New Zealand submission to the Subsidiary Body for Scientific and Technological Advice

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

March 2012

1. In making this submission New Zealand is responding to an invitation to Parties and accredited observers to provide views on issues identified in Decision 1/CP.16, paragraph 72, and Appendix II, in particular on how to address drivers of deforestation and forest degradation and on robust and transparent national forest monitoring systems (NFMS) as referred to in paragraph 71(c) of that decision. This submission only addresses NFMS.

Introduction

2. New Zealand considers that excellent progress has been made on REDD+ over the last several years, and that this is reflected in Decisions 1/CP.16 and [-/CP. 17]. In particular, New Zealand notes the developments on forest reference levels and forest reference emission levels (reference levels). The central role that reference levels play in REDD+ was confirmed under Decision [-/CP.17] with the agreement that reference levels expressed in tonnes of CO_2 equivalent per year are benchmarks for assessing each country's performance in implementing REDD+ activities.

3. New Zealand considers that these decisions on reference levels underscore the need for robust and transparent data to be used in constructing country-specific reference levels, and that NFMS are essential to this process.

4. Decision 1/CP.16 at paragraph 71 requests developing country Parties aiming to undertake REDD+ activities (as specified in paragraph 70 of the decision) to develop a set of specific elements. One of these elements is a robust and transparent national forest monitoring system for the purposes of monitoring and reporting REDD+ activities.

5. New Zealand also notes that Parties agreed in Decision [-/CP.17] that a step-wise approach to reference levels may be useful, enabling Parties to improve the reference level by incorporating better data, improved methodologies and, where appropriate, additional pools. The mechanism for attaining this improved data is through a well-developed NFMS.

6. The scope of REDD+ is another factor that underlines the importance of NFMS. The original RED concept dealt only with deforestation. However, the concept has evolved, Decision 1/CP.16, at paragraph 70, sets out five REDD+ activities, being: reducing emissions from deforestation; reducing emissions from forest degradation; conservation of forest carbon stocks; sustainable management of forests; and enhancement of forest carbon stocks. The so-called plus elements of REDD+ (the latter 3 activities), and the activity of reducing emission from forest degradation, all require NFMS that include a system for monitoring forest carbon stock and carbon stock change.

7. New Zealand considers that Decisions 2/CP.13, 4/CP.15 and 1/CP.16 provide the foundation for SBSTA's work on NFMS. New Zealand notes the preliminary guidance provided in Decision 4/CP.15. At paragraph 1(d), Parties are requested:

> To establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems and, if appropriate, sub-national systems as part of national 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) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties.

8. New Zealand notes that the Intergovernmental Panel on Climate Change (IPCC) Good Practice Guidance (GPG) for Land Use, Land-Use Change and Forestry provides a framework for approaches and methodologies to estimate and monitor emissions and removals of greenhouse gases and changes in carbon stocks resulting from REDD+ activities. The GPG include principles of transparency, consistency, comparability, completeness and accuracy.

Guidance to SBSTA

9. Many developing country Parties are either actively undertaking or contemplating work on a NFMS or sub-components of such a system (such as mapping via remote sensing). It is essential that such efforts are directed as efficiently as possible, and that redundancies of effort, as a result of a lack of direction to Parties, are avoided.

10. Whilst, as noted above, some existing guidance is available, many developing country Parties are seeking more clarity as to what is required of them. New Zealand's view is that consideration of NFMS should be a priority for SBSTA this year.

11. New Zealand notes the value expert meetings provided in furthering SBSTA's consideration of reference levels and systems for providing information on how safeguards are addressed and respected.

12. New Zealand proposes, as an initial step, that Parties may wish to consider agreeing a set of high-level principles at SBSTA in May 2012. New Zealand suggests the following:

Parties affirm the following principles to guide the development of NFMS:

- That the respective capabilities and national circumstances of developing country Parties be recognised;
- That NFMS systems provide transparent, complete, consistent and accurate information, and that this be used in the construction of reference levels/reference emission levels;
- That early commencement of NFMS and maximum participation by developing country Parties be encouraged;
- That the development of NFMS should be seen as a process and continuous improvement encouraged;
- That external review provides a valuable mechanism for improving NFMS;
- That incremental development of NFMS be enabled, but that such developments should be compatible with future, potentially more comprehensive, systems;
- That NFMS may, as an interim measure, focus on forest areas and/or REDD+ activities[1] where forest carbon stock change is assessed as most significant;
- That NFMS include both remote sensing and ground-based sample plot measurement;
- That NFMS enable informed policy decisions; and

[1] As set out in 1/CP.16 at paragraph 70.

- That the role of indigenous peoples and local communities in the development of NFMS be recognised.

13. New Zealand suggests that consideration be given to scheduling an expert meeting on NFMS in the second half of 2012. Such a meeting could be used to elaborate the above principles. It could also enable consideration of whether further detailed guidance on NFMS is necessary at this time, and, if so, what issues such guidance should address. This may include considering whether to invite the IPCC to develop supplementary guidance on particular aspects of NFMS for REDD+.

New Zealand's experience: Lessons learnt for REDD+ NFMS (Summary)

14. To inform Parties' consideration of NFMS for REDD+, New Zealand presents in this submission a list of lessons learnt in the development of New Zealand's forest carbon inventory system (Land Use & Carbon Analysis System – LUCAS). New Zealand's LUCAS was custom-built for use as a carbon reporting and accounting system, and as such provides valuable insight for consideration of NFMS for REDD+ countries, despite New Zealand's differing reporting and accounting commitments. It is worth noting that New Zealand's forest carbon inventory system was built from the ground up over a period of only around ten years. During this time, LUCAS was subject to continuous improvement, incremental investment, and contributed to meeting New Zealand's reporting obligations.

15. The list below is presented as a guide. Where necessary, we've included additional commentary on the specific implications for REDD+ (in italics). A more detailed explanation including an elaboration of New Zealand's experience is provided in Appendix I.

i. The establishment of a specifically designed network of ground-based sample plots is considered best practice for NFMS. Ground-based sample plots are necessary to accurately measure forest carbon stock and stock change.

   In recognition of the respective capabilities and national circumstances, IPCC default emission factors provide an acceptable approach for REDD+ countries while NFMS are being fully developed. The development of specific regional emission factors could also provide a valuable interim step.

ii. Where possible, and if necessary, initial mapping should be undertaken prior to the operational design of a forest inventory, so as to provide the basis for selecting forest sample plots on a systematic grid (with a randomised starting point) .

   Not all plots need to be installed and measured immediately for a REDD+ NFMS, but developing a national framework ensures that where measurements are taken they will be able to be incorporated into a national system in a statistically valid manner. This is particularly important where Parties may be planning to use sub-national forest monitoring systems as an interim measure, or where particular areas are being targeted for measurement due to a high probability of land-use change[2].

   The exercise of mapping forest area should be undertaken periodically.

iii. Permanent sample plots (PSPs) may be preferable to temporary plots as a greater number of temporary plots are necessary to estimate forest carbon stock change to the same level of accuracy and confidence. PSPs may be more expensive to establish and re-measure on a per plot basis, and have maintenance costs that temporary plots do not incur, but fewer

[2] Paragraph 71(c) of Decision 1/CP.16 permits REDD+ countries to use, 'if appropriate, sub-national monitoring and reporting as an interim measure, in accordance with national circumstances'.

are required; therefore, the higher per unit costs may be offset by the lower number of plots required. In addition, the data collected from permanent plots are not subject to spatial variability that could mask real temporal changes.

iv. Existing data (carbon stock, forestry concession etc) may provide useful background, but NFMS should be designed on a first principles basis. A number of questions should be addressed prior to the use of existing plot data, including: was the sample randomly or selectively located, is the sample size adequate, are the data collected sufficient, and does the sample increase accuracy or confidence of the country's estimate.

v. The use of trial inventories can greatly assist in finalising the inventory sample design, testing field measurement protocols, and providing improved cost estimates for the inventory. They can also be used to confirm that the inventory sample intensity is practical and sufficient.

vi. Remote sensing data are a valuable tool for mapping forest area (or more specifically woody land use classes), and in conjunction with other data can detect land-use change, and assign land-use classifications. It is possible to determine forest area and detect land-use change via ground-based sample plots, but the number of plots required can be cost prohibitive (as a large number of plots are necessary to achieve acceptable detection probability and sampling error), and such an approach is also vulnerable to fraud (as plots may be treated differently).

vii. A combination of remote sensing and ground-based sample plots is recommended for an effective NFMS. This strategy offers the advantage of potentially improving the precision of data from each source.

The relative importance ascribed to remote sensing and ground-based sample plots should be determined initially by respective capabilities and national circumstances of developing country Parties, recognising forest characteristics, land-use, and existing expertise and systems.

viii. A substantial, long-term investment is necessary for an effective NFMS. Data processing and analysis comprise a substantial component of the required investment, and training and capacity building of field teams needs to be factored in.

A long-term commitment also ensures that the system is sustainable. For example, the annual re-measurement of a proportion of ground-based sample plots is not only more practical, but helps ensure that expertise is retained. Similarly, it is important that funding for mapping be constant, so that maps of consistent (or improving) quality can be compared.

ix. Information sharing amongst Government agencies and others relevant entities should be encouraged and existing data, where suitable, should be used to enhance knowledge of the area in forest.

x. Significant effort is required to accurately prepare forest maps for an historical base year, with a lack of existing data of sufficient precision the primary factor.

This is likely to be even more of an issue for REDD+ countries. Consideration should be given as to what is an appropriate base year or time period necessary for historical data.

xi. The development of a NFMS should be seen as a process. The goal should be continuous improvement. Advice from external sources is vital for improvement.

16. New Zealand looks forward to discussing the above ideas with other Parties in May 2012, and continuing to work on what we consider to be a fundamental element of an effective REDD+ mechanism.

Appendix I- New Zealand's experience: Lessons learnt for REDD+ NFMS (detailed discussion)

New Zealand's national forest inventory was custom-built for use as a carbon reporting system, and as such provides valuable insight for consideration of NFM for REDD+, despite New Zealand's differing reporting and accounting commitments.

New Zealand's experience of developing a national forest carbon inventory system (to meet UNFCCC and Kyoto Protocol reporting obligations) has direct parallels with the work many developing country Parties will need to undertake for REDD+. At the time of establishment, New Zealand did not have an existing functioning national forest inventory on which to build the national forest carbon inventory. As such, New Zealand was not able to use existing national unbiased estimates of total stem volume combined with biomass expansion factors to predict total biomass, nor derive individual tree biomass allometric functions from existing data to apply to a national sampled set of individual tree measurements.

New Zealand collects data on both planted production and natural forests, but neither process produced information with sufficient detail and coverage to be used for national forest carbon inventory purposes. Data on planted production forests are collected annually in a voluntary survey, the National Exotic Forest Description (NEFD). It focuses on timber availability for planted production forests, and is based on forest area, forest age-class distribution, silviculture, and harvest rates, as reported by those that respond to the survey, from within the forestry sector. The NEFD has parallels with forestry concession data collected by some developing country Parties. Data on natural forests are collected for a wide variety of purposes and stored in the National Vegetation System (NVS) (as detailed below). The NVS stores a large volume of vegetation survey and plot data, including data on tree and shrub stem measurements of diameter at breast height (DBH), and vegetation composition measures such as cover by height tier and seedling counts in sub-plots.

Initial work began on designing a system to meet UNFCCC reporting requirements in the late 1990s. The design and implementation of the natural forest inventory and Soil Carbon Monitoring System (Soil CMS) began with funding allocated on an annual basis. Land cover maps were used as a substitute for land use maps to identify where the sample plots should be established. The system was built to allow the inclusion of a subset of existing permanent plots (the NVS plots mentioned above) to take advantage of their existence and to get an early understanding on what if any carbon stock change was occurring in natural forests. The subset of plots were not representative of the vegetation mapped as natural forest and therefore provided an assessment only of the carbon stock changes occurring on those plots rather than providing any level of confidence in what was occurring at the national level.

Following New Zealand's ratification and entry into force of the Kyoto Protocol, long-term funding was committed and the work programme extended on New Zealand's national forest carbon inventory (Land Use & Carbon Analysis System – LUCAS). The programme comprises three main components:

- mapping of land use and land-use change since 1990 and the change between 2008 and 2012;
- the establishment of a forest carbon inventory which enables the measurement of forest and soil carbon stock and change; and
- the establishment of IT, database and carbon accounting systems for verification, calculation and reporting.

LUCAS focuses principally on carbon inventory and modelling for natural forest, planted forest and soils, and is designed to provide the data required for New Zealand's UNFCCC and Kyoto Protocol reporting and accounting obligations. A first priority was to develop sound techniques for collecting land-use data, and then to work out how to calculate the carbon values for each of the five carbon pools (above ground biomass, below ground biomass, dead wood, litter, soil organic matter). In doing so, it was critical that the methodologies used met the Intergovernmental Panel on Climate Change Good Practice Guidance. The results of investigations and method development for each component are published in independent peer-reviewed journals. This provides transparency and ensures that New Zealand's approaches are acceptable to the international community.

In order to determine carbon stocks at a national level for plantation forest, site-specific data are gathered through permanent sample plots in the two categories of forest – first in post-1989 and subsequently in the pre-1990 forests. Post-1989 forest sites are located throughout New Zealand where a randomly allocated 4-km grid coincides with mapped post-1989 forest. Between 2007 and 2008 around 300 permanent post-1989 forest sample sites were measured by ground crews using forestry inventory methodology developed from standard protocols.

In order to measure land-use change New Zealand made extensive use of satellite imagery, aerial photography, and other spatial data. It should be noted that land-use mapping from satellite imagery over New Zealand is hampered by two factors. First, it is difficult to get complete coverage of the country in one summer due to cloud cover. Second, steep slopes cause shadowing which makes automatic classification of the imagery difficult. To counter the latter issue, New Zealand developed techniques to remove the effects of terrain from satellite imagery, which significantly improved image classification and subsequent land-use mapping.

New Zealand's experience – lessons learnt for REDD+ NFMS:

(i) The establishment of a specifically designed network of ground-based sample plots is considered best practice for NFMS. Ground-based sample plots are necessary to accurately measure forest carbon stock and stock change.

General comment

The use of ground-based sample plots is well established as a mechanism to measure and quantify bio-physical and environmental attributes.

New Zealand notes the findings of a UNFCCC technical paper on NFMS (FCCC/TP/2009/1). The paper states at paragraph 92: 'For most of the tropics, existing data sets are generally insufficient, and so collecting additional field measurements using standard forest carbon inventory methods for each ecosystem likely to be deforested or degraded will be necessary'.

In recognition of respective capabilities and national circumstances, IPCC default emission factors may provide an acceptable approach for REDD+ countries while NFMS are being fully developed.

New Zealand experience

New Zealand used a systematic grid approach for the establishment of a network of permanent sample plots. Where the grid intersected forest or woody vegetation a permanent sample plot was installed. The plots were established systematically on a 4 or 8-km grid - natural forest (8-km grid); pre-1990 planted forest (8-km grid); and post-1989 forest (4-km grid). New Zealand used 20 m x 20 m permanent plots to measure the natural forest. In total approximately 1256 plots were installed in natural forests between 2002 and 2007, which provided carbon stock estimates within ±4% (95% confidence intervals).

New Zealand's permanent sample plots are used to measure above ground volumes of live and dead biomass, and then converted to carbon stocks per hectare using models, allometric functions and regression equations. A ratio of above to below ground biomass is applied to estimate below ground biomass. Additional plot data have been collected to meet other national and international reporting requirements, such as forest composition measurements and full vascular plant species lists.

(ii) Where possible, and if necessary, initial mapping should be undertaken prior to the operational design of a forest inventory, so as to provide the basis for selecting forest sample plots on a systematic grid (with a randomised starting point) .

General Comment

Not all plots need to be installed and measured immediately for a REDD+ NFMS, but developing a national framework ensures that where measurements are taken they will be able to be incorporated into a national system in a statistically valid manner. This is particularly important where Parties may be planning to use sub-national forest monitoring systems as an interim measure, or where particular areas are being targeted for measurement due to a high probability of land-use change[3].

New Zealand experience

In New Zealand, the establishment of both ground and LIDAR sample plots for post-1989 plantation forests were installed without a map of the area. Forest plots were established at around the same time as the 1990 base mapping work was being carried out. This created a number of challenges as planted forest consultants were engaged to independently identify where the post-1989 forests occurred. As a result, a number of post-1989 forest plots were located in other land uses, and a number of additional plots have been identified that were missed in the first measurement round.

(iii) Permanent sample plots (PSPs) may be preferable to temporary plots, as a greater number of temporary plots are necessary to estimate change to the same level of accuracy and confidence. PSPs may be more expensive to establish and re-measure on a per plot basis, and have maintenance costs that temporary plots do not incur, but fewer are required; therefore, the higher per unit costs of PSPs may be offset by the lower number of plots required. In addition, the data collected from permanent plots is not subject to spatial variability that could mask real temporal changes.

In New Zealand's experience, with the objective of estimating national carbon stock change, the advantages of permanent sample plots outweigh their disadvantages and the extra costs per plot, as it was determined that more temporary plots (at a higher overall cost) would be needed to estimate the carbon stock change to the same level of uncertainty.

New Zealand notes that a statistical sampling approach applied to a national permanent sample plot network can significantly reduce costs. In taking such an approach the statistical design, stratification and plot design require careful consideration. Methodologically, the approach must avoid bias such that in extrapolating emission factors for instance, estimates are neither under-estimated nor over-estimated.

(iv) Existing data (carbon stock, forestry concession etc) may provide useful background, but NFMS should be designed on a first principles basis. A number of questions should be addressed prior to the use of existing plot data, including: was the sample was randomly or

[3] Paragraph 71(c) of Decision 1/CP.16 permits REDD+ countries to use, 'if appropriate, sub-national monitoring and reporting as an interim measure, in accordance with national circumstances'.

selectively located, is the sample size adequate, are the data collected sufficient, and does the sample increase accuracy or confidence of the country's estimate.

In New Zealand, the National Vegetation Survey (NVS) databank stores vegetation data that have been collected over the last 50 years. Currently, it contains records from approximately 77,000 vegetation survey plots which include over 19,000 permanent plots. The types of plot data held include tree and shrub stem measurements of diameter at breast height (DBH). It also includes vegetation composition measurements, such as cover by height tier and seedling counts in sub-plots.

To assess the data's usefulness for estimating carbon stocks, plot data were selected from a subset of plots. DBH and indirect estimates of tree height were converted to above-ground biomass (AGB) using allometric equations based on previous destructive biomass studies and wood density data from a range of historical wood density surveys. An assessment of these plots identified a range of issues including: tree height had to be inferred from height tier data to enable estimates of AGB to be made; and none of the other carbon pools could be estimated from the data available in NVS. In addition, some forest types and regions were not sampled and others were poorly represented.

It was determined that despite the existence of these plots a systematic network of new permanent sample plots was necessary in order to measure forest carbon stock and stock change for New Zealand's natural forest.

(v) The use of trial inventories can greatly assist in finalising the inventory sample design, testing field measurement protocols, and providing improved cost estimates for the inventory. They can also be used to confirm that the inventory sample intensity is practical and sufficient.

New Zealand undertook two trial inventories in developing LUCAS. An East-West transect across the South Island was assessed for natural forest, while the Nelson-Marlborough region was assessed for planted production forests.

New Zealand's sample intensity for natural forests is quite sparse – 1 hectare measured for every 27,000 hectares of post-1989 forest, 107,000 hectares for pre-1990 forest and 160,000 hectares for natural forest. The sample inventories enabled these intensities to be analysed and confirmed prior to the roll-out of this approach nationwide.

Significantly, the use of trial inventories also demonstrated the principles of a large-scale, national inventory in a country more used to either project and/or catchment-based inventories for native vegetation.

Prior to the establishment of the trials, initial research was carried out to determine plot size and likely variability of carbon per hectare between plots (suggested as a co-efficient of variation for each of the populations). This research suggested that a plot area of around 0.04 hectares was the most efficient under New Zealand conditions.

In New Zealand's natural forest the data collection methodology applied at the plot level was developed from existing permanent plot measurement protocols. Two of New Zealand's major research organisations worked together to refine the methodology and build capacity for the level of activity required to carry out the inventory work to a high standard. Considerable efforts were made in the early stages to ensure the data collected were suitable for carbon stock calculations and that the large number of staff required to carry out the work were trained to a high standard. The field manual was trailed over the first two field seasons and then finalised for the remaining four field seasons of the establishment phase of the inventory. New Zealand's natural forests

occupy a third of its land area (8.1M ha) and the plot network takes five years to carry out one full measurement cycle. Quality assurance work carried out in the early stages of the project ensured the methodology was being applied consistently amongst the field teams.

(vi) Remote sensing data are a valuable tool to determine forest area (or more specifically woody land use classes), and in conjunction with other data can detect land-use change, and assign land-use classification. It is possible to determine forest area and detect land-use change via ground-based sample plots, but the number of plots required could be cost prohibitive (as a large number of plots are necessary to achieve acceptable detection probability and sampling error) and such an approach is also vulnerable to fraud (as plots may be treated differently).

New Zealand uses as many sources of data as possible to assist in the process of classifying land use and confirming land-use change. Aerial photos are extremely valuable as are ground-based survey and plot data. Remote sensing on its own cannot confirm whether destocked areas are harvested before a land-use change event or are harvested areas that remain in forest land use and will be replanted. New Zealand therefore uses aerial photos to enable deforestation to be confirmed.

(vii) A combination of remote sensing and ground-based sample plots is recommended for an effective NFMS. This strategy offers the advantage of potentially improving the precision of data from each source.

General comment

New Zealand notes that guidance provided to Parties under Decision 4/CP.15 includes the 'use of 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'.

New Zealand notes that the relative importance ascribed to remote sensing and ground-based sample plots should be determined initially by the respective capabilities and national circumstances of developing country Parties, and recognise forest characteristics, land-use, and existing expertise and systems.

New Zealand experience

New Zealand has implemented a system for both planted production and natural forests that utilises a combination of remote sensing and permanent sample plots.

In New Zealand, remote sensing is used to supplement ground-based sample plots to improve the estimate of carbon stocks and reduce the level of uncertainty about this estimate (or equivalently, reduce the cost from that which would be incurred from using only ground plots – with an equivalent level of uncertainty). In New Zealand's experience there is also no substitute for on-the-ground field verification to ensure an effective NFMS.

New Zealand also uses airborne LiDAR (Light Detection and Ranging) in a double sampling scheme for New Zealand's post-1989 production forests (see text at the bottom of this section for additional information on the use of LiDAR in New Zealand). Research demonstrated that regression models using LiDAR metrics could predict both total and above-ground carbon stock with a high degree of certainty – R^2 in the order of 70 – 80%.

Use of LiDAR

Based on the use of LiDAR for post-1989 forest, it was clear that a more formal, innovative double sampling design using LiDAR would improve sampling efficiency for the next survey - that of the pre-1990 exotic forests. It was considered that this could be achieved by strip-flying across forests containing ground plots on an 8-km systematic grid, augmented by a high ratio of additional LiDAR plots on an embedded 8-km by 1-km grid. Although it was necessary to fly the length of the country (over 1600km), it was expected that the cost of the LiDAR plus ground plots would be reduced from that which would be incurred using ground plots alone, to achieve the same precision.

In the pre-1990 inventory, four times as many LiDAR plots were flown compared to 190 permanent plots measured on the ground. This enabled the uncertainty on the estimated total forest carbon (expressed a confidence interval at the 95% probability) to be reduced from ±14% without LiDAR to ±11% for the combined LiDAR and ground.

This is the first example of the use of LiDAR at a national scale to estimate biomass and carbon stocks and parallels the development of LiDAR sampling for standing stem volume at the county level in Norway.

New Zealand notes that LiDAR may be useful for developing countries developing NFMS. However, both the direct cost of LiDAR and access to the technology and expertise may limit its application, especially in the short term. The relative lower cost of undertaking field inventories in developing countries is also a factor to consider.

(viii) A substantial, long-term investment is necessary for an effective NFMS. Data processing and analysis comprise a significant component of the necessary investment, and training and capacity building of field teams needs to be factored in.

A long-term commitment also ensures that the system is sustainable. For example, the annual re-measurement of a proportion of ground-based sample plots is not only more practical, but helps ensure that expertise is retained. Similarly, it is important that funding for mapping be constant, so that maps of consistent (or improving) quality can be compared.

General comments

New Zealand notes the findings of a UNFCCC technical paper on NFMS (FCCC/TP/2009/1). It states at paragraph 23 that ‘although some remote sensing datasets are available ‘free of charge’, there are additional resources required to get the data ready for the interpretation and analysis of forest area change’. New Zealand notes the additional resources required can amount to a significant cost impost (including costs for specialist software, on-going licensing fees, and computer hardware).

A further cost associated with the use of remote sensing data is that trained professionals (preferably locally-based staff) are necessary to effectively use the data. Generally, to be proficient in satellite image analysis a university diploma or degree is required. In many countries only a small number of analysts are formally qualified in this area. A further complication is the ability of government departments to retain skilled staff.

New Zealand is aware of work underway internationally to address the need for pre-processed satellite data for developing country Parties. This work is important and should be encouraged.

New Zealand experience

A critical component of the LUCAS programme involved building and acquiring the necessary IT infrastructure, analytical tools and expertise. This was a major undertaking for New Zealand and required a significant amount of time, effort and investment.

In addition, considerable efforts were made in the early stages to build capacity for the level of activity required and to ensure that the large number of staff required to carry out plot establishment work were trained to a high standard.

(ix) Information sharing amongst Government agencies and other entities should be encouraged, and existing data, where suitable, should be used to enhance knowledge of the area in forest.

The accuracy of wall-to-wall mapping depends on the ability to distinguish land use classes. In New Zealand the release of GIS layers to other government departments provided much needed information, and acted as an important verification check. The Ministry of Agriculture and Forestry's incorporation of the land use maps with their own GIS system enabled regional officers to identify and correct mistakes in classification or delineation of boundaries. A co-benefit was improved information for regional planning. Partnering with the forest industry in New Zealand has similarly provided benefits for both the inventory system and the industry.

(x) Significant effort is required to accurately prepare forest maps for an historical base year, with a lack of existing data of sufficient precision the primary factor.

This is likely to be even more of an issue for REDD+ countries. Consideration should be given as to what is an appropriate base year, or time period necessary for historical data.

(xi) The development of a NFMS should be seen as a process. The goal should be continuous improvement. Advice from external sources is vital for improvement.

New Zealand uses the reporting and annual expert review process to refine and improve the system and quality of data for reporting. Reviewers' recommendations are prioritised for investigation and implementation above other possible improvements that could be worked on.