Analysing REDD+

Challenges and choices

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Chapter 16

A stepwise framework for developing REDD+ reference levels

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- Developing forest reference (emission) levels for REDD+ is an urgent and challenging task, given the lack of quality data in many countries, genuine uncertainties about future rates of deforestation and forest degradation and potential incentives for biasing the estimates.
- The availability and quality of data should determine the methods used to develop reference levels. Consideration of the drivers and activities causing deforestation and forest degradation will be important for adjusting reference levels to national circumstances.
- A stepwise approach to developing reference levels can reflect different country circumstances and capacities and will facilitate broad participation, early startup and the motivation for improvements over time, alongside efforts to enhance measurement and monitoring capacities.

16.1 Introduction

Forest reference level (RLs) and forest reference emission levels (RELs) are most commonly used as a business as usual (BAU) baseline to assess a country's performance in implementing REDD+ (UNFCCC 2011c).[1] RLs are needed to establish a reference point or benchmark against which actual emissions (and removals) are compared. In fact, emission reductions cannot be defined without having first agreed on the RL, which is therefore critical for gauging the effectiveness or forest carbon impact of REDD+ policies and activities.

A second use of the RL is to serve a benchmark for payments in a results-based REDD+ mechanism. This financial incentives benchmark (FIB) determines the emission levels after which a country, subnational unit or project should start being paid for their results. The way the FIB is set has implications for REDD+ transfers, and ultimately for environmental integrity (carbon effectiveness), cost efficiency and equity (benefit sharing).

Despite its critical importance, political consensus on how to set reference levels is limited to general guidance (UNFCCC 2011c, see Box 16.1) and science does not provide clear proposals for how to proceed (Huettner *et al.* 2009; Obersteiner *et al.* 2009; Estrada 2011). Three challenges are prominent. First, there is a critical lack of data and the reliability of the few data that exist is often questionable. An essential step in estimating RLs is to get historical activity data on deforestation and forest degradation, but for most countries these are limited, due to the lack of forest monitoring capacities (Meridian Institute 2011b; Romijn *et al.* 2012).

Second, BAU scenarios are by nature forward looking. While predicting the future is always difficult, rates of deforestation and degradation show much greater annual variability than, for example, emissions from fossil fuels. There is genuine uncertainty that cannot be fully resolved by better data and models; factoring in uncertainty therefore becomes a key aspect of setting RLs.

Third, there can be incentives among actors to distort the estimates (Chapter 2). Donors, governments and project proponents, for example, may all have an interest in high BAU baselines, which will make the impact of any policy or project look more favourable. NGOs, for example, need to demonstrate success to ensure continued funding, while governments need to prove to voters or the international community that their policies have been effective. The sharp decline in Brazilian deforestation since 2004 is a case in point, with debate over whether it has been due to good policies or to falling commodity prices and the global economic crisis. Financial interests are even more

1 The difference between reference level (RL) and reference emissions level (REL) is not always clear. The distinction is often made that REL refers to gross emissions from deforestation and forest degradation, while RL refers to deforestation and forest degradation, as well as other REDD+ activities on enhancement of carbon stocks, sustainable management of forests and forest conservation. In this chapter we use RL as a general term, which encompasses RELs; much of the discussion here focuses on emissions.

Box 16.1 UNFCCC COP17 guidance and its implications

UNFCCC (2011c) provides modalities for forest RLs, supported by an annex with 'Guidelines for submissions of information on forest RLs'. The RLs should be consistent with anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks in a country's greenhouse gas inventories and thus in accord with available historical data. When developing RLs, countries are invited to submit details about their national circumstances and, if the RLs are adjusted to take these into account, to include details as to how this was done. Furthermore, UNFCCC has agreed that a stepwise approach to national RLs may help countries to improve their benchmark over time and recommends that countries should periodically update their RLs to take into account new knowledge and new trends. Importantly, the UNFCCC decision acknowledges that subnational RLs may be elaborated as an interim measure, with an eventual transition to a national RL. The possibility of omitting non-significant carbon pools or specific REDD+ activities in the construction of RLs – as expressed in the UNFCCC decision – is of great importance because it allows countries to take a conservative approach to estimating forest carbon stock changes (Grassi *et al*. 2008).

pronounced in setting the financial incentive benchmark (FIB) in a results-based REDD+ mechanism: for any given level of emissions, the payment is directly related to the level of FIB. This situation calls for an institutional system with clear guidelines on how to develop RLs and a strong element of expert judgement and independent verification.

International guidance on the development of RLs is emerging, including that provided by the UNFCCC (2011c) (Box 16.1) and the VCS methods for REDD+ projects (Chapter 14). Yet, in the absence of more specific guidelines and in a context of the lack of good data and genuine uncertainty, countries must choose how to proceed with their RL development processes. This includes, for example, the exact historical reference period to use and which national circumstances to include in BAU baseline calculations.

This chapter will not pursue the discussion on international guidelines and modalities for setting RLs, but readers should refer to the UNFCCC decisions (Box 16.1) and the discussion in Meridian Institute (2011a; 2011b). Neither does the chapter much discuss RLs in REDD+ projects, an important issue that is thoroughly covered in Chapter 14. While maintaining a national focus, this chapter should also be relevant for RLs in projects and for the further development of international guidelines on RL setting.

One way to deal with the three challenges of data, uncertainty and interests is a *stepwise approach*, which is presented in this chapter. This approach aims to better structure and deal with the variety of RL methods that exists, the variability in data and their quality, uncertainties and country circumstances. The framework should help stimulate broad country participation in estimating RLs, and provide a starting point, even with limited data, from which to improve RL setting as countries progress through the REDD+ implementation phases and build their capacities.

Section 16.2 of this chapter gives an overview of key concepts, including the distinction between the BAU baseline and the FIB. It further discusses the main methods for setting the BAU baseline and the considerations that are relevant when moving from BAU baselines to FIB. Section 16.3 presents the stepwise framework and elaborates each of the three steps, from simple historical extrapolations with limited data available, to more sophisticated predictions at disaggregated scales. Section 16.4 discusses the problem of uncertainty and different ways of handling it. The final section offers some concluding thoughts.

16.2 Concepts and methods

16.2.1 Two meanings of RLs

Two distinct meanings and different uses of RLs may be distinguished. First, the RL is used for the *BAU baseline*. This is used to measure the impact of REDD+ policies and actions and to define emission reductions, which are the difference between realised emissions and the RL. Second, the RL is used as a benchmark for estimating results-based incentives, e.g. direct payments to countries, subnational units or projects for emissions reductions. This has been referred to as the crediting baseline (Angelsen 2008a), compensation baseline (Meridian Institute 2011b) or the financial incentive benchmark (FIB) (Ecofys 2012). We use the third term in this chapter.

The distinction between the different meanings and roles for RLs is important since they answer different questions: i) what would the emissions be without REDD+; and ii) at what level of emissions reductions should a country, subnational unit or project start receiving payments? Yet the distinction between the BAU and the FIB is politically controversial because it raises the possibility that the FIB could be set lower than the BAU baseline, which could result in less than full payment for results. This touches on wider issues in the climate negotiations, such as the allocation of responsibilities and costs among countries. The BAU and FIB concepts are therefore *not* recognised in any UNFCCC decision; nevertheless, from an analytical viewpoint it is essential to make this distinction to clarify the analysis and discussion.

There is broad agreement that RLs should take into account historical data and be adjusted to national circumstances (UNFCCC 2009a: Decision 4/

CP.15). This makes good sense from an analytical perspective: historical deforestation and degradation is a good predictor for the near future, but rates of deforestation and degradation also change. The factors that can lead to higher or lower rates of deforestation and degradation, as compared to the historical ones, are often referred to as 'national circumstances'. This is a broad term, and interpreted in different ways by the Parties and recent attempts to specify these have not reached consensus.

Following the distinction between the BAU and the FIB, we find it useful to distinguish between national circumstances that are relevant for setting BAU baselines and those that are relevant to consider when setting the FIB. This is illustrated in Figure 16.1. The question to ask regarding whether national circumstances are relevant for a BAU baseline is: 'Does the inclusion of a particular national circumstance generate more accurate (less biased) and more precise (lower variation) BAU baseline predictions?' We return to this question in Section 16.3.6). The relevant national circumstances for a FIB are based on political considerations as to what is considered 'fair' and are discussed further in Section 16.2.3.

16.2.2 Methods for estimating BAU baselines

Three different methods for estimating future BAU deforestation and degradation have been proposed in the literature, e.g. by Gutman and Aguilar-Amuchastegui (2012).

1. **Strictly historical approach:** This approach uses only average annual rates of deforestation during the recent past (typically over 10 years) (Santilli *et al.* 2005). A prominent example of this approach is the RL used by the Amazon Fund in Brazil, which is incorporated in the agreement between

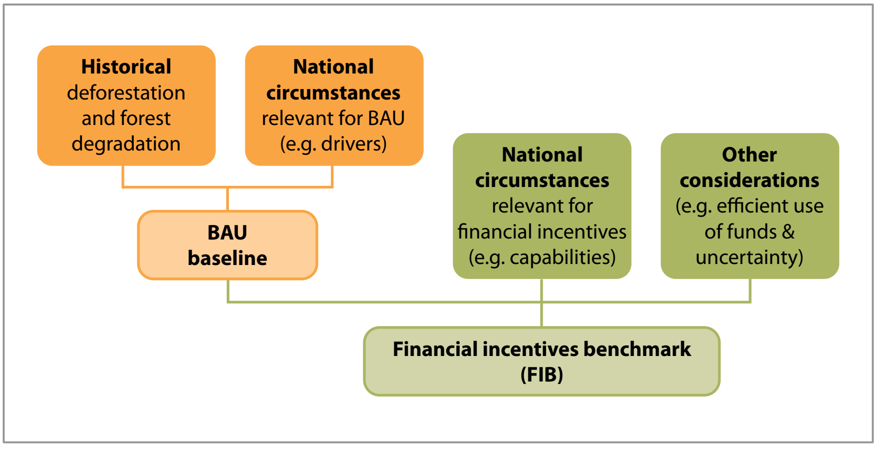

Figure 16.1 Key elements for setting reference levels

Brazil and Norway and uses average deforestation over the past 10 years, updated every 5 years.

2. **Adjusted historical approach**: Historical rates are the point of departure, but other factors that are considered important are included to improve predictions. Examples of such factors are the stage in the forest transition, i.e. the degree to which countries with high forest cover and low deforestation rates expect to see accelerating deforestation in a BAU scenario.
3. **Simulation models:** Future deforestation and resulting emissions can be predicted by simulation models, which come in many forms (Huettner *et al.* 2009). Such models may include historical rates of deforestation, but the basis is typically land rent and the demand and supply of new land for agriculture. The supply is determined by factors such as accessibility (e.g. roads) and agricultural potential. A much cited example is the cellular automata model by Soares-Filho *et al.* (2006) for the Brazilian Amazon.

Regression analysis can be used to test the importance of different potential drivers of deforestation and degradation when disaggregated national data on these activities and deforestation rates are available for different points in time. A recent study (Ecofys 2012) tested different multiple regression models to predict deforestation in three countries with historical data of good quality: Brazil, Indonesia and Vietnam (see Box 16.2). Further testing of these models as more data becomes available will – hopefully – yield more robust conclusions about what and how different national circumstances can be included in BAU baselines to improve prediction.

More complex modelling approaches can be suitable for RL development in countries that have high-quality data. These can be used to test different methods for RL setting, model deforestation drivers and explore the implications of different policy scenarios. Examples of such models include IIASA's GLOBIOM model and the OSIRIS modelling tool (Martinet *et al.* 2009). Modelling drivers can be particularly important when dealing with uncertainties. However, it should be noted that more complex and sophisticated modelling does not necessarily provide more accurate predictions of BAU emissions. When data are limited, extrapolation and complex modelling are often based on assumptions and can run the risk of multiplying errors and increasing uncertainties that could compromise the integrity of REDD+. Another uncertainty related to simulation models is their political acceptability as the basis for determining BAU baselines or FIBs, either within a future UNFCCC-based REDD+ regime or in bilateral agreements. Relatively simple adjustments of the historical emissions appear to be a more acceptable approach, as the Guyana–Norway agreement has illustrated.

16.2.3 From BAU to financial incentives

The reasons for setting the FIB differently from the BAU baseline have been discussed at length by the authors in Ecofys (2012) and only a summary is provided here. Three different considerations are relevant, see Figure 16.1.

First, there are circumstances particular to the country that may be relevant to the FIB. One possibility is to invoke the UNFCCC principle of 'common but differentiated responsibilities and respective capabilities' (CBDRRC) and use the FIBs to allocate varying degrees of payment among REDD+ countries. A key question concerns the specific criteria to use to differentiate between responsibilities and capabilities. This could, for example, be *per capita* income, where middle income countries have their FIBs adjusted downwards, whereas least developed countries receive relatively higher FIBs. While the specific interpretation of the CBDRRC principle is among the most controversial issues in climate negotiations (and goes well beyond REDD+), the post-Durban discussions have increasingly put this on the table.

Second, there are effectiveness and efficiency considerations that suggest that FIB should to be set below the BAU baseline. Consider the case where a donor country has a fixed sum of money to spend for REDD+ and makes a deal with a REDD+ country. As long as the REDD+ country has positive net benefits from the deal, the lower the FIB could be, the higher the carbon price and the greater the incentives for larger emission reductions (Angelsen 2008a; Meridian Institute 2009). Alternatively, for a given carbon price, the lower the FIB, the lower the costs for a carbon buyer and the money saved can be spent on REDD+ elsewhere.

Third, we suggest that the financial incentives benchmarks might be an adjusted BAU baseline to reflect uncertainty. Options for handling uncertainty are discussed in Section 16.4.

16.3 A stepwise approach

16.3.1 Key dimensions of the stepwise approach

The stepwise approach proposed by the UNFCCC (2011c), as is the case with many issues in REDD+ implementation, will evolve and consolidate over time (Box 16.3). As countries move through their REDD+ implementation phases, they have to develop national, or as an interim measure, subnational forest RLs. The understanding, reliability and validity of data for RLs are bound to improve through that phased process.

Box 16.2 Regression analysis to estimate deforestation drivers

One way to move beyond Step 1 is through the use of multiple regression analyses.[a] The method can be used to test the importance of historical deforestation and different national circumstances, including deforestation drivers. It requires that disaggregated national data (subnational level) on deforestation, forest cover and other relevant factors are available for at least two periods (i.e. covering three points in time). We undertook such an analysis in three tropical countries: Brazil, Indonesia and Vietnam.

Figure 16.2 shows the importance of different factors in predicting deforestation. Historical deforestation is a good predictor of future deforestation in all three countries, with the effect (elasticity) of deforestation being highest in Vietnam (0.57) followed by Brazil (0.51) and last by Indonesia (0.21). Elasticity refers to the percentage change in deforestation rate associated with a 1% increase in the variable in question. For example, in Figure 16.2, a 1% increase in the historical deforestation rate in a province in Vietnam gives a predicted future deforestation rate that is 0.57 % higher. The fact that the elasticity is less than one suggests that a simple extrapolation of historical rates can be misleading.

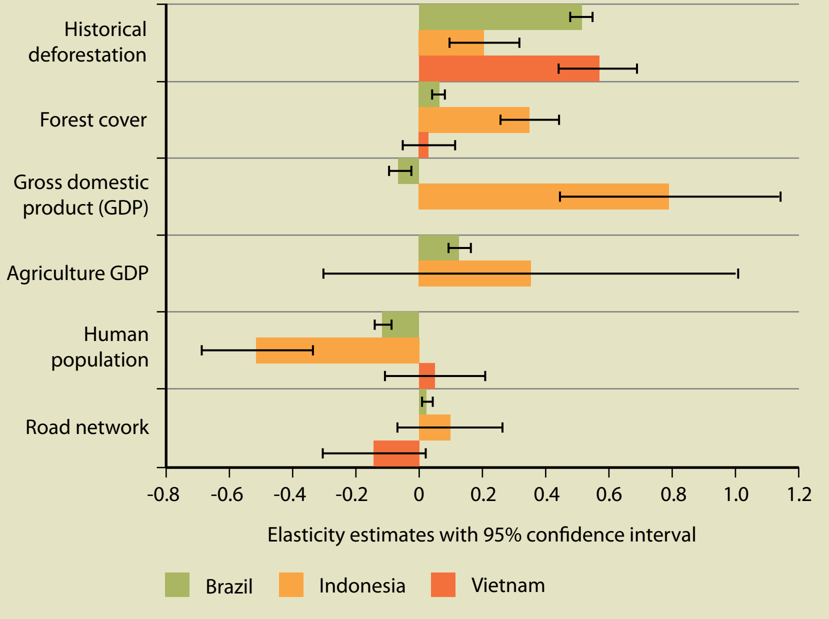

Figure 16.2 Predictors of deforestation in Brazil, Indonesia and Vietnam

Notes: Brazil and Vietnam regressions include a time trend variable not included in the graph. All variables are in logarithmic form. The black lines gives the 95% confidence interval of the coefficient estimate, i.e. if that line crosses the '0' on the horizontal axis, the regression coefficient is not significant.

Large forest areas contribute to higher rates of deforestation, although the effects are small: Indonesia (0.35), Brazil (0.06), and Vietnam (0.03). The forest area provides a direct test of forest transition hypothesis, which suggests that countries with large forest cover can be expected to have *accelerating* deforestation (Mather and Needle 1998; Mather *et al*. 1999). The small and insignificant effect observed in Vietnam is consistent with recent trends of net reforestation in the country (Meyfroidt and Lambin 2008). In contrast, Indonesia is experiencing higher deforestation rates and thus the higher elasticity is not surprising.

The analysis also incorporated other factors that are potentially important in setting RLs. In Indonesia, economic growth is associated with higher deforestation rates, another indication of many parts of the country being at an early stage in the forest transition (income level also provides a test of the forest transition hypothesis). In Brazil, high population growth is associated with lower deforestation rates. Surprisingly, roads have no significant effect on deforestation rates, beyond what is already captured in the impact on historical deforestation rates.

Regression analysis of this kind will not capture all of the drivers and variables that cause deforestation. Variables that show no variation within the country, although they may be important drivers of deforestation, cannot be included in this type of regression model because it is the variation within the country that produces the results. Also, new drivers or policies are hard to analyse, since these predictions are based on the historical relationship between variables.

Source: Ecofys (2012)

a Regression analysis is a statistical method that seeks to establish the quantitative relationship between one dependent variable (e.g. current deforestation rate) and a set of independent variables (e.g. historical deforestation rates, current forest cover and income per capita). Regression analysis estimates the conditional expectation in the form of a set of regression coefficients, e.g. how much current deforestation is expected to increase if income increases while other variables are kept constant. One possible model specification, used in this analysis, is the logarithmic model (log-log), which uses the natural logarithms of deforestation, forest area and other variables. This makes the interpretation of results easier as the coefficients of each variable can be interpreted as elasticities, which answer the question of how much deforestation changes in percent when the value of an independent variable (e.g. forest cover) increases by one percent.

Reflecting the variability in available data from which to estimate future trends and the lack of capacity in many countries (Herold 2009; Romijn *et al.* 2012), a stepwise approach provides a starting point for all country situations. The approach is conceptually similar to the use of different IPCC Good Practice Guidelines (GPGs) approaches for estimating activity data and tiers for carbon stock/emission factor data (see Box 16.3 and Chapter 15 for details) and reflects gradual improvements in several dimensions (Table 16.1).

Table 16.1 Dimensions of a stepwise approach to developing reference levels (see also Box 16.3)

	Step 1	Step 2	Step 3
Activity data/ area change	Possibly IPCC Approach 1 (national net change) but also 2 (national gross changes) or 3 (national gross changes spatially explicit)	IPCC Approaches 2 or 3 (to estimate gross changes)	IPCC Approach 3 (spatially explicit data required)
Emission factors/ carbon stocks	IPCC Tier 1 (defaults) but also 2 and 3 (national data) if available	Tier 2 or 3 (national data)	Tier 2 or Tier 3 (national data)
Data on drivers and factors of forest change	No driver data available or used	Drivers at national level known with quantitative data for key drivers	Quantitative spatial assessment of drivers/activities; spatial analysis of factors
Approaches as guidance for developing reference levels	Simple trend analysis/projection using national statistics, based on historical data	Country-appropriate methods for interpolation/ extrapolation using historical data and statistical approaches	Potential to use options such as spatially explicit modelling and other statistical methods for considering both drivers and other factors of forest cover change
Adjustments/ deviation from historical trend	Simple rules (in technical terms)	Assumptions and evidence for adjustments key drivers/activities	Analysis and modelling by drivers and activities
Scale	National or subnational	National or subnational	National (required in REDD+ Phase 3 for results-based payment)

Inclusion of REDD+ activities	May focus on only 1 or 2 activities with a need to consider emissions, i.e. deforestation and/or degradation	Aims to focus on all five REDD+ activities but emissions (deforestation and forest degradation) to be considered as minimum	Aims to focus on all five REDD+ activities but emissions (deforestation and forest degradation) to be considered as minimum
Omission of pools and gases	Focus on key category pools and gases with conservative omissions	Focus on key category pools and gases with conservative omissions	Aims to consider all pools and gases in context of full IPCC key category analysis
Uncertainty assessment	No robust uncertainty analysis possible; use of default uncertainties and/or conservative estimates	Modelling to accommodate uncertainties and testing using available data	Independent and quantitative uncertainty analysis possible, sensitivity analysis and verification using available data

Box 16.3 3 Phases, 3 Approaches, 3 Tiers, 3 Steps

'Phases', 'approaches', 'tiers' and 'steps'. Confused? Not after reading this box. These different terms all have quite specific meanings in the REDD+ and climate mitigation debates.

***Phases* of REDD+ implementation**

REDD+ implementation is following a phased approach, suggested by Meridian (2009) and agreed at COP16 (UNFCCC 2010). The three phases are:

Phase 1 – the readiness phase: the initial phase focuses on the development of national strategies or action plans, policies and measures, capacity building and demonstration activities.

Phase 2 – policy reforms and results-based demonstration activities: the second phase focuses on the implementation of national policies and measures, as well as on demonstration activities that use results-based payment mechanisms.

Phase 3 – results-based actions: transitioning into Phase 3 will involve moving to more direct results-based actions, i.e. emissions and removals that should be fully measured, reported and verified, with payments based on these results.

***Approaches* for estimating area change in land use (activity data)**

The IPCC guidelines provide three approaches and tiers for estimating emissions, with increasing levels of data requirements, analytical complexity and accuracy for higher tiers and approaches (GOFC-GOLD 2011). REDD+ countries are encouraged to use the 'Good Practice Guidance for Land Use, Land Use Change and Forestry' (IPCC 2003) to assist in their reporting on greenhouse gas emissions and removals. To estimate emissions and removals, two primary variables are important: activity data and emission factors, which can be estimated with different levels of sophistication. Three approaches can be used for tracking activity data or forest area change:

Approach 1: total area for each land use category recorded, but no information included on conversions (only net changes)

Approach 2: tracking of conversions between land use categories (only between 2 points in time)

Approach 3: spatially explicit tracking of land use conversions over time.

Tiers **for estimating change in forest carbon stocks (emission factors)**
Emission factors give the change in forest carbon stocks for different types of forests, and for up to five carbon pools: aboveground, belowground, deadwood, litter and soil organic carbon. Emission factors are used to determine how much carbon per hectare is lost and released to the atmosphere as a result of a human activity, e.g. deforestation. Data for estimation can come from different tiers.

Tier 1: default values for forest biomass and forest biomass mean annual increments corresponding to broad continental forest types (e.g. African tropical rainforest). Tier 1 also uses simplified assumptions to calculate emissions.

Tier 2: country-specific data (i.e. collected within the national boundaries) and forest biomass recorded at finer scales through the delineation of more detailed strata.

Tier 3: actual inventories with repeated measures on permanent plots to directly measure changes in forest biomass and/or well parameterised models in combination with plot data.

Steps **for developing reference (emission) levels**
Using the following three steps for developing reference levels is a new idea, developed in this chapter and in earlier work by the authors. It has been recognised by COP17 (Decision 12/CP.17, par. 10: “Agrees that a stepwise approach to [RL/REL] may be useful, enabling Parties to improve the [RL/REL] by incorporating better data, improved methodologies and, where appropriate, additional pools …”). The different steps are useful because they provide a starting point for all countries to explore (initial) RLs. They lay out the means to improve RLs as capacity increases and data availability improves. The approach is designed to lead to more comprehensive and accurate RLs for higher steps, and when moving towards results-based compensation (i.e. in phase 3):

Step 1: Use available data (even if uncertain) to provide a starting point for RL establishment with simple projections, based on historical data.

Step 2: Build more robust national datasets for country-appropriate extrapolations and adjustments, including data for key drivers.

Step 3: Integrate spatially explicit assessments and modelling, using reliable data on activities and drivers.

For more details on the steps, see Table 16.2.

16.3.2 The three steps

The concept of the stepwise approach largely depends on the available data and country capacities and thus requires adjustments for national circumstances and uncertainties.

Step 1 is the starting point for countries to engage in RL setting and can be based on coarse national-level data only. It will be challenging to provide quantitative evidence for deviating from the projected historical trend and only simple rules should be used for potential adjustments to take account of national circumstances. All countries should be able to undertake a Step 1 approach with only modest effort using available data, even if uncertain. Examples of a Step 1 methodology can be taken from the Brazilian Amazon Fund (a subnational approach) and Guyana (a national approach). The Amazon Fund REL is based on gross deforestation and a conservative estimate of aboveground carbon stocks of 100 tC/ha. The annual deforestation rates used in the calculation of emission reductions are compared to the average deforestation rates over ten year periods, which are updated every five years (Amazon Fund 2009). For Guyana, the predicted BAU deforestation was set as the average between the mean *national* deforestation rate for 2000–2009 and the mean *global* deforestation rate. An aboveground carbon stock of 100 tC/ha was also assumed for Guyana, and these formed the basis for payments (Norwegian Ministry of Environment 2011).

Step 2 makes a first attempt to include national circumstances quantitatively, i.e. by undertaking evidence or driver-based assessments to adjust historical rates, and by using better country data (e.g. Tier 2 for carbon stocks) than can be gained by relying on Step 1. However, at this stage historical trend data are likely to dominate the estimate of future trends. This is exemplified in the results of regression analyses (Ecofys 2012), where predictions were made based on subnational activity data for at least decade or so in Brazil, Indonesia and Vietnam. These examples are described further in Box 16.2. Currently, only a few countries have the data available to undertake a Step 2 approach, but the situation is expected to change significantly over the next two to three years (Box 16.4).

Step 3 develops the Step 2 approach further, using higher quality data that allow a wider choice of modelling methods. In particular, more spatially explicit activity data and driver-specific information support, for example, the use of more complex spatially explicit regression or simulation models that should allow for a more robust and forward looking estimate. The approach may actually avoid the need to use historical deforestation as the key predictor since specific drivers and activities may be analysed, modelled and predicted individually (but calibrated with historical trends). Approaches for Step 3 RL have been presented in the scientific literature (e.g. Soares-Filho *et al.* 2006), but so far no REDD+ country has developed RLs using this approach.

The idea for the stepwise framework is to provide a pathway for reducing uncertainty and moving to higher steps over time, which will allow countries to develop more accurate forest RLs for assessing the impact of their policies and measures, if for example payment rates are higher for higher quality of RLs. Approaches have been documented that use available data sources and improve monitoring capacities to provide quality activity data and emission factors (GOFC-GOLD 2011). Countries can acquire data to develop forest RLs at higher steps fairly quickly and at a reasonable cost (UNFCCC 2009a).

16.3.3 The importance of historical data

Getting reliable information on the recent history of forest change is critical in any approach to RL setting (Meridian Institute 2011b; Romijn *et al.* 2012). UNFCCC guidelines (Box 16.1) highlight the importance of a data-driven approach to setting RLs. In addition to including data on recent forest area changes and associated emissions and using approaches suggested in the IPCC GPGs (IPCC 2003), the development of forest RLs also requires information on drivers and activities. The empirical analysis of the relationship between drivers and their contribution to national emissions is one approach to advancing through the steps. COP Decision 1/CP.16 (UNFCCC 2010) encourages countries to identify land use, land use change and forestry (LULUCF) activities, in particular those that are linked to the drivers of deforestation and forest degradation and to assess their potential contribution to the mitigation of climate change.

For Step 1, consistency and transparency are very important, while data can contain significant uncertainties that are largely unknown and should be assessed and managed using default uncertainties and conservative assumptions. Step 2 and Step 3 for developing RLs would be based on improved national data coming from activity data using IPCC Approach 2 and 3 (Box 16.3).

16.3.4 National circumstances

National circumstances are already a reporting requirement for all UNFCCC parties. The assessment of national circumstances could include information (UNFCCC 2003) on geographical characteristics (e.g. climate, forest area, land use, other environmental characteristics), population (e.g. growth rates and distribution), economy (e.g. energy, transport, industry, mining), education (e.g. including scientific and technical research institutions) and any other information considered relevant by the country. As there are currently no clear guidelines, each country has the freedom to assess these variables using autonomous methods.

The overall rationale for inclusion of particular national circumstances is to generate more accurate and precise BAU baseline predictions. The question remains whether guidelines, for example in the form of a list of potential variables that can be used to adjust historical emission rates, are feasible from a political and scientific viewpoint. An alternative would be to decide on the documentation needed to validate variables beyond historical emissions. A combination is also possible, i.e. a short list of acceptable variables and documentation requirements if a country goes beyond that list. The potential for biased estimates suggests the need for clear guidelines and an independent verification process.

Scientific discussions have just started on how to make robust adjustments to historical rates and some early evidence is presented in Box 16.2. Meridian Institute (2011b) discusses three potential national circumstances: the stage in forest transition, the role of specific drivers and existing development plans, but also notes the lack of broad evidence on these. The inclusion of national circumstances is expected to improve as part of the stepwise RL development, as more and better data become available and capacities increase.

16.3.5 National versus subnational approaches

The stepwise approach includes the option for subnational RLs as an interim measure, but countries need a clear rationale for doing so and they need to understand how these will eventually be compiled into a national RL. It is often difficult to scale up subnational RLs into a national RL that is transparent, complete, consistent and accurate.

Testing the development of forest RLs at the subnational scale and as part of a learning-by-doing approach may provide useful insights on how to develop RLs at the national level for Phase 3 of REDD+, when any financial accounting scheme will be based on results-based actions. In this context, a Step 3 approach for RLs will be based on subnational analysis, e.g. to account for different ecological conditions and different drivers across subnational units.

16.3.6 Flexibility in considering carbon pools, other gases and REDD+ activities

Countries have the flexibility to omit non-significant carbon pools, other GHG gases and specific REDD+ activities in the construction of forest RLs (UNFCCC 2011c), and it makes good sense to focus on key categories during early steps when data are highly uncertain (see also Chapter 15). In this context, estimating emissions is generally more important than estimating removals. Similar to the concept of IPCC key source categories

Box 16.4 Developing RLs in Indonesia

Several countries are working to develop RLs at higher steps, investing significant efforts in consolidating and improving their historical data and analysing their national circumstances, including deforestation and degradation drivers (e.g. Pham and Kei 2011; Sugardiman 2011). In Indonesia, the Ministry of Forestry, supported by AUSAID under the framework of the Indonesian National Carbon Accounting System (INCAS), continues to refine the forest carbon monitoring and accounting capacity as a complement to the national forest inventory (NFI), which is used as a basis for estimating emission factor. For activity data, current land cover maps were generated from mosaic Landsat TM/ETM satellites (for 2000, 2003, 2006 and 2009) with 30 metre spatial resolution and partly validated through field validation. The methods for setting up the RLs and projecting future BAU deforestation are based on combining spatial planning data with historical deforestation rates at subnational units. This includes province/district development plans and projections of 'planned deforestation', such as expansion of estate crops (plantations), mining and conversion of forested lands that are legally designated as convertible forest or other land uses. As in the Amazon Fund in Brazil, projected deforestation rates will be adjusted every five years. For Indonesia, the national RL is more likely to be an aggregate of subnational RLs (Step 2).

The province of Central Sulawesi, which is a pilot study of the UN-REDD Programme, has undertaken a detailed study on carbon accounting, compiling NFI data and collecting additional field data with the intention of implementing the Stock–Difference approach in five years time (UN-REDD Programme 2011a). Furthermore, under the Letter of Intent (LoI) between the Governments of Indonesia and Norway signed in May 2010, Central Kalimantan was selected as a pilot province for REDD+ measurement, reporting and verification (MRV) activities. The REDD Task Force brings together government agencies and has recently finished the MRV strategy guidelines. The agencies include the Ministry of Forestry, the National Council on Climate Change, the National Institute of Aeronautics and Space, the Ministry of Environment and the National Survey and Mapping Coordination Agency. RELs are proposed for two different forest landscapes: forests on mineral soils and peatlands. While these MRV demonstration activities should be finished by the end of 2012, emission factors are most likely to be predicted based on a hybrid of Gain–Loss and Stock–Difference approaches.

Under the LoI with Norway, a third REDD+ phase (see Box 16.3) is to be introduced, starting in 2014, where Indonesia is to "receive annual contributions for independently verified national emission reductions relative to a UNFCCC reference level (or a reference level set by Indonesia and its partners based on Indonesia's emissions reductions pledges and UNFCCC methodological guidance (4/CP 15), in accordance with relevant decisions of the Conference of the Parties, if no UNFCCC reference level has been set for Indonesia)."

(Chapter 15), a country is obliged to report on emissions while reporting on removals is optional. Emissions from deforestation need to be reported as do forest degradation emissions, unless they are rigorously proven to be insignificant. In addition, consistency is key: once pools and/or activities are omitted from the RLs, they cannot be included in REDD+ performance reporting. If additional pools, gases and activities are added, the RLs need to be adjusted retrospectively with suitable data to ensure consistency in reporting performance.

16.4 Linking uncertainty in stepwise RLs and financial incentive benchmarks

The stepwise approach provides RL development options ranging from approaches based on simple and (likely) uncertain data (Step 1) to those using more complex data and a rigorous uncertainty analysis (Step 3). It is reasonable that higher levels of certainty should be rewarded by higher rates of payment. This incentive is important to help the stepwise approach to work and encourage countries to graduate to higher steps in order to develop higher quality RLs. Step 1 RLs may in many instances be considered too uncertain to be used or accepted in a REDD+ payment scheme. The stepwise system has to take uncertainty into account for reasons of effectiveness, efficiency and for 'fair risk sharing' between the parties of the agreement. Several options have been proposed for dealing with uncertainty and these are summarised in Table 16.2.

One proposal is to allow an *ex post* adjustment of the RL, originally termed 'Compensated Successful Efforts' (Combes Motel *et al.* 2009). Deforestation pressures in, for example, the Brazilian Amazon are closely linked to the profitability of cattle and soybean production and allowing the adjustment of RLs based on the prices of these commodities would better reflect the true BAU scenario and therefore allow the better measurement of real emissions reductions.

The corridor approach, proposed by Schlamadinger *et al.* (2005), recognises that any point estimate of the reference level will be uncertain. A factor is therefore introduced where greater emissions reductions get increasingly lower discount factors (i.e. higher price per tCO_2). The approach defines an interval (corridor) around the point estimate of the RL, with the discount factor increasing from 0 to 1 (zero to full payment) within this interval. Thus, REDD+ countries would get some payment even if they face strong deforestation drivers, making their policies less successful in reducing deforestation. A donor country, on the other hand, would not pay fully where deforestation is reduced for other reasons than successful REDD+ policies. The corridor approach has, to our knowledge, not been applied in any agreements

Table 16.2 Options for dealing with uncertainty in setting RLs (Ecofys 2012)

Option	Elaboration	Pros	Cons	Most applicable for
1. *Ex post* adjustment of RL	RL formula agreed *a priori*; final RL set when parameters (e.g. agricultural prices) are known	Predictable; adjustments made as more data become available	Hard to establish the formula	Steps 2 & 3
2. Corridor approach	Gradually increasing payments within a RL corridor	Flexible; payments also mimic marginal cost curve	Political acceptability	Steps 1–3
3. Uncertainty or conservativeness factor adjustment	Estimated difference between the outturn and RL multiplied by an uncertainty or conservativeness factor (<1), based on assessment of data quality	Reduced risk of over-payment and hot air; incentives to produce better data; somewhat accepted by UNFCCC; easy to implement	Makes REDD+ less attractive for countries with poor data	Steps 1–3
4. Renegotiation	Renegotiate RL during the course of implementation of a REDD+ agreement	Flexible, can incorporate unforeseen factors	Political gaming	Steps 1 & 2
5. Insurance	Could design insurance contract-based approaches in Steps 1 & 2	Well developed markets for insurance	Probably expensive; complex contract	Steps 2 & 3

so far, although the recent adjustment of the Guyana–Norway agreement has some elements of the approach.[2]

Another approach is to use uncertainty or conservative adjustments. In this context, an adjustment to the RL could reflect the degree of uncertainty, such that countries with the poorest data would apply a multiplicative discount based on the degree of uncertainty, e.g. in the form of a lower price per tCO_2. This approach addresses one of the problems of uncertainty, namely the risk of overpayment and unjustified REDD+ credits. The use of conservative assumptions is reflected in the recent UNFCCC decision (UNFCCC 2011c) concerning the possibility of omitting non-significant carbon pools or specific REDD+ activities in developing RLs. Thus, this approach is, at least in principle, already used by the UNFCCC and currently provides the simplest and most suitable option to account for uncertain RLs in payment schemes (Grassi *et al.* 2008) and allows participation in REDD+ while better inventory systems are being developed.

Other options for dealing with uncertainty are contract renegotiation or insurance, but these have not been explored in the context of REDD+ RLs. The question of insurance in relation to permanence has been discussed by Dutschke and Angelsen (2008) and options reviewed there are relevant to RLs as well.

Table 16.2 includes a column on the applicability of the various adjustments to particular steps. Since many countries will start with Step 1 or 2 approaches, conservative adjustment currently provides the simplest solution. Regular renegotiations are also a possible option, but are vulnerable to political bias. The corridor approach has several attractive features and can be considered an elaborated variant of the conservative adjustment approach (with progressive adjustments).

16.5 Conclusions

Establishing forest reference levels for developing countries is among the most urgent and challenging tasks in REDD+. While some general guidance from the UNFCCC on developing forest reference levels exists (UNFCCC 2011c), significant challenges remain. Countries are asked to choose the approaches they will take for setting RLs, but many struggle from a lack of quality data, genuine uncertainties about future rates of deforestation and degradation and potential incentives for biasing their estimates, in particular when reference

2 The revised reference level under the Guyana–Norway partnership follows the concept of a corridor approach whereby any increase in deforestation from the current extremely low rates would be penalised (by reduced payment) and above a certain cut-off level, payments would completely disappear (Norwegian Ministry of Environment 2011).

levels are linked to payment schemes and payment levels. To reflect this, we have highlighted two different meanings and uses of RL: the RL used as a benchmark for measuring the effect or impact of REDD+ policies and action and RL used as benchmark for calculating payments for emissions reductions to countries, subnational units or projects.

A stepwise approach to developing forest RLs can help to overcome the challenges of lack of data, uncertainty and competing interests, and could encourage wider participation by countries in REDD+. It is a data-driven approach; thus the availability of more and higher-quality data will increase the robustness of the RLs over time. While taking a Step 1 approach is simple and the results may have a high level of uncertainty, it does allow countries to at least initiate RL activities and provides a benchmark for assessing trends and interim performance. Step 2 allows greater inclusion of national circumstances and links RLs to known drivers of deforestation and degradation as a means to adjust historical land use change rates. Step 3 develops this approach further, with greater spatially disaggregated data and a more explicit analysis of drivers and factors. Step 3 could be implemented, for example, through the use of spatial simulation models that also allow a more forward-looking modelling component.

The stepwise approach, by nature, will result in RLs of varying levels of uncertainty and this should be taken into account in any payment scheme. Where uncertainty varies (between countries for example), the financial incentive benchmark that modifies the BAU baseline is a means to reward efforts to reduce uncertainties and move to higher step RLs over time. There are several approaches for dealing with RL uncertainty; the conservative adjustment factor currently provides the most suitable option. This approach is, at least in principle, already being discussed and considered by the UNFCCC (Grassi *et al*. 2008; UNFCCC 2011c).