forest products and commodity prices), in combination with calculated data from the previous option, is applied. This requires good knowledge of the drivers of forest degradation and how these drivers are associated with the proxy data. More complex models require more assumptions and tend to become highly scrutinized at the international level; accuracy is typically regarded as low. This approach has been tested and found not to be sufficiently accurate (personal communication Dr. Pham Manh Cuong).

- The major forest policies that have impacted forest land use and cover, such as Decrees 327 and 661, can probably be integrated as national circumstances into the historical reference level to the degree possible. While detailed spatial information on areas affected is most likely not available, statistics down to the commune level can probably be obtained. The commune-level statistics can then be used to exclude the areas under such government policies from deforestation RELs. The quality of the information on areas covered under the Decrees is of concern: If the quality is low then that will degrade the confidence with with strata can be constructed and thus the accuracy of the biomass estimates. It could be better in this case to not consider these areas separately, but include them implicitly in the assessment of the homogeneity of the strata and account for heterogeneity through the sampling of a larger number of plots for the stratum. Evaluation of these options requires a first assessment of the quality and completeness of the information on areas covered under the Decrees.

The above recommendations are based on the current status of negotiations at the UNFCCC and in compliance with current IPCC guidelines on the reporting of greenhouse

7 This is not necessarily the case. Areas that have in the more distant past been subject to degradation but which have since been deforested will be accounted under the deforestation historical reference emission level. Only for those areas that are currently degraded can potential *future degradation* not be claimed. Given that Viet Nam forest policy is already effectively addressing forest degradation this amount is relatively small compared to the potential for enhancement of carbon stock.

gas emissions from forest land. However, future negotiations on the REDD mechanism may make some of these recommendations obsolete or deficient and attention has therefore to be given to integrating new guidelines in the REL/RL development.

5.1 Stratification of the Vietnamese territory

The purpose of the stratification of the Vietnamese territory is to arrive at a number of relatively homogeneous strata of forest. The homogeneity is important as reduced variance in the measurements of carbon – which may be expected in homogeneous strata – requires fewer samples to arrive at an estimate with minimal error and maximum confidence. This translates directly into higher benefits from REDD as buyers will be more confident that reported emission reductions or carbon sequestration are real and not "hot air".

The stratification leads to a number of *strata* that share certain characteristics, primarily rooted in ecology but also based on management regime and current condition. Most strata will be regionally based – e.g. the Southern Annamites – but they do not have to be contiguous – e.g. Tam Dao National Park being surrounded by agricultural areas. The strata are composed of a number of *units* which are the basic accounting areas for REDD. Every stratum can be composed of very many units. A unit is for instance the forest area allocated to a household under Decree 661 or a block under management by a forest company. The units are also the smallest area for measuring biomass and for the reduction of emissions. Over time these units may change their boundaries which is no problem for the stratification so long as the units are completely contained within a single stratum for which a reference level is defined[8].

Stratification of the territory by climate, soil, eco-region and management are considered *good practice* by the IPCC (2006; see Chapter 3).

5.1.1 Error and confidence

The confidence level used in determining the number of sample plots per forest stratum is a major factor in the cost of carrying out forest inventory work. A confidence level of 95% rather than 90% requires many more sample plots (i.e. more work by households or forest companies in making measurements). As noted above, less uncertainty in the assessment of above-ground carbon will most likely lead to higher payments for carbon emission reduction estimates. Inversely, if the expected error in the data, established through statistical analysis, is high, then the error margins at the onset and end of the reporting period may approach each other, and few carbon credits will be issued (figure 2). To determine the number of sampling plots in a forest stratum, given a certain confidence level and maximum error, one can apply the following formula:

$$n = \left(\frac{z^* \cdot \sigma}{e \cdot \mu} \right)^2 \qquad (3)$$

8 It may be problematic for accounting purposes, in particular for financial benefits, but this is outside of the scope of the current study.

where z^* is the distribution critical value at a certain confidence level (published in any textbook on statistics), σ is the standard deviation of measurements of biomass in the stratum, e is the maximum allowable error, and μ is the average biomass in the forest stratum.

For a forest stratum where μ is 400 t/ha with σ is 65 t/ha, if you want to have an error of at most 5%, with 90% confidence level (z^* = 1.645):

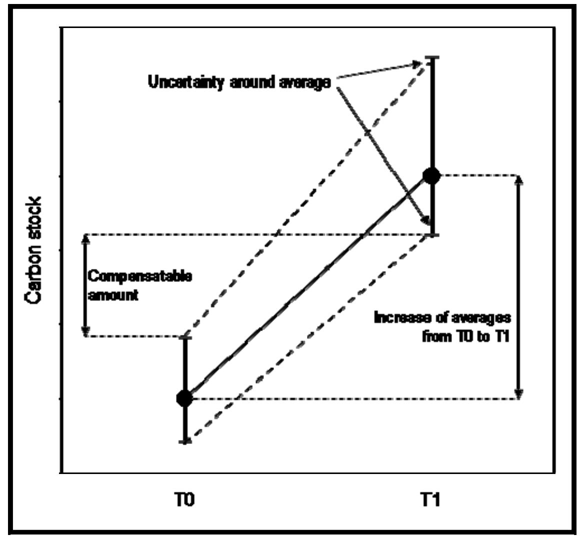

Figure 2: Estimate uncertainty and stock enhancement credits.

$$n = \left(\frac{1.645 \cdot 65}{0.05 \cdot 400}\right)^2 = 28.58 = 29$$

For a 95% confidence level (z^* = 1.960):

$$n = \left(\frac{1.960 \cdot 65}{0.05 \cdot 400}\right)^2 = 40.58 = 41$$

Inversely, given a certain number of samples, the expected error can be calculated:

$$e = \frac{z^* \cdot \sigma}{\sqrt{n} \cdot \mu} \tag{4}$$

From the above formula it can easily be observed that reducing the expected error by 50% requires 4 times as many samples. Reducing the standard deviation σ – through proper stratification of the forest – has a one-on-one relationship: 50% lower standard deviation gives a 50% lower expected error with the same number of samples.

In all cases the average biomass in the forest stratum μ and its standard deviation σ need to be established first. This is best done by inventory specialists, such as from FIPI or FSIV, using generally accepted techniques for sampling. In practice this implies a minimum of 30 randomly located samples per forest stratum. Note that this has to be done per *stratum*, not for every individual forest *unit* within the stratum.

Protocols regarding confidence levels are likely to be adopted nationally. The number of samples required to reach that confidence level given a certain maximum error for each stratum should be determined by e.g. FIPI or FSIV, using accepted statistical practice. The number can be reduced by careful stratification of the forest ecosystem / type, because that will reduce the standard deviation of the samples in each stratum, and this is strongly recommended.

5.1.2 Stratification criteria

The stratification should take place at several levels in order to create homogeneous units. The first level is the ecological zone of the area. The ecology determines the potential forest type, how it develops over time and what its climax vegetation is like. The second stratification criterion is the type of management that the forest is subject to. This can range from no intervention (e.g. National Parks), production forests under management by the forest companies, land under Decree 661 managed by individual households for production of timber or minor forest products, or any other type of human intervention in the forest. The third level is the current status of the forest in relation to its trees composition and climax state (e.g. level of degradation).

The ecological zone is the primary determinant of the type of forest. Viet Nam has several primary ecological zones, such as the Southern Annamites montane rain forests and the Indochina mangrove forests prevalent primarily in the south of the country. Each of these ecological zones has endemic tree species and more common tree species may have expressions that are impacted by the ecological zone. The ecological zone is of importance because it determines what the climax vegetation looks like and is thus essential in determining the level of degradation, the potential sequestration of carbon and the sustainable use scenarios of the forest. There will also be ecological zones that have very little remaining forest, such as the Red River freshwater swamp forests, but they should still be included as they may support natural forests in small pockets now or in the near future as a result of REDD interventions.

The management regime of the forest is also of importance in stratifying the forest. Gazetted areas of the former State Forest Enterprises have been subject to management practices that may have altered the natural composition of the forest, both in terms of species composition and age distribution of the trees, and the forest will thus respond differently to interventions than natural forests. Plantations for timber or pulp, areas of forest regeneration, mangroves with measures for coastal defense, etc. each impact forest growth and response to interventions differently and thus need to be treated separately.

The third level stratification concerns the current status of the forest, i.e. the composition of tree species and the level of degradation. Within a single ecological zone there may be different forest types, or specific associations depending on local environmental conditions or tree community dynamics. For degradation status the concern is not biomass – this can be considered the result of degradation rather than a cause – but those aspects of the current status that impact the resilience of the forest to sequester carbon and regenerate towards a natural state of climax vegetation: species composition and abundance, age distribution, disturbances (e.g. exposure to drought, wind, light penetration). Both the tree composition and degradation status need to be based on field observations in order to obtain sufficient accuracy in the stratification.

Each of the three criteria leads to a number of exhaustive, mutually exclusive strata. In combination, this could lead to a large number of distinct strata which may seem unmanageable. However, each stratum requires rather little effort to "manage" (sample to determine average biomass and standard deviation thereof, establishment of REL for reduced deforestation and RL for stock enhancement) because of its homogeneity. When this "management" is properly set up, for instance using GIS for data management and spatial analysis, it does not have to be more complicated than managing large areas with high standard deviation and resulting large expected error in the estimate of biomass.

RELs and RLs can actually be defined on the basis of the first level stratification only. In this case they refer not to a specific point in time relative to its past and future, but to a trajectory on the forest development curve with the current status of the forest providing a link to the temporal domain. In practical terms: an REL for deforestation and an RL for stock enhancement are developed for every ecological zone; every unit of forest within the ecological zone has a degradation status that determines how long it takes to reach climax vegetation, but all of the units follow the same "development" along the curve.

5.1.3 Current territorial stratification in Viet Nam

Viet Nam currently employs a territorial stratification which is being considered for REDD as well. This stratification has been developed for agro-ecological zoning and divides the country into eight zones, each consisting of a number of adjacent provinces (figure 3). This stratification is not recommended for REDD because it is not based on

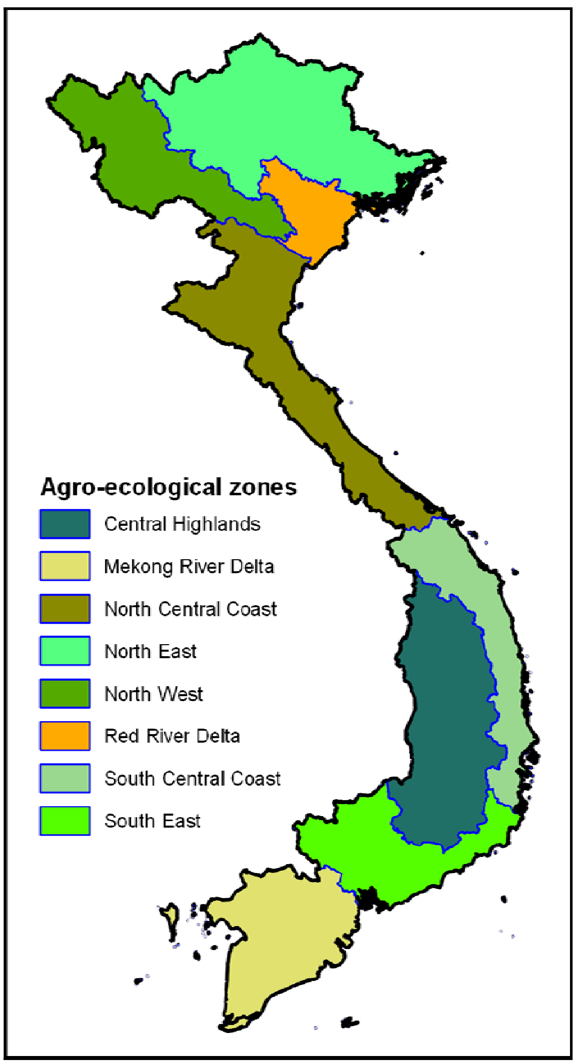

Figure 4: Agro-ecological zones of Viet Nam.

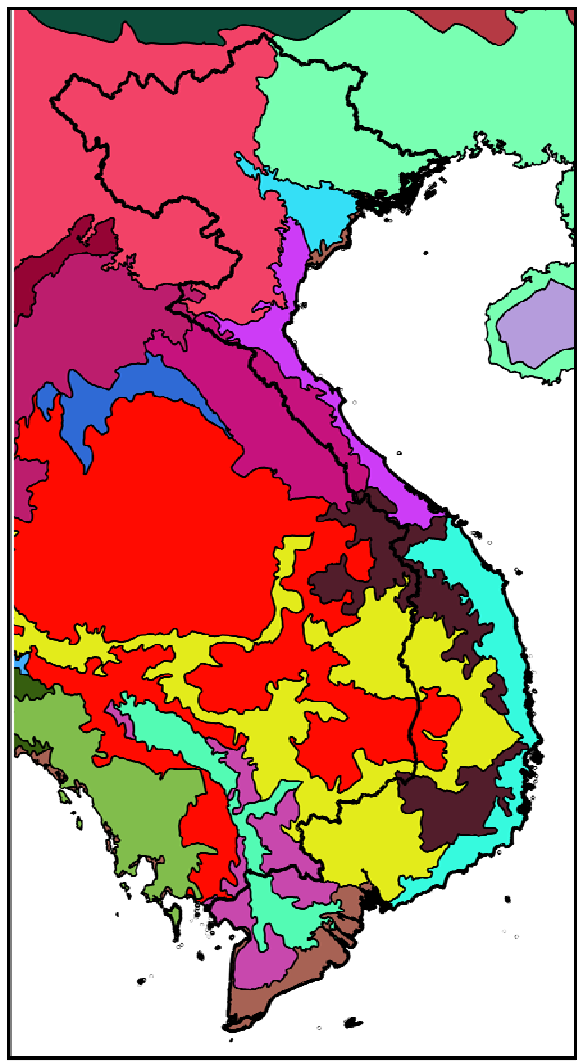

Figure 3: Terrestrial eco-regions of Indochina.

forest ecology, management or condition and it does therefore not contribute to increasing the quality of biomass estimates required both for REL/RL establishment and REDD accounting.

The powerful feature of the current stratification is that it is based on current administrative structures in Viet Nam (principally the provinces) and it thus relates easily to policies and other instruments of the government. The use of modern technologies such as GIS can help making the proposed stratification compatible with the administrative division by assigning individual units of forest within the strata to provinces; in other words, each unit of forest is completely contained within a single province. This would satisfy both the administrative attribution and the principle of homogeneity.

5.1.4 Stratification methods and data

For the stratification many existing data sources can be applied. First level ecological stratification can be based on the terrestrial eco-regions map produced for the World Wildlife Fund (WWF) (Olson et al., 2004). The Indochina section of this map is represented in figure 4. The territory of Viet Nam encompasses 13 different eco-regions (table 1). While this stratification is already based on many environmental factors, it can be fine-tuned for the Vietnamese case by using higher resolution data sets such as those for elevation, soil, geophysical position, rainfall and drought patterns, etc.

Table 1: WWF eco-regions found in Viet Nam.

Eco-regions
South-China-Vietnam subtropical evergreen forests
Luang Prabang montane rain forests
Northern Annamites rain forests
Northern Indochina subtropical forests
Red River freshwater swamp forests
Indochina mangroves
Northern Vietnam lowland rain forests
Central Indochina dry forests
Southern Annamites montane rain forests
Southeastern Indochina dry evergreen forests
Tonle Sap-Mekong peat swamp forests
Tonle Sap freshwater swamp forests
Southern Vietnam lowland dry forests

Elevation data can be taken from the ASTER Global Digital Elevation Model. (This data is made freely available by the Japanese Space Agency JAXA. A full record for Viet Nam has already been downloaded.) This data has been recorded by the ASTER instruments over the last few years. The ground resolution of the data is 30 meters and the vertical accuracy is better than 10 meters. This makes it very suitable for application in the REDD program. Elevation data can be used to better stratify the ecological regions or to delineate potential tree associations that are dependent on elevation.

Several derivatives can be generated from the DEM that are useful for the stratification. In the first place the exposition or aspect can be used. Especially in the northern part of Viet Nam steep mountain slopes have different tree associations depending on a northerly or a southerly exposition. A second derivative is the geophysical position. Automated analysis of DEM data can identify distinct geophysical features such as plains, table lands, undulating hills, foothills, steep slopes, etc. (Van Laake & Hyman, 2000). The geophysical position has important implications for other characteristics such as soil type and sub-surface hydrology and it can be used as a proxy in the sense of site quality, which is often used in forestry. Slope is not a direct predictor of forest type and insofar as it is, it is already accounted for in the geophysical position.

The soil type is an important determinant for ecological type and through its properties the available soil moisture and thus drought susceptibility. A soil map is apparently available at MONRE, but the consultant has not been able to confirm this or any of its properties.

Climate data is another determinant for ecological type. Viet Nam has a reasonably good climate database at IMH. Otherwise use can be made of the global WorldClim database (Hijmans et al., 2005), which gives monthly data for temperature and rainfall at a resolution of about 1 kilometer. Especially the seasonality of rainfall will be strongly related to forest type. For this purpose a number of "bio-climate" variables have been based on the standard monthly data (such as total rainfall in the three wettest months).

When these data sets are available in digital format, as all of the specifically mentioned data sets are, it is very easy to combine the data in a GIS. The combination itself is very easy, but finding the right combination of factors requires detailed knowledge of the Vietnamese conditions and general principles of bio-geography and forest ecology. Such a task is therefore best executed by a specialized institute such as FSIV.

Stratification on management regime and forest condition has to be based on information available within the forest institutions in Viet Nam. The condition of the forest could be based on the existing forest inventory data, including that which is currently generated by various institutions and projects in Viet Nam. Management regime refers to the officially established use in gazetted areas, for instance National Parks or production forests. However, for many uses no accurate information is available (e.g. the areas falling under Decree 661). A practical approach could then be to use the officially established management regime (from FIPI data) and update the status as the National REDD Programme registers the forested areas of Viet Nam for data collection and benefit distribution.

5.1.5 Forest stratification and intervention strategies

Properly stratified units of forest can play an important role in guiding interventions in forest management aimed at reducing emissions or sequestering carbon for REDD purposes. Given a certain intervention regime, all forests belonging to a certain stratum may be expected to respond likewise. Different intervention strategies could be employed on individual units to pilot intervention strategies in order to determine the most promising strategies for that stratum.

5.2 Establishment of separate reference levels

Five mechanisms for generating REDD credits are currently being considered by the UNFCCC:

1. Reduction of emissions from deforestation.
2. Reduction of emissions from forest degradation.
3. Carbon stock enhancements.
4. Conservation of forests.
5. Sustainable management of forests

The first two of these mechanisms require the establishment of reference emission levels, while the third and fifth may require a reference level. The emission reduction mechanisms require retrospective RELs as well as prospective targets. Carbon stock enhancement and SFM require only a prospective target. As argued at the beginning of this chapter, determination of emission reductions from reduced forest degradation is going to be very difficult due to the unavailability of adequate historical data. Therefore disregarding reductions of emissions from forest degradation, Viet Nam has to prepare three different RLs:

1. Retrospective reference emission level for reduced deforestation.
2. Prospective reference emission level for reduced deforestation.
3. Prospective reference level for carbon stock enhancement and SFM.

5.2.1 Retrospective and prospective reference emission level for reduced deforestation

The retrospective REL for deforestation can be based on the currently available forest inventory data at FIPI. Independent study has concluded that the statistics reported on the basis of FIPI data are largely coincident with independent estimates based on other sources of data (Meyfroidt & Lambin, 2008). However, the accuracy of the data has to be verified using approaches suggested by IPCC (2006).

Given the recent development of the forest resources in Viet Nam it is very important to define what is being considered for the REL. Establishing an REL has no meaning if the net deforestation is negative, i.e. forest area is increasing, as is the case according to recent FIPI statistics. These national statistics, however, do not distinguish between natural forest and reforestation or plantations for pulp or timber. The retrospective REL should contain only deforestation of natural forests; reforestation and plantations can be considered differently under REDD. Luckily the FIPI inventory data distinguishes between natural forests and plantations. However, the quality of the data outside of areas under the control of the former State Forest Enterprises may not be as good as that within, due to the emphasis in previous inventories on serving the needs of the forest production sector.

Even when only natural forests are considered, there may be eco-regions where net deforestation is close to zero. In such cases it may not be economical to determine the REL since the emission reduction credits will be marginal, particularly if a discount is applied to account for estimation inaccuracies or for the sake of generating net emission reductions at the global level. Assessment of the viability for claiming emission reduction credits should be undertaken for each individual stratum. Strata that are not interesting for emission reduction credits from deforestation may still qualify for carbon stock enhancements, SFM or conservation.

The method for establishing the REL should probably not be simple linear regression of the available natural forest cover data at FIPI, as this will most likely lead to negative deforestation rates at the present time or in the near future. Instead, a polynomial or logarithmic relationship may be assumed: with progressively lower deforestation rates, but not quite zero (e.g. Hirata, 2009). Stratification of the Vietnamese territory will probably yield some areas where substantial deforestation is still prevalent – e.g. the Central Highlands region, mostly Southeastern Indochina dry evergreen forests – while others will indeed have marginal deforestation rates.

The prospective REL for reduced deforestation is essentially a forecast of the retrospective REL, possibly modified for expected policy and socio-economic developments.

5.2.2 Prospective reference level for carbon stock enhancement

Carbon stock enhancement through reduced degradation is probably the largest carbon source that Viet Nam can control. Forest degradation is probably still occurring in many forests in Viet Nam, but there is very little hard evidence of previous or current degradation that can be used for REDD. However, if Viet Nam indeed forgoes emission reduction credits from reduced forest degradation it can more easily claim carbon stock enhancement from improved forest management as an impulse from the REDD mechanism.

The prospective reference level for carbon stock enhancement may not be necessary. The UNFCCC has to date not indicated that it would be required. If it is going to be required its nature will be different from RLs for emission reductions since there is no historical reference on which it is based. In its most basic form it will be a flat line: all carbon stock enhancement after the start of the REDD programme will generate credits without consideration of specific interventions to achieve the stock enhancements. Depending on deliberations at the UNFCCC, this rather straightforward approach may have to be appended by an expression of the government on how to enhance carbon sequestration and which part of that will be considered human-induced, i.e. attributable to specific interventions in forest management rather than natural regeneration in areas without human interference. It may also be used to base a crediting baseline upon, i.e. a discount to first achieve some net reduction of atmospheric CO_2 due to carbon sequestration before credits – emission displacements – are issued.

5.2.3 Establishing reference levels by forest strata

Reference levels have to be established for each of the forest strata defined (section 5.1), leading to sub-national reference levels. This could be at the first level stratification (i.e.

the 13 WWF eco-regions), although it could be beneficial to develop these for the larger number of strata at higher levels of stratification – more homogeneous units of forest – as they will have higher accuracy. This more detailed establishment of RLs could be deferred to a later stage however, with initial development focusing on the first level stratification.

A sub-national reference level is here meant to be a reference level that applies to a certain part of the country based on some objective criterion, like the 13 eco-regions. Multiple sub-national reference levels will encompass the entire territory of Viet Nam and they will jointly form the national reference level. This is not to be confused with the sub-national *approach* to enable early participation on e.g. a project level, as is proposed in the "Nested Approach", submitted to the UNFCCC by CATIE, although there are some similarities between the two methods.

5.2.4 Aggregation of reference levels by forest strata to administrative units

When RLs are being established by strata on ecological principles there is no correspondence to administrative units. It is important to have such a relationship as the administrative units have direct relevance to government policies and resources, including those for REDD. It is, however, very straightforward to determine how much of every individual RL falls within every individual province, district or other administrative unit, so long as the units that jointly make up the stratum for which the RL is determined all fall within a single administrative unit. Effectively this means that the RLs can be established along the most rational lines based on ecological and environmental conditions, yielding the most accurate and effective RLs, while the aggregation of all units within the administrative territory produces a composite RL with individual targets, policies and intervention options for every administrative unit, whether that is a commune, district or province.

Such a stratification and aggregation approach is easy to implement, but it requires central administration in order to avoid discrepancies within individual strata between different administrative units. This need not be an obstacle, as the determination of RLs requires knowledge and expertise present at the central level anyway, e.g. as found in FSIV or FIPI. Communication of the rationale for stratification and the resulting composition of strata in the territory of an administrative unit is essential, in order to foster acceptance of the territorial division and adoption of strategies aimed at specific strata. This is particularly of concern for provinces, which are the most affected by the presence of multiple strata and which do also make and implement policy for REDD interventions and other activities in forestry, agriculture and rural development that may impact REDD.

5.3 Determination of emission factors

The amount of emission reduction through reduced deforestation is determined from the area that is not deforested and its emission factor. In its simplest form, the emission factor of a forest upon deforestation is equal to the total biomass prior to deforestation (but see section 2.3 for more details). This assumes that all biomass from the forest is released into the atmosphere as CO_2 through burning or rapid decomposition; hence there is assumed to be no off-take of timber for use in long-term products such as construction or furniture (which would fall under the IPCC calculation for Harvested Wood Products). This is simple and conservative and it is the recommended practice.

Viet Nam, however, is most likely only going to consider above-ground biomass for the calculation of REDD credits, assuming that the other carbon pools are stable. While this is conservative for carbon stock enhancements (expected gains in the soil organic matter carbon pool are excluded, for instance), it is not for conversion of forest land to another category. Some estimate of the other carbon pools has to be made for the determination of the emission factor due to deforestation. Estimates of the dead wood and litter carbon pools are easily made, especially if uniform estimates at the first level stratification are being used (i.e. one estimate for each of the 13 eco-regions in Viet Nam). Estimates of below-ground biomass and, especially, soil organic matter[9] are less easy to come by as they require specialized collection and measurement techniques. If such data are not available in Viet Nam, IPCC Tier 1 estimates could be used.

The emission factors due to deforestation may be determined from FIPI forest inventory and FSIV forest research data for all the major forest types in each of the strata. The emission factors have to be established through rigorous statistical analysis of all available data from undisturbed inventory plots and full account must be given of the procedures and data applied in the determination of the individual emission factors. The statistical analysis should follow established international and national practices (see also section 5.1.1).

An alternative to the current FIPI and FSIV data is the use of allometric equations of some of the more common dominant species such as those in the genera of *Acacia*, *Dipterocarpus* and *Eucalyptus*, with a generic allometric equation used for other species. Recent publications give allometric equations for *Dipterocarpaceae* (*Dipterocarpus*, *Shorea*, *Palaquium* and *Hopea*) (Basuki et al., 2009) and other species (e.g. Ketterings et al., 2001; Chave, 2005). The advantage of using allometric equations is that they can be based on a few, easily measured tree properties and they can be developed to include the below-ground biomass carbon pool. Their development is more cumbersome, but they can be developed over time, starting initially with more generic allometric equation, such as the pan-tropical allometric equation in FAO Forestry Paper 134 (Brown, 1997). In addition, these allometric equations are also useful in converting locally measured tree data into biomass, under the REDD participatory carbon stock measurements, and they therefore have to be developed anyway.

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9 Soil organic matter builds up differently depending on soil type, physiographic position, rainfall patterns and tree association. Additionally, while other carbon pools are rapidly decaying, such that "immediate" release of CO_2 in the atmosphere may be assumed, soil organic matter can persist for a long time and is released into the atmosphere slowly, which has to be quantified. Since the soil organic matter carbon pool can be large relative to the other carbon pools, including above-ground biomass, its consideration in deforestation emission factors is crucial.

6 Forestry data in the National Communication to the UNFCCC

All developing countries are encouraged to submit National Communications to the UNFCCC, according to the stipulations in Decision 17/CP.8. For the forestry sector net emissions of the following greenhouse gases have to be supplied:

- Changes in forest and other woody biomass stocks – CO_2.
- Forest and grassland conversion – CO_2, CH_4, N_2O, CO and NO_x.
- Abandonment of managed lands – CO_2.
- CO_2 emissions and removals from soils – CO_2.
- Other (specify) – CO_2, CH_4, N_2O, CO and NO_x.

(UNFCCC, 2003)

For the case of CO_2 the same inventory data used for the establishment of reference levels can be used. The other gases require more specific measurements, but it is debatable whether these are very relevant to Viet Nam. Emissions of CH_4, N_2O, CO and NO_x are typically associated with agriculture and water-logged soils. They will be relevant to the peat swamps of southern Viet Nam and the mangrove forests; otherwise they are likely to play a very minor role. All emission of gases should be converted to CO_2e amounts for reporting.

Viet Nam has made its initial National Communication to the UNFCCC in 2003, using 1994 as its reporting year (Viet Nam, 2003). Forestry data is taken from the 1995 forest inventory cycle. Figures for net emissions of CO_2 and other gases are given, but their provenance or quality are not indicated. Future national communications to the UNFCCC could well benefit from improved forestry-related information, such as is required for the reference levels. In particular information on carbon content of forests may be added to future reports.

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Appendix 1: Terms of Reference

Expert: International expert on reviewing methodologies for establishment of Reference Emission Levels (RELs) and Reference Level (RL)

Output: 1.2

Responsible UN Agency: FAO

National / International: International P4 level

Duration: 6 person/weeks on "When-Actually-Employed" basis
Dec 2009 – March 2010

Duty station: Expert's home base and travel to Hanoi as necessary

Background:

The UN-REDD Programme assists Vietnam to strengthen the country's capacity to be ready for REDD implementation. One of the key analyses forest changes including the major driving forces of change; development to assess a national Reference Emission Level (REL) from deforestation and/or forest degradation, and national Reference Level (RL) from sustainable management of forests and from enhancement of carbon stocks, leading to a national reference scenario through time of greenhouse gas emissions and removals. The RELs and RL should be consistent with and support the goals of the Vietnam National Target Programme to Respond to Climate Change. Therefore, the REL and RL to be developed should meet international requirements/standards and suit the national circumstances.

Objectives:

The overall objective of the assignment is to provide technical advice on the establishment of REL and RL for Vietnam.

Supervision:

Under the general supervision of the Budget Holder of FAO (FAO Representative of Viet Nam) and the NPD; and under the direct supervision of the Lead Technical Officer of the FAO Forest Resources Management Unit (FOMR); and in close collaboration with the National REDD Team Leader, other national and international organizations and donors working towards generating RELs and RL in Viet Nam.

The consultant will take on the following specific responsibilities:

- Review methodologies for estimation of forest carbon stock and monitoring the changes, and establishment of RELs and RL at the national and sub-national levels proposed by various parties;

- Review literature on the dynamics and trends of forest changes in Vietnam, availability of historical forest inventory and remote sensing data and its potential use for estimation of forest carbon stock and RELs;

- Review literature on methodologies for the assessment of Vietnam national circumstances and national capabilities and capacities. National circumstances are also related to socio-economic aspects of Vietnam's development;

- Review requirements of preparing the National Communication to UNFCCC and current systems on forest monitoring and assessment and GHG Inventory in Vietnam;
- Recommend options for establishment of REL and RL that are suitable for Viet Nam situation;
- Follow-up on international technical dialogue on RELs establishment and reflect the most updated developments in recommended options for Viet Nam;
- Engage in dialogue with the related National REDD Network and Technical Working Group members to form consensus among members of the most relevant options for RELs establishment in Viet Nam; and
- Perform other tasks as directed by NPD and FAO designated officer.

Qualifications, Experience and Competencies

- Post graduate degree in Environmental Science, Natural Resource Management, Environmental Economics, or similar.
- At least 5 years of working experience on forest inventory, monitoring and assessment and experience on these fields in Vietnam is required
- Depth of knowledge of and practical experience on REDD related issues and forest monitoring and assessment.
- Proficiency in both spoken and written English.

Appendix 2: Draft text on REDD from SBSTA 30

This appendix contains – verbatim – the Draft Decision of the 30th session of SBSTA on Agenda item 5: Reducing Emissions from Deforestation in Developing Countries. The text is reproduced here from document FCCC/SBSTA/2009/3, available from the UNFCCC web site at http://unfccc.int/, because it is of immediate reference to the current study, being the latest publication on the UNFCCC web site related to the establishment of reference levels. In particular articles 1(b), 1(c) and 5 are relevant.

Text in [square brackets] is still being negotiated, possibly being suggested by some Parties but no agreement could be reached by SBSTA before submission to the CoP.

Due to the failure of the CoP at its 15th session to come to an agreement regarding the text of a new climate agreement, the submission of SBSTA to its session was not considered. Therefore the current text from SBSTA has no official status, but it is likely to be considered – and hopefully adopted – by the CoP at its next session.

Draft text for a decision on methodological guidance for activities relating to reducing emissions from deforestation and forest degradation in developing countries

[Draft decision [-/CP.15]

Decision on methodological guidance for activities relating to reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries

The Conference of the Parties

Recalling decisions 1/CP.13 and 2/CP.13,

Acknowledging the importance of reducing emissions from deforestation and forest degradation, and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries,

Noting the progress made by the Subsidiary Body for Scientific and Technological Advice in its programme of work on methodological issues related to a range of policy approaches and positive incentives,

Noting also the range of ongoing activities and cooperative efforts being undertaken by Parties and international organizations, in accordance with decision 2/CP.13, paragraphs 1, 2, 3 and 5,

Recognizing the need for full and effective engagement of indigenous peoples and local communities in, and the potential contribution of their knowledge to, monitoring and reporting of activities relating to decision 1/CP.13, paragraph 1 (b) (iii),

Recognizing the importance of promoting sustainable management of forests and co-benefits, including biodiversity, that may complement the aims and objectives of national forest programmes and relevant international conventions and agreements,

Noting experiences and lessons learned from ongoing activities and efforts in capacity-building, testing methodologies and monitoring approaches, and a range of policy approaches and positive incentives[, including those guided by the indicative guidance contained in the annex to decision 2/CP.13],

1. *Requests* developing country Parties, on the basis of work conducted on the methodological issues set out in decision 2/CP.13, paragraphs 7 and 11, to take the following guidance into account for activities relating to decision 2/CP.13, and without prejudging any further relevant decisions of the Conference of the Parties[, in particular those relating to measurement and reporting]:

(a) [To identify drivers and activities within the country that result in reduced emissions, increases in removals and stabilization of carbon stocks in the forestry sector;]

(b) Use the most recently adopted Intergovernmental Panel on Climate Change guidance and guidelines, as appropriate, as a basis for estimating[, as appropriate,] anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(c) To establish, according to national circumstances and capabilities, robust and transparent [national forest[1] monitoring systems and, if appropriate, subnational systems as part of national monitoring systems that] [forest monitoring systems that]:

(i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

(ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

(iii) [Ensure that these monitoring systems and their results are open to independent review as agreed by the Conference of the Parties;]

2. *[Recognizes* that further work may be needed by the Intergovernmental Panel on Climate Change, in accordance with any relevant decisions by the Conference of the Parties, to provide supplemental guidance on the application of methodologies for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;]

3. *Encourages,* as appropriate, the development of guidance for effective engagement of indigenous peoples and local communities in monitoring and reporting;

4. *Encourages* all Parties in a position to do so to support and strengthen developing countries' capacities to collect and access, analyse and interpret data, in order to develop estimates;

5. *[Recognizes* that [developing countries, when establishing] [methodologies to establish] [national] reference emission levels and reference levels [should] take into account, [inter alia,] national circumstances; respective national capabilities and capacities; historical data; [if necessary adjustments for expected future emission trends]; relevant socio-economic factors; drivers of deforestation; and existing domestic legislation, policies and measures[, or those under development], as appropriate;]

6. *Invites* Parties to share lessons learned and experiences gained in the application of the guidance referred to in paragraph 1 above and the annex to decision 2/CP.13 through the web platform on the UNFCCC website;

7. *Urges* relevant international organizations, non-governmental organizations and stakeholders to integrate and coordinate their efforts in order to avoid duplication and enhance synergy with regard to activities relating to decision 2/CP.13.]

1 [Taking note of, if appropriate, the guidance on consistent representation of land in the Intergovernmental Panel on Climate Change *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.]