Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

Deutsches Zentrum für Luft- und Raumfahrt

Organized by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

BMZ-DLR International Conference on MRV of REDD

with a special focus on the use of satellite data for measuring forest degradation

21st - 22nd September 2015

Stadthalle Bad Godesberg, Bonn, Germany

Conference Report

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ABBREVIATIONS AND ACRONYMS

BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
CBD	Convention on Biological Diversity
CCBT	The Climate, Community and Biodiversity standards
CCBA	Climate, Community & Biodiversity Alliance
CCBT	The Climate, Community and Biodiversity standards
CDM	Clean Development Mechanism
CEOS	Committee on Earth Observation Satellites
COP	Conference of Parties
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center)
ESS	Environmental and Social Safeguarding
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FPIC	Free, Prior Informed Consent
GHG	Greenhouse Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
FREL	Forest Reference Emission Level
GOFC GOLD	Global Observation of Forest and Land Cover Dynamics
HR	Human Resources
ILUA	Integrated Land Use Assessment (FAO Programme)
IPCC	Intergovernmental Panel on Climate Change
LiDAR	Light Detection and Ranging
LULUCF	Land Use, Land-Use Change and Forestry
MRV	Measurement, Reporting and Verification
NGO	Non-governmental Organization
NFI	Nation Forest Inventory
NFMS	National Forest Monitoring System
NNL	No Net Loss
NSDI	National Spatial Data Infrastructure
RADAR	Radio Detection and Ranging
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emission from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries (+)
REL	Reference Emission Level
R&D	Research and Development

RL	Reference Level
RS	Remote Sensing
SBSTA	Subsidiary Body for Scientific and Technological Advice
SFM	Sustainable Forest Management
ToR	Terms of Reference
UN	United Nations
UNDP	United Nations Development Programme
UNDP-GEF	United Nations Development Programme – Global Environment Facility
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
VCS	Voluntary Carbon Standard
WWF	World Wide Fund for Nature

EXCECUTIVE SUMMARY

The German Federal Ministry of Economic Cooperation and Development (BMZ) together with the German Aerospace Center (DLR) invited participants to an International Conference on MRV of REDD with a special focus on the use of satellite data for measuring forest degradation. The event, which took place from 21st to 22nd of September 2015 in Bonn, Bad Godesberg, Germany, attracted 80 participants and presenters from international institutions including FAO and UNFCCC, national REDD+ related offices from Indonesia, Brazil, Mexico and Zambia, further representatives from 16 countries (11 developing and emerging countries), as well as representatives from the Global Forest Observation Initiative (GFOI) and space agencies participating in GFOI. The conference was organized and moderated by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

In their welcoming and opening remarks the inviting organisations explained their role in developing the forestry sector, respectively the acquisition of forest related information, especially in relation to REDD+. They emphasized their commitment to further support of the forest sector and the monitoring of forest changes.

The presentations from the countries show that operation cost of systems and methods for monitoring LULUCF vary greatly – mainly depending on the level of detail of the analysis (forest – non-forest vs. different land use classes), the required precision of the estimates and the necessary quality of the data used. Methods range from manual interpretation to fully automated systems but usually are hybrid solutions to find the best balance between cost efficiency and acceptable uncertainty. Free and publicly available data sets like GOOGLE Earth, Bing Maps or the “Hansen Map” can be valuable inputs as reference data to check the precision of the estimates, toolkits like FAO’s Open Foris facilitate the application. Consequently, developing countries try to fit applications and adaptations of methods to their country needs and their country capacities. On one end of the scale countries without functioning systems in place and limited capacities can still generate valuable results using those data sets and tools, but with high uncertainties, whereas on the other end of the scale a comprehensive and semi-automated system like the Mexican MAD-Mex does allow the processing of wall-to wall high resolution optical satellite data to generate detailed land cover change maps and statistics annually. However, systems like MAD-Mex do require well trained staff and a certain consistency and continuity in institutions mandated with the production of the AD data. Operating costs of most systems, like MAD-Mex, the Brazilian PRODERS or University of Maryland’s vegetation density product increase proportionate to the accuracy and resolution demanded by producers and users of AD data. Sampling approaches for the production of wall-to-wall products are unnecessary, considering the very low production cost of automated wall-to-wall products, but they are a very viable option for the quality control and/or visual based editing of automated products, as showcased by the processes implemented in Mexico or Brazil.

Cost efficiency of an organization's production and use of any of its map products can be improved through multi-use of the data and results. Brazil and Indonesia have reported on producing increased details from forest monitoring over time as a result of on-going upgrading of overall national capacities in satellite image interpretation.

Monitoring degradation, i.e. here observing changes in the carbon content of forest areas can not be resolved by remote sensing data alone, it requires the intelligent processing and analysis of remote sensing products and in situ data of varying sampling densities, for instances those of forest inventories or similar efforts. This increases costs for data procurement and higher technical capacities to process the data, the systems design has to be carefully balanced between ambition and realistic objectives, a viable and relevant definition of degradation helps to reduce data gathering cost and increases relevance of the processed information.

The following group work discussions focussed on causes for degradation and their impact on monitoring systems, perspectives on operational and cost-efficient concepts and methods in practice and specific needs, gaps and challenges for data and capacity building.

In all working groups the need for definitions and standards of forest degradation were discussed. All agreed that definitions for forest degradation may be needed for results based payments, but also, that standards for required accuracy and precision will be needed to allow participation in such result based payments.

On the side of the remote sensing data, there was the general notion, that more consistent and coherent remote sensing data and methods, if freely and easily available, would have a great potential to improve forest monitoring. While it has been made clear, that there is no one-size-fits-all, the need for easy access to "analysis-ready" pre-processed data and the availability of more robust, accuracy assessment methods (i.e. data and uncertainty management systems, toolboxes) has clearly been voiced. Along with established methods using optical data, great potential is also seen in time series analysis and possibly radar data. What the appropriate spatial and temporal resolution would be to capture the degradation processes, remained open, but it was suggested, that better data and methods than possible from Landsat and sampling approaches alone are needed. The development of an indicator system, however, was mentioned to be helpful. Especially for low capacity countries, a set of accepted products and methods with respect to carbon would be helpful.

The fact that not all types of logging and tree harvesting lead to forest degradation has been identified as a challenge in monitoring forest degradation. The assembled experts were convinced that measuring and monitoring of forest degradation is laborious, difficult and expensive. All expressed concerns that too high standards for reporting and monitoring might become prohibitive for developing countries due to a perceived or even real lack of institutional, human and financial resources.

Another concern of participants, based on experience from working with other conventions was the need to avoid contradictions with other definitions that may evolve and change under those other conventions or International Forums (e.g. “sustainable management of forest” instead of SFM to avoid UNFF definition overlap, or “enhanced forest carbon stocks” to avoid overlap with CDM). Other attendees insisted, that consistency needs to be ensured in definitions across countries, also over time. Finally, all participants agreed, that no matter how daunting the task, monitoring of forest degradation is important - not only to garner for financial support for national forest management but to recognize and appropriately counteract drivers of degradation.

The working group (WG1) on causes of forest degradation agreed that present methodologies, as well as local capacities, have to be upgraded to deal with the challenges of forest degradation monitoring. Control of degradation of forests, though in many cases the emissions per area unit may be small, plays a major role in reducing CO_2 emissions from forest, because the total area of forest exposed to degradation is large. Appropriate methodologies for forest degradation monitoring will have to be a combination of ground survey and remote sensing technologies.
The working group (WG2) on perspectives and cost efficient concepts recognised that not only capacity building but institution building in developing countries will be required to ensure longevity of operational monitoring systems. Comparability of data over regions and time and the financial viability of the system are considered crucial by the group.

The working group (WG3) on specific needs and gaps for data discussed the set-up of national forest inventories as one of the important systems to deliver data. Criteria and indicators for monitoring forest degradation need to include also indicators to identify and describe the loss of site productivity. Fields for capacity building have been identified and it is has been emphasized that trainings and lectures need to include the younger generation of a country’s foresters.

1. INTRODUCTION

On September 21st to September 22nd 2015 the German Federal Ministry of Economic Cooperation and Development (BMZ) together with the German Aerospace Center (DLR) invited participants to an international conference on MRV of REDD with a special focus on the use of satellite data for measuring forest degradation. The conference was organised by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH at the Stadthalle Bad Godesberg, Bonn, Germany.

The rationale for the workshop was based on the fact that the "Framework for REDD+"1[1] – which was adopted at the UNFCCC climate conference (COP19) in Warsaw in November 2013 – also contains a decision on MRV (measuring, reporting, and verification), wherein, "Parties are encouraged to improve the data and methodologies (…)".

Similarly, reducing emissions from forest degradation is contained in a UNFCCC COP16 decision on REDD in Cancun in 2010 – one of five eligible activities of REDD+.

Forest degradation can be seen as an outcome that results in no change to forest area as such, but as a change to quality of the forests' condition[2]. Given the many different ways to approximate forest degradation levels, and the strong dependence of forest type on approximating such degradation, there is a clear need to focus on measures of degradation and ways to assess their uncertainty.

Even though forest degradation is seen as "one of the major sources of greenhouse gas (GHG) emissions"[3], there is a tremendous lack of information and understanding regarding its significance and quantification on a global scale and at national level, also in the context of "result-based financing". On the whole, this shows the urgent need for suitable operational data and monitoring methods that are scientifically sound, applicable in practise, and cost-efficient, to report on forest degradation on large scales within the scope of REDD+.

The conference was conducted back to back with a meeting of the CEOS Space Data Coordination Group in support of the Global Forest Observation Initiative (GFOI). GFOI supports the sustained availability and utilisation of observations for national MRV systems consistent with IPCC guidance and UNFCCC requirements for REDD+ reporting. CEOS is the Committee on Earth Observing Satellites and brings together international space agencies to collaborate on missions, data systems, and global initiatives that

[1] http://unfccc.int/land_use_and_climate_change/redd/items/8180.php; decision 14/CP.19 as part of FCCC/CP/2013/10, paragraph 44

[2] Lanly, Deforestation and forest degradation factors. Congress Proceedings B, XII World Forestry Congress, pp. 75-83. Quebec City, 2003

[3] Simula and Mansur, Measuring Forest Degradation, Unasylva No. 238, Vol. 62, 2011/2, FAO, Rome, 2011

benefit society. CEOS co-leads the GFOI together with Norway, Australia, the USA and the FAO.

The objectives of the conference were

- to deliver an overview of existing implementations of REDD+ MRV systems
- to provide an overview of available experiences and concepts of national MRVs with a special focus on approximating forest degradation
- to discuss definitions of forest degradation with a particular focus on ecosystem services, impact of degradation on emissions and ways to report on forest degradation
- to discuss the examples provided and the levels of certainty which can be achieved using current best practises with the aim to identify knowledge gaps and options to close those gaps
- to display and discuss cost-efficiency of current system and multi-level applications (basic cartography, infrastructure, agricultural monitoring etc.)
- to discuss the specific needs for data and capacity building
- to foster the exchange with the Global Forest Observation Initiative (GFOI)

2. DETAILS OF THE WORK GROUP DISCUSSIONS

To discuss and elaborate on the subjects listed immediately below – the conference participants were divided into working groups – based on their experience in various countries in the set-up of forest monitoring systems using remote sensing technology – as well as on field assessment methods to do either wall to wall or sample assessments of changes in forest coverage and forest status to support MRV:

- Causes of forest degradation and their impact on the direct and indirect monitoring and measurement methods
- Perspectives on operational and cost-efficient concepts and methods in practice – especially for countries with low capacities
- Specific needs, gaps and challenges for data and capacity building

Guiding questions for the discussions were:

- Is it realistic to define a standard minimum accuracy for degradation monitoring using remote sensing? and, What would be the preconditions to achieve that, in terms of data, methods, etc.?
- Which variables that are relevant for quantification of degradation can be observed/modelled from remote sensing? (Which sensor specifications are required?) and, What other sources of information are necessary?

The Groups identified issues related to their topic and outlined ways to deal with those issues. They also identified areas of cooperation and activities for the agencies related to climate change control – and for donor agencies and providers of supporting methods and data used in MRV.

2.1 Questions and issues cross cutting all work groups

The question of need for definitions and standards of forest degradation were discussed in all work groups and during Q&A sessions of many presentations.

A particular point raised and highlighted was, that definitions for forest degradation may not be urgently needed for result based payments – but definitions of required accuracy will be needed for countries to participate in result based payments.

When definitions are developed they need to avoid overlap with other definitions that may evolve and change under other Conventions or International Forums (e.g. "sustainable management of forest" instead of SFM to avoid UNFF definition overlap, or "enhanced forest carbon stocks" to avoid overlap with CDM). The participants were also clear on the point that measuring and monitoring of forest degradation is laborious, difficult and expensive. Consistency in definitions over countries – but also over time – is needed to ensure the option of comparison and elaboration of time lines. When developing countries have to meet high requirements, they may tend to not monitor and report at all, to avoid the high cost and the risk of not recovering the expenses from any climate finance scheme.

2.2 WG I: Causes for degradation & impact on monitoring methods

Working Group I – with the topic "causes for forest degradation and their impact on the direct and indirect monitoring and measurement methods" – was moderated by Kay Kallweit, Advisor, REDD Early Movers Programme, GIZ.

This group identified causes for forest degradation to vary and to depend on local conditions and drivers – from mining in Laos to shifting cultivation and re-settlement in Brazil. Activities leading to forest degradation listed all kinds of timber harvesting – but also animal husbandry and shifting cultivation. But when assessing forest degradation it has to be considered that not all timber extractions can be considered as forest degradation. Sustainable forest management activities are not degrading the forest. Other details on this topic had been worked out during a workshop in Wageningen (see: http://www.gfoi.org/rd/second-rd-workshop/).

The challenges for monitoring thus require adaptation to prevailing circumstances. All agreed that present knowledge and methods need enhancement to cope with these challenges. It is important to monitor forest degradation, though the emissions on a per hectare basis are significantly smaller in degradation compared to deforestation. However, considering the large area of "forests remaining as forests" still makes this an important factor in CO_2 emission from forestry.

On the topic of system requirements, the group acknowledged the need for both, ground-based survey and RS based methods. The focus of R&D in the near future – while still needing to consider adapting to local circumstances, needs and financial resources – should be on methods consisting of a combination of remote classification and mapping of degradation stages – with on the ground measurements to estimate biomass and carbon stocks.

The methods and the input needed – as well as a country's interest in monitoring forest degradation – vary with the different drivers and causes of forest degradation. Examples from different countries were highlighted – and included:

- Laos – major causes assumed to be shifting cultivation and mining. Interest of Gov. to reduce impact of causes of degradation. Methods for monitoring are remote sensing and ground verification based.
- DRC – methods developed are based on community participation. Difficulties are related to the combination of RS techniques and participatory field assessment. There is no practical experience yet.
- Indonesia – monitoring to understand the process of forest degradation and deforestation. Support to forest governance with monitoring results. Difficulties in elevating local monitoring observations to national level.
- Brazil – monitoring of deforestation and forest degradation prior to REDD+ related to control of resettlement program and taxation. Public availability of results and maps increased pressure on politicians and lead to establishment of large protected areas. Now these monitoring systems can be used for the REDD+ monitoring obligations.

Methods and systems for monitoring forest degradation need to be <u>adapted to local circumstances</u>, there is no single systems that fits all conditions.

Examples from Brazil and Indonesia – on the identification of layers as an indicator to classify degradation – show the direction for development of methods and also their limitations. When, for instance, the highly sophisticated but very expensive LIDAR technology could be used only on limited areas, intelligent use of this technology would be required to expand findings from selected spots to larger areas.

The group suggested a <u>stepwise development</u> of a monitoring system starting with a few basic variables and further integration of other variables to monitor other requirements (e.g. CBD, Degradation, etc.). Systems have to rely on appropriate spatial and temporal scales (e.g. canopy cover closure times, phenology effects, etc.). Systems should use a combination of remote sensing and ground assessment methods – while sustainability with regards to cost has to be observed in consideration of each country's own circumstances.

Finally the question of the <u>importance of monitoring forest degradation</u> was discussed. On the one hand, it is critical to understanding the processes involved – because forest degradation happens in steps that themselves are a major step towards deforestation. On the other hand, it is also necessary to identify the <u>drivers of degradation</u> – which differ from country to country – but must be understood to support political decision making, which relies on clear explanation of processes and transparent monitoring results to take action (see example Brazil).

2.3 WG II: Perspectives for operational & cost efficient concepts

The Working Group II with the topic "perspectives for operational and cost-efficient concepts and methods in practice, especially for countries with low capacities" was moderated by Dr. Thomas Baldauf, German Federal Ministry of Food and Agriculture (BMEL).

The work group identified the need to build on country circumstances and enhance existing infrastructure and basic capacities through capacity building, appropriate mandating the involved institutions. First steps here should be analysing existing institutional set-up and capacity as well as existing institutional responsibilities and mandates.

Sustainable availability of data for improved forest degradation monitoring systems can be ensured when data and information used for monitoring are affordable for developing countries. To reduce cost for monitoring, system development needs to consider the use – but also the acceptance – of global products

Acceptance and use of global products is related to country specific concerns on data security and national security issues in publication of maps. Countries sovereignty anxieties have to be overcome, when proposing the use of global products.

Maximizing the user of locally available data, such as national and regional forest inventories, and such as the results of other local land and forest mapping procedures, would contribute to reducing cost. Also the multiuse of map products will increase acceptance and reduce overall cost of national monitoring (one map concept) activities.

Capacity building thus has to consider improving of national spatial data infrastructure (NSDI) to facilitate forest monitoring and to increase intra-ministerial exchange of data and multi-use of data and map products. Economic feasibility of involvement in REDD+ financing schemes – and related monitoring – need to be considered when demanding the establishment of forest monitoring systems. Due to high investment costs, internal rates of return may not be adequate for countries to invest more in climate change financing scheme.

Development of toolboxes and options for pre-processed data use, use of new sensors and combining of sensors, and improved data management approaches are the major fields for R&D when aiming at establishing sustainable systems for forest degradation monitoring. Since dense time lines of observations are needed the use of "data cube" arrays was suggested by participants.

The group saw limitations for system functions in developing countries because monitoring systems will require huge volumes of data, which may not be easily accessible because of low internet speeds. Sophisticated data management and data storage systems, based on cloud systems may raise concerns of national security agencies on data security and sustainable availability.

New or enhanced methodologies need to be consistent with IPCC guidelines and have to ensure comparability over time and areas. Special attention has to be paid to accuracy of information, where participants suggested defining error estimation procedures. Crucial here again is also the need for capacity development in developing countries. Suitability of systems goes together with economic feasibility, especially when high data volumes require costly acquisition and data management systems.

One option to improve economic feasibility of systems is to ensure multiple use of data and related outputs. This group also emphasized the need for a phased development of systems with different levels of input and effort to allow production of basic observations and results and with increasing capacities of monitoring institutions (e.g. automating processes, increasing of field observations, etc.) to provide more details on forest degradation.

2.4 WG III: Specific needs, gaps for data and capacity building

Working Group III with the topic “specific needs, gaps and challenges for data and capacity building” was moderated by Prof. Dr. Christoph Kleinn, Chair of Forest Inventory and Remote Sensing, University of Göttingen, Germany).

This group discussed the need to develop a set of criteria and indicators for forest degradation and pointed out that these need not only cover loss of carbon stocks but also loss of site productivity, as regrowth and regeneration determine the potential for carbon sequestration. A ”best” solution might be to define a set of criteria and indicators for monitoring of forest degradation and leave it to individual countries to decide on a definition of forest degradation and standards for monitoring these. The indicators should not only focus on changes of carbon stocks but include changes in productivity and provision of all types of services from forests.

Indicators for biodiversity and productivity need to be identified for each country, as they may be different for different eco-regions. Example indicators from the Mexico Monitoring System are:

- Functional (pollinator and epiphyte presence, seed dispersal etc.),
- Structural (LAI, number of forest layers/stories, undergrowth presence, canopy closure, etc.) and
- Compositional (species richness etc.)

The set-up of monitoring systems on national level is to be closely related to already existing basic systems, such as National Forest Inventories. Thus the design of NFIs can have a crucial influence on the options for forest degradation monitoring.

The point of departure to establishing a forest monitoring system varies greatly from country to country. Setting up a monitoring system on the basis of NFIs will in many countries need external support. An initial step in the design of an NFI is the definition of information content and the intended use of data and related outputs. Other information that could be collected to allow multi-use of the NFI data will determine the overall extent of the NFI data collection.

Monitoring systems should go beyond just assessment of carbon stock and changes of carbon stocks. Ultimately, the minimum requirements on accuracy of results have to be clear before the technical design is elaborated. Policies on the rate of repeat measurement are difficult to formulate – as monitoring costs increase with short repetition rates- while uncertainties of observations increase with the length of the period between measurements. Local observations on logging impacts might be feasible, elevating the observations to a national level observations will be difficult.

This group also identified capacity building as a crucial factor for successful degradation monitoring – with the fields requiring special consideration including; methodology and techniques for assessment, data management, uncertainty management, and institutionalizing forest inventory and monitoring systems. Capacity building measures also need to ensure to include the young generation of foresters in the trainings and education on monitoring.

Finally the group was clear on the fact that global leakage monitoring would be ideal, but unrealistic. Thus a national approach should be implemented

3. DETAILS OF THE PRESENTATIONS AT THE CONFERENCE

3.1 Welcome Notes

3.1.1 Dr. Tania Rödiger-Vorwerk – Deputy Director General, Directorate 31, BMZ

Dr. Tania Rödiger-Vorwerk from BMZ welcomed the participants and outlined the interest and the early activities of BMZ in support of forest monitoring and REDD+. She explained that Germany provides support to the forestry and biodiversity sector in the range of EURO 500 million annually and that the same amount of support is planned for coming years. Dr. Rödiger-Vorwerk recognised the forest resources as crucial for economic development, for climate and biodiversity protection and deforestation and degradation as an important source of greenhouse gas emissions. She further explained that REDD+, forest landscape restoration (FLR) and “deforestation-free supply chains” for forest products are the main pillars of the BMZ strategy in the forest sector.

Details from the Presentation:
As the Forest Sector is crucial for economic development, climate and biodiversity protection, the BMZ declared its support to this sector already at an early stage;

- From 2013 onwards, the German government provided EURO 500 million per year for forestry and biodiversity, and will provide at least the same amount in the next years
- REDD+, with its related reduction of deforestation and reduction of forest degradation, next to forest landscape restoration (FLR) and "deforestation-free supply chains for forest products" are the main pillars of the BMZ strategy in the forest sector.
- Since deforestation and degradation are an important source of greenhouse gas emissions (GHG) – and since there is relatively high uncertainty regarding the magnitude of forest degradation due to problems in quantifying its impact – monitoring forest degradation is demanding and requires a methodological mix of remote sensing and ground inventory data
- This conference therefore discusses:
    - Levels of uncertainty and its consequences,
    - Cost-efficiency of current systems and multi-level applications,
    - Specific needs for data and capacity building.
    - Definitions of forest degradation with a particular focus on ecosystem services,
    - Impact of degradation on emissions and ways to report on forest degradation.
    - Identification of knowledge gaps and options to close those gaps
- This conference does not expect to find quick solutions for knowledge gaps or for all of the challenges associated with MRV of REDD+ – but it will make a start on it.

3.1.2 Dr. Rolf Densing – Program Director, DLR

Dr. Rolf Densing of the DLR gave an introduction to the importance of modern space technology for earth observations, including the monitoring of vegetation and its changes in coverage and density. He named the Copernicus programme as part of the global earth observation system made available by the European space partnership and ensured the participants that Europe's latest contribution to improved earth observation with the new launch of satellites Sentinel-1 and Sentinel-2 are expected to play a major role in forest monitoring. Dr. Densing said that cooperation amongst the different organisation is necessary to provide needed and comparable data and that DLR is committed to improve synergies between DLR and BMZ for improved cooperation development.

Details from the Presentation:

- Space technology has provided, with satellite data, the now widely used and most mature instruments for forest monitoring
- DLR is interested in learning more about existing challenges and is looking forward to the discussions and contributions from the various participating countries
- DLRs contributions to REDD+ are the development of earth observation satellite missions and the scientific exploitation of the data namely the German TerraSAR-X, TanDEM-X and RapidEye data, as well as the European Copernicus programmes.

- Europe's, and within that Germany's, latest contribution to improved earth observation is with the new launch of satellites Sentinel-1 and Sentinel-2 , which are expected to play a major role in forest monitoring
- Cooperation amongst the different organisation is necessary to provide needed data for forest monitoring and to make these data comparable
- DLR is committed to improve synergies between DLR and BMZ for improved cooperation development.

3.2 Setting the Scene for MRV requirements

3.2.1 Dirk Nemitz / UNFCCC – MRV in the Warsaw Framework for REDD+

The framework for REDD+ monitoring of forest changes and forest degradation was set by Dirk Nemitz from the UNFCCC Secretariat. He outlined the latest decisions of UNFCCC in relation to REDD+ from the Conference of Parties (COP 19) at Warsaw. The COP 19 decisions 9 to 15 set the result-based payments for REDD+ in regard to the obligations for setting up national forest monitoring systems as a basis for periodic reporting, preparation of forest reference levels and addressing the drivers of deforestation and forest degradation.

In follow up to the decisions the UNFCCC has established a REDD+ Web Platform, where countries are encouraged to present their REDD+-related activities and results (http://unfccc.int/land_use_and_climate_change/redd_web_platform/items/4531.php). The next activities of the UNFCCC secretariat will be to fill this platform with more data, for example on RELs, where 5 new countries have submitted their REL and are presently undergoing technical assessment. Drafts of decision on non-market-based approaches, non-carbon benefits and safeguards have been prepared for next COP for adoption.

Details from the Presentation:

- The Road to Warsaw REDD+ decisions on MRV started in 2007 in the Decisions of the Conference of Parties (COP) 13 in Bali where parties agreed on the start of REDD
- Latest decisions on REDD+ are made at COP 19, where 7 decisions were adopted as the Warsaw Framework for REDD-plus
    - 9/CP.19 Work programme on results-based finance to progress the full implementation of the activities referred to in decision 1/CP.16, paragraph 70
    - 10/CP.19 Coordination of support for the implementation of activities in relation to mitigation actions in the forest sector by developing countries, including institutional arrangements
    - 11/CP.19 Modalities for national forest monitoring systems
    - 12/CP.19 The timing and frequency of presentations of the summary of information on how all the safeguards referred to in decision 1/CP.16, appendix I, are being addressed and respected

  - 13/CP.19 Guidelines and procedures for the technical assessment of submissions from Parties on proposed forest reference emission levels and/or forest reference levels
  - 14/CP.19 Modalities for measuring, reporting and verifying
  - 15/CP.19 Addressing the drivers of deforestation and forest degradation
- As eligible activities to contribute to mitigation actions in the forest sector decision 1/CP.16, known as the Cancun Agreements, lists in paragraph 70:
  - Reducing emissions from deforestation
  - Reducing emissions from forest degradation
  - Conservation of forest carbon stocks
  - Sustainable management of forests
  - Enhancement of forest carbon stocks
- The same agreement describes the start of REDD+ as an implementation in stages, with early implementation and full implementation phase
- Decision 9 of COP 19 introduces the result-based payments with adequate and predictable results-based finance in a fair and balanced manner, which an increased number of countries should be able to obtain and receive
- In order to be able to receive these payments the countries have to develop the following elements:
  - National strategy or action plan
  - National forest reference emission level and/or forest reference level
  - Robust and transparent national forest monitoring system
  - System for providing information on how the safeguards are being addressed and respected
- Decisions from COP 19 introduce the establishment of a REDD Web Platform where countries are encouraged to present their activities and their results on working on the drivers of deforestation and forest degradation (http://unfccc.int/land_use_and_climate_change/redd_web_platform/items/4531.php)
- The need for establishment and submission of RELs and RLs had already been addressed earlier in Decision 12/COP 17, where it is explained that RELs and RLs are expressed in tonnes CO2 equivalents per year, RLs could be developed stepwise and could also be updated with new methods. The submission is voluntary, the REL/RL will be validated following a technical assessment, the need for capacity building and technical support for developing countries regard REL/RL development is acknowledged
- Decision 4/COP15 and Decision 11/COP19 describe that as basis for reporting robust and transparent national forest monitoring system (NFMS) should be set-up, which are expected to use a combination of remote sensing and ground-based forest inventory approaches with results transparent, available and suitable for review
- The same Decision describe the need for reporting on safe guards and how they are being addressed and respected
- The same system is expected to be use to record and report on REDD+ activities implemented in the country

- The reporting frequency is fixed to the frequency of National Communications and Bi-Annual Updates or voluntarily on the UNFCC REDD Web Platform
- Outlook for Actions in 2015:
    - Negotiations: SBSTA 42 forwarded three draft decisions to COP 21 for adoption (on non-market-based approaches, non-carbon benefits and safeguards)
    - Standing Committee on Finance: The 3rd forum of the SCF with a focus on financing for forests took place from 8 to 9 September 2015 in Durban, South Africa
    - Technical assessment of reference levels: 5 countries are currently undergoing technical assessment, Deadline for inclusion in next technical assessment is 4 January 2016
    - Technical analysis of REDD+ results: First country is undergoing technical analysis
    - Further update of the REDD Web Platform and its filling with data.

3.2.2 Inge Jonckheere / FAO – MRV requirements in UN REDD

Inge Jonckheere from FAO reported on her organisations efforts to support 58 developing countries in design, implementation and operationalization their National Forest Monitoring System (NFMS). In these systems not only observation of deforestation should be included but also monitoring of forest degradation. Yet this part is still experimental and exhaustive experience is not available.

Most countries, except for a few, are struggling with technical and HR capacities. Thus the FAO support focus on the development of toolboxes, such as the OpenFORIS for free and easy use by partner countries and provision of training related to the use of these tools. For reduction of cost of MRV systems the multi-use of data and the use SEPAL Cloud computing structure are possible options.

Problems encountered in developing countries in application of the tools and operation of MRV systems are the low capacity of internet-connections and the selection of appropriate trainees to ensure capacity building measures reach the actual user of tools. Free satellite data and data products, such as the Hansen Map can help countries to reduce costs and improve their uncertainty if used as reference data for checking the precision of the estimates, i.e. the maps the country generates. Uncertainty and the respective reduction of uncertainties is also a key aspect for accessing potential climate financing.

Details from the Presentation:

- FAO is supporting (often in cooperation with European countries) 58 developing countries to design, implement and operationalize their National Forest Monitoring System (NFMS).
- The basic principle of calculation of carbon dioxide emissions is a simple multiplication of forest stocked area (activity data) and average carbon stock changes on an area unit (emission factors)

- The activity data are estimated from satellite imagery in combination with other information, such as land register, forest management plan, etc. where
  - high resolution imagery (e.g. RapidEye) required for forest degradation estimates and testing with active sensor data (Radar or LIDAR)
  - medium to lower resolution (e.g. LandSat) needed for deforestation estimations
- Basic systems applied are
  - Sample based assessment, which allows careful classification of vegetation types at the sample points, but may create larger errors for rare classes
  - Spatially exhaustive assessment results into also cross-sectoral useful maps, but may have a bias based error
- Degradation monitoring is experimental at the moment as there is no exhaustive experience available. At the same time most developing countries are fighting with capacity gaps, except for some Asian (China, India) and American (Mexico, Argentina) countries.
- Experience shows that countries are struggling with access to technology, basic facilities such as high speed internet and the high cost for data acquisition. The WB has provided a decision making tool for making informed decisions on the system set-up.
- FAO has long experience in supporting forest resource assessment in developing countries and is presently providing a suite of free downloadable open source tools for forest assessment – OpenFORIS; Problems using the system are related to internet speed and complex software maintenance.
- FAO is promoting and providing training to partner country institutions in using SEPAL Cloud computing structure, which allows easy and fast query, access and processing of earth observation data. In connection with the system FAO provides training and capacity building and promotes the multi-use of RS data. Results achieved are:
  - Development of methodologies for forest monitoring adapted to national context and documented in the OpenForis Wiki or national report
  - National estimate of forest cover and forest cover change
  - Independent national assessment of map accuracy
  - Knowledge exchange and network building
  - Autonomous and sustainable capacities to manage, process and analyse satellite data
- The availability of free satellite data and data products, such as the Hansen Map Product allows countries to produce country specific evaluations and results, yet the issue is the analysis for accuracy and uncertainties, which is required for accessing climate financing. There is a guiding article available on the journal "Remote Sensing of Environment": *Good practices for estimating area and assessing accuracy of land change*, by Pontus Oloffson, et al, 148 (2014) pages 42-57) – downloadable at "Science Direct".

- Experience from support in developing countries latest example Zambia, where using the tools and support of FAO helped to finalize the actual assessment of forest change and the development of REL show that:
    - A few dedicated individuals can make all the difference
    - Need to see capacity building in broader terms, to ensure the right persons receive the right training
    - Integration NFI and RS
    - On-the-job training is key; in-country training should be promoted
    - Sharing data and data access is crucial and key.

3.2.3 F. M. Seifert / ESA/GFOI – Global Forest Observation Initiative (GFOI) Overview

An overview on objectives and engagements of the Global Forest Observations Initiative (GFOI) was presented by Mr. Frank Martin Seifert.

Mr Seifert underlined the need for satellite based earth observation data for forest monitoring, where GFOI is taking a coordination role to ensure availability of annual, wall to wall, world-wide and long term data. The provision of medium resolution optical data is a goal, where LandSat and CBERS have set the scene, and soon the European Sentinel program will start with free provision of higher resolution data (10m) to support better earth observation with permanent recording along an orbit that ensures repeated observation of the same spot every 10 days. The launch of Sentinel II will reduce the repetition rate to 5 days and in combination with Landsat it will be possible to have an observation at a point every 3 days. GFOI is, similar to FAO, focussing on technical trainings to enhance forest monitoring capacities – but GFOI also supports R&D to amend technical problems by provision of data and knowhow to researchers following a country prioritisation.

Details from the Presentation:

- The Global Forest Observations Initiative (GFOI), which was founded by the Group on Earth Observations (94 governments, 77 international organisations) is led by Australia, Norway, USA, FAO and Committee on Earth Observation Satellites (CEOS).
- The objectives of GFOI are
    - To foster sustained availability and use of satellite image data for forest carbon stock change monitoring
    - Coordination of observations to ensure availability of annual, wall to wall, world-wide long term data – which has been achieved in the last two years for optical data. Radar data are available only for parts of the earth. Multiple data will be made available form next year onward.
    - Provision of training to developing country experts in the country to enhance in-country capacities
    - Research and Development (R&D) to amend practical problems are supported with provision of data and knowledge following a country prioritisation

- Support, methods and developments are in line with UNFCCC decisions and IPCC guidelines provided for forest carbon monitoring
- Support and development needs to be tailored to countries' individual situation to respect the already existing developments and knowledge. There is no one fits all solution
- Provision of medium resolution optical data is a goal, where LandSat and CBERS have set the scene and the European Copernicus programme has started with free provision of higher resolution data (10m) from its Sentinel satellites to support better earth observation with permanent recording along an orbit that ensures repeated observation of the same spot every 10 days. Next year's launch of the second Sentinel-2 will reduce the repetition rate to 5 days and in combination with Landsat it will be possible to have an observation at any point every 3 days.
- The GFOI is also looking to improving the availability of high resolution data and active sensor data.
- Another issue to deal with is the improvement of the regional download facilities for satellite data
- As GFOI's "Methods and Guidance Document" (MGD) a methodological support is following the UNFCCC requirements and the IPCC guidelines. Methods to be developed need to be easy to handle and understandable. A guide titled "*Integrating remote-sensing and ground-based observations for estimation of emissions and removals of greenhouse gases in forests*" under the lead author Dr Jim Penman (IPCC Lead Author) is now available in 3 major languages
- Further MDG is to be provided through the web application online application where users can work through the steps of developing an MRV system and search/gain access to guidance/case studies/examples relevant to their situation with various tools and modules.

3.3 Concepts and cost of measurement and monitoring of forest degradation

3.3.1 Prof. Dr. Martin Herold / University of Wageningen, Netherlands – Overview on forest degradation monitoring concepts and operational maturity – report from the GOFC-GOLD expert workshop

Prof. Dr. Martin Herold from the University of Wageningen informed participants about an expert workshop on MRV of REDD+ in Wageningen (http://www.gfoi.org/rd/second-rd-workshop/). Basic findings on issues in monitoring forest degradation from that workshop can be summarized as difficulties to distinguish degrading timber harvests form those that are not. Proper measurements of regrowth and the consideration of timelines add to the problems in measurement of emissions from forest degradation. These complications result in difficulties in defining "forest degradation", which lead to so far more than 50 definitions in the literature.

Despite these difficulties, the assessment of forest degradation is important, because even with lower emission compared to deforestation per area unit, the sheer extent of "forest remaining forest" and secondary effects of degradation result in significant carbon emissions worldwide.

Further to the above, the monitoring of forest degradation is important to observe and avoid displacement of emissions. National forest monitoring systems including degradation monitoring can be based on aggregated methods, which rely on remote sensing and ground-based assessments. Aggregated methods would be simpler and potentially more precise than disaggregated methods. Disaggregated methods are using tracking of specific degradation processes, which have to be separated for different degradation processes and have to follow political guidance to be described and distinguished.

Dr. Herold also reminded participants that guidance to select methods for mapping of forest degradation based on monitoring needs and national circumstances and the yet needed R&D for implementing the method is provided in the GOFC-GOLD Training Materials http://www.gofcgold.wur.nl/redd/Training_materials.php.

In the discussion at the end of his presentation participants remarked that monitoring of site degradation will have a high importance, as the degradation of the site conditions reduce the re-growth capacity which is fundamental for future carbon sequestration.

Details from the Presentation:

- Measuring carbon emissions from forest degradation is related to various difficulties in developing countries. First, it is related to harvest of wood, but not all harvest are degradation, second, most measurements do not consider regrowth properly, and third, distinction of forest degradation and deforestation includes some difficulties related to time lines
- Capacities of developing countries to do forest resources assessments have increased, mainly related to improved capacities in remote sensing
- Basic issues and arguments to consider when discussing measurement of forest degradation are:
  - Forest degradation (changes in forests remaining forests) leads to a decline in carbon stock
  - Emission levels per unit area are lower than for deforestation; cumulative and secondary effects can result in significant carbon emissions
  - Monitoring forest degradation is important also to avoid displacement of emissions from reduced deforestation
  - More severe degradation (area/intensity) usually results in more distinct indicators for efficient national monitoring
- Definition of forest degradation seems to be difficult; more than 50 definitions can be found in literature, which related degradation to loss of carbon in "forest remaining forest" in a way.
- Difficulties in definitions and measuring the indicators or other issues lead to reluctance in inclusion of degradation in RELs and reporting, such as

  - Processes leading to unsustainable use and persistent decline in carbon stocks in the tropics
  - Countries circumstances, such as degradation as a common precursor to deforestation in some; some countries may have degradation as a key emission source, some have degradation as a stable forest state (all degraded but no deforestation)

- Monitoring of degradation can be on short-term, but more important is the impact of forest degradation, which needs long-term observations for monitoring
- Development of national forest monitoring systems including degradation monitoring can be based on aggregated methods (using remote sensing and ground-based assessments; simpler and potentially more precise) and dis-aggregated methods (using methods that tracks specific degradation processes, they also need political guidance and should clearly define and disaggregate different processes)
- A guide to view and select methods for mapping of forest degradation based on monitoring needs and national circumstances and the still needed R&D for implementing the method are provided in the GOFC-GOLD Training Materials http://www.gofcgold.wur.nl/redd/Training_materials.php)
- Questions in the connected discussion were related to the need of monitoring of site degradation, as the possible growth rate and its effects are fundamental for carbon sequestration.

3.3.2 Dr. R.A. Surgardiman, B.A. Margono / Ministry Environment & Forestry / Indonesia – Monitoring deforestation and forest degradation on national and local level in Indonesia

Insights to present Indonesian efforts in monitoring forest degradation where provided by R.A. Surgardiman and B.A. Margono.

Mapping of deforestation and forest degradation in the NFMS of Indonesia is based on “Hansen Map” (http://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.2.html). This map is further improved through visual interpretation using LandSat data and LIDAR data for parts of the country to produce the activity data. The emission factors are assessed in an NFI which assesses sampling units of 9 sampling points distributed on a regular 20x20 km grid over the country. The results of these assessments were used to produce an REL in 2015, which covers an observation period from 1990 to 2012.

Observation of forest degradation using medium resolution LandSat data for the assessment of Indonesian rain forest were difficult due to problems in distinguishing forest types and degradation classes. Improvement of degradation observations were tested with the LIDAR system. The data can be used to identify the number of different layers in a forest and degradation identified on the assumption of less layers in degraded forests. Yet the use of the system on large areas is not feasible because of the high cost of data acquisition. Finally, a system of buffer zones around logging infrastructures was applied to estimate the degraded forest area, assuming that forest locations in vicinity of logging infrastructure are degraded and logging itself is a driver for forest degradation. The presenters gratefully mentioned the technical support Indonesia's forest sector is receiving from German Development Cooperation through GIZ in the framework of the FORCLIME Program with the objective of "Improved capacities for good local forest governance at FMU and DA level to achieve sustainable forest management, climate change mitigation (REDD+), biodiversity conservation and livelihood improvement".

Details from the Presentation:

- Indonesia has the third largest forest cover (approx. 100 M ha) but at the same time the country is the third largest emitter of GHG worldwide (approx. 2 GT CO_2) with over 67% from deforestation (e.g. palm oil plantations, mining, etc.)
- Drivers for deforestation are direct conversions into oil palm plantations, mining and infrastructure, and to some degree slash and burn practices, whilst degradation is a slow and subtle process driven by legal and illegal logging, fire and other unsustainable management activities
- Forest definitions in use are the legal definition, based on the FAO definition of forest and working definitions related to features recognizable on satellite imagery and land use classifications (7 forest classes)
- Mapping of deforestation and forest degradation based on "Hansen Map" (http://earthenginepartners.appspot.com/science-2013-global-forest/download_v1.2.html) using LandSat imagery with improvements using also LIDAR data for parts of the country to produce a REL in 2015. A time series was produced which serves as basis for the REL
- Mapping for forest monitoring is a cooperation of different ministries, peat lands by Ministry of Agriculture, forest by Ministry of Environment and Forestry – the maps are available online
- Indonesia has a national forest inventory (initiated in 1989) with the features: Systematic Stratified Sampling in a grid of 20 km x 20 km, Grid fixed in UTM, done for Forest state area, using seven (7) forest classes, where sampling units consist of 9 sampling points (100x100m per point), of which the centre point is a permanent sampling point
- The NFI is also part of the national forest monitoring system and 75% of the data used for FREL establishment (some data were considered not useful for FREL and rejected). Data do not include Mangrove areas
- Indonesia does tests with forest carbon mapping using LIDAR in the Framework of the MBZ/GIZ supported FORCLIME Project in 3 Regions of Kalimantan
- When mapping forest degradation using LandSat imagery it is difficult to distinguish degradation for other forest, thus a system of buffer zones around logging infrastructures was applied to estimate the degraded forest area, assuming that forest locations in vicinity of logging infrastructure are degraded and logging itself is a driver for forest degradation
- LIDAR is not feasible for large areas, thus sample areas were mapped. With LIDAR the structure of the forest can be identified through identification of presence of lay-

ers in the forest, where multi layers including very high trees represent un-degraded forest; Cost for LIDAR vary greatly depending on area covered, accessibility and of course mainly with the density of points per m²

- The REL development in Indonesia is completed to submit during COP 21
- Reference Period for REL is 1990-2012, covered are deforestation, forest degradation and peat decomposition, with a historic emissions (mean) calculation method
- The reference level for Indonesia is calculated with 58.0 MT CO_2e yr^{-1}
- GIZ is supporting Indonesia's forest sector through the FORCLIME Program with the objective of "Improved capacities for good local forest governance at FMU and DA level to achieve sustainable forest management, climate change mitigation (REDD+), biodiversity conservation and livelihood improvement".

3.3.3 Dr. M. Schmidt / National Commission for Biodiversity / Mexico – MAD-Mex in support of the national Mexican REDD+ MRV system

Dr. M. Schmidt from the National Commission for Biodiversity of Mexico explained the country's forest change monitoring system MAD-Mex to the participants.

The MAD-Mex system is based on automated segmentation and a classification procedure of optical satellite imagery. The system allows for classification of a high number of land use classes ideally on a time series of minimum 2 seasons. The results are a standardized map on land cover including accuracy statistics and land cover change objects labelled with into four different change types (regeneration, degradation, reforestation, deforestation) rendering high accuracy, high resolution (minimum mapping units of up to 0.25 ha) information on land cover changes. The system identifies 35 land occupation classes in Mexico, of which 16 are forest classes.

Assuming that forest degradation will affect structural diversity, functional diversity and taxonomic/compositional diversity of a given (forest) ecosystem – which can be identified by the system in a combination of in situ (NFI) and remotely sensed data, as such, may be used for the assessment of degradation – Dr. Schmidt is confident that the MAD-Mex system will be useful in the monitoring of forest degradation. Though the accuracy of particular area statistics among the 35 discerned classes may not be very high, the results of periodic monitoring will be very consistent and thus useful for management.

The operation cost of the system, including the national forest inventory with 36.000 sites, covering the bulk of the cost, and the purchase of high resolution satellite data – at about US$ 14 million – is substantial, however, as the data are shared among different departments, ministries and with the Mexican states in need of data that can be gained from satellite based earth observations, such as infrastructure, poverty and development indicators, settlement areas, etc, cost efficiency in data and information gathering is considered in Mexico very good. With the expectations of REDD+ payments on a national level to Mexico, the operation of the system is anticipated to result into a positive balance for Mexico.

For REDD+ reporting obligations the activity data gained from the MAD-Mex system are complemented with emission factor data from the national forest inventory using the interpretation of 36.000 points over the whole of Mexico which are re-measured in a 5-year cycle with over 140 parameters assessed at the each point.

Details from the Presentation:

- Mexico is using the interpretation of 36.000 points over the whole of Mexico for its National Forest Inventory, which are re-measured in a 5-year cycle with over 140 parameters assessed at the each point
- The second pillar of the national MRV is MAD-Mex, which produces national Activity Data. The system allows for the classification of a high number of land use classes in a time series in parallel based on national needs. Firstly, Landsat data at 1:100.000 is processed historically and currently between 1990 and 2020. For the period 2011 until 2020, additionally RapidEye, high-resolution imagery at wall-to-wall 1:20.000 is processed. MAD-Mex delivers an already high accuracy high resolution pre-product, which is then manually / visually refined and edited by experts of the national statistics office (INEGI) to be published within a year as an official Mexican government map and data table.
- Standard products of MAD-Mex are 2 land cover change (LCC) classifications at scales of 1:100 000 and 1:20 000, respectively and 2 land cover (LC) classifications at the same scales.
- The current legal definition of forest in Mexico (0.5ha minimum patch size) requires monitoring at scales greater than 1:50.000, hence the RapidEye approach rendering 1:20.000.
- The purpose of the MAD-Mex processing system is not limited to REDD+ MRV but also explicitly encompasses other uses such settlement area assessment, urban sprawl, infrastructure mapping, and population growth assessment.
- The system delivers 6-8 IPCC classes at very high accuracies (> 85% overall); for higher thematic resolutions of up to 35 classes, 16 of which are forest types, visual inspection and expert based editing is strongly recommended.
- The production chain of the national cartography for the MRV system, integrates automated techniques, i.e. MAD-Mex, with expert based systems and field based assessments on accuracy of the national map products. The latter does help to enhance the classification with the local knowledge of the situation on the ground by field staff and furthers the integration of the map products on state and municipality level by converting local actors into map producers.
- MAD-Mex national products are in a second step further integrated with additional in situ monitoring data, such as camera traps and microphones in the field to compute indicators on functional and structural diversity of ecosystems. The national indicator is computed using 18 different variables and is labelled “Ecosystem Integrity (EI)”. By definition that indicator is the inverse of degradation, the higher the integrity, the lower degradation. It is currently annually computed in Mexico at a scale

of 1:2,000,000 (1 km pixel size), beginning in 2004 and CONABIO is striving to increase resolution to 250 or even 100 m. EI is modelled based on various input variables, currently 18, and a classic accuracy assessment is therefore impossible, but the resulting map is verified and cross-checked by renowned Mexican experts and delivers credible and applicable information.

- IE or degradation is composed of 3 sub-indicators:
  - structural diversity,
  - functional diversity and
  - richness / composition
- IE will be employed on the federal level to assess the efficacy of, which amount to several 100 million USD in Mexico. Currently, Mexico has no means to assess impact of these payments and quantify their efficiency in obtaining the desired output (carbon increase, biodiversity maintenance, etc.). The cost of the particular branch of the NFI which deals and delivers degradation relevant data needs therefore to be seen in perspective of the ESS payment expenses and can be deemed negligible. Cost for operating the whole MRV, including NFI, MAD-Mex, AD, EF and Safeguard Monitoring) will amount to US$ 14 million annually
- The system is continuously improved and expanded – also to neighbouring countries, such as Peru and the Caribbean, where the system will be used for land use and forest monitoring.

3.3.4 G.H. Lui / Ministry of Environment, D.M. Valeriano INPE / Brazil – INPE - Brazilian development towards forest degradation national definition and MRV system

G.H. Lui from the Ministry of Environment and D.M. Valeriano from INPE of Brazil explained the progress in MRV in Brazil and provided a time-line of forest monitoring and its impacts on policy and forest management in their country. Similar to the indicators for forest degradation in Indonesia they also described a loss of understorey layers as degradation and further loss of canopy coverage as the next step towards deforestation. Over-logging is the step-stone to loss of forest, after which increased forest fires induced by slash-and burn farming are leading in stages to a loss of forest structure to finally a complete conversion into farmland.

Based on the principles of using in-house capacities and flexible use of sensors Brazil has set-up a series of forest observation schemes, each of them with its own objectives. The DETER is using MODIS data for early warning on deforestation, working with high repetition rates to monitor vegetation changes. PRODES is based on LandSat to identify annual deforestation areas to produce country official maps and statistics.

Two further mapping products are also in use; DEGRAD is to identify illegal and over-logging and DETEX is to identify early stages of forest degradation by identification of tree harvesting operations and forest fires. Altogether the systems connected through a policy of transparency and public availability (except for DETEX) of data and maps, which has forced the politics to react and to develop and apply strict controls on losses of forest area and stocks resulting in a reduction of the deforestation rate by about 80% in the last 10 years.

Brazil is receiving financial support from Germany and Norway since 2006 to monitor deforestation and forest degradation and is now looking forward to climate financing schemes from REDD+ to contribute to funds for forest monitoring. To ensure participation in those, Brazil has submitted a nation REL to the UNFCCC in 2014.

Details from the Presentation:

- Monitoring of forest degradation means monitoring the steps of degradation. In Brazil these 4 major steps are: i) logging, ii) over-logging and loss of understorey through fire started by slash and burn activities, iii) loss of canopy cover through “crown” fires again through intensified slash and burn, iv) loss of forest structure – conversion into farm land
- Technical requirements for sustainably working system are i) in house capabilities, ii) flexible use of satellite sensors
- Identification of first steps of forest degradation, when no larger scale canopy losses can be identified on satellite images, is based on the identification of logging infrastructure
- Using different colour compositions and dilation filtering structures, human activities which degrade the natural forest structure become more clearly visible and can be mapped out, though parameters to identify the “degree” of degradation still need to be determined
- DETER – using MODIS for early warning on deforestation, working with high repetition rates to observe vegetation changes
- PRODES – using LandSat to identify annual deforestation to produce country official maps and statistics
    - Classification of forest, non-forest including non-forest vegetation (annual re-measurement of change indicators for deforestation areas), water bodies
    - Images from PRODES are available on the internet and the transparency of the system creates political pressure to act on reducing deforestation, creating high level commitments which lead to sub-national government, private sector and civil society engagement, which in turn has led to reduction of deforestation rate in the last ten years by about 80%
    - Innovative financial instruments allow running the system since 2006 (financial support from Germany and Norway)
- DEGRAD – product to identify degradation of forest – series in operation since 2007, mainly to identify illegal logging – or legal logging which is not according to rules and plans; issue here is that legal logging itself is considered management and management of forest is not forest degradation
- DETEX – product to identify early stages of forest degradation, using the assessment of soil/vegetation ratios and the identification of burned area through dilation filtering (Sobel) and colour compositing to identify logging areas – series in operation since 2010

- For mapping and monitoring of forest degradation, methodologies are available, but definitions of degradation degrees are needed to estimate the emission from degradation
- Assessment of open vegetation types like Cerrado, Caatinga or Pampa require method development
- REDD+ strategy developed in Brazil which envisages, after approval the establishment of respective REDD+ related governance structures to allow the transition from the current model of REDD+ implementation to the new model (MRV of results, governance, payments for results, safeguards, south-south cooperation), the inclusion of Safeguard Information System and a Modular System for Monitoring Emission Reduction Actions (SMMARE) for the Amazon
- A national reference level has been submitted to UNFCCC in July 2014
- Guidelines for fund raising quotas to subnational levels and criteria to resource allocation will be needed
- A challenge in Brazil is the registration of forest land and land ownership to improve regular and sustainable management – problems are related to the immense size of land and number of land owners.

3.3.5 D. Mollicone / FAO - Rome/Italy – Collect Earth: an open source tool to assess LULUCF and forest trends

The “Collect Earth” tool in the OpenFORIS environment monitoring tool box of the FAO was presented by D. Mollicone.

The “Collect Earth” methodology is based on assessment of sampling units, which is used to produce statistical reports and not forest maps. To support the claim of the effectiveness of forest statistics from sampling, also for REDD+ related reporting, Mr. Mollicone presented various examples of statistical sampling based NFIs in developed countries, including most European countries and the US.

The tool has been designed for developing countries on the basis of open source software (Saiku) and the use of free available data (Google Earth, Bing maps, LandSat). The sample assessment is constructed around a grid overlay in Google Earth with a geo-link to multiple image repositories. A sampling unit of several points is located at each grid node and may be assessed not only to identify forest and non-forest, but for various observations and classifications of vegetation. Even time series of the same points are possible with the multi temporal image basis in Google Earth and Bing Maps. Observations are registered in the Saiku table system, which allows easy generation of statistical reports, charts and graphics on land use and forest area situation and changes, basically everything needed to report on activity data in REDD+. The system can be operated after a short training, which FAO is providing in-country to technical experts and thus allows the integration of local knowledge of vegetation and landscape in the assessment. More than 30 countries have been supported in 2014 and 2015 to use this Toolbox.

Details from the Presentation:

- Sampling assessment of LULUCF is wide spread in the UNFCC Annex 1 countries:
  - Example: Canada is using sampling method to assess Carbon Dioxide Emission from "forest remaining forest" with detailed statistics on drivers for emissions
  - All Annex 1 countries use sampling system for forest monitoring usually in a phased approach with the first phase use RS bases assessment and in a second phase doing a field assessment for selected sampling points (examples: Germany with 4x4 km grid based permanent sampling points, Italy with a 3 phased unaligned systematic sampling system, France with a 4 level systematic sampling and the USA with a multiphase unaligned systematic sampling, Czech Republic with a multiphase sampling, Switzerland with a two phase sampling system)
  - Only exceptions are Sweden and Australia which use wall to wall approach, which produce satellite imagery of the forest area, but not forest maps
- The tool designed for developing countries is based on the experience from developed countries and principles for sustainability of use of the system, such as open source software, based of public available data (Google and Bing satellite images), rely of existing open source software (e.g. Saiku), learning from what is working, clear strategy from measurements to submission to UNFCCC
- The tool also allows making use of local knowledge to the greatest extent, as the interpretation work is based on visual interpretation, the procedure is simple and can be done by local experts
- The Collect Earth Tool has several stages to finally produce land use change statistics
  - the overlay of satellite images in Google Earth with a sampling grid, with an assessment unit at each sampling grid node
  - geo-link with multiple image repositories (e.g. Bing Maps, or national image sets) to overlay with the same assessment unit for comparison and confirmation
  - multi-temporal assessment using the Google Earth temporal image repository
  - Integration of assessment results into Saiku built-in table system
  - Use of Saiku for generation of statistical reports, charts and graphics on land use and forest area situation and changes (Activity Data)
  - For reporting to the UNFCCC on GHG Inventory the country can then use the Activity Data statistics and apply the Emission Factor Data (either from its own national data (NFI) or IPCC standards, fire emission calculator, etc.) to arrive at GHG report
  - Depending on the interpretation detail at the sampling point, the statistical reporting tool can be used to identified the drivers of changes
- FAO is, apart from providing and maintaining the free software package, supporting countries with training and introduction of the tool package. More than 30 countries have been supported in the use of the FAO Toolbox in 2014 and 2015.

- FAO is working on the assessment of global drylands, using the same tools.

3.3.6 A. Siampale / Ministry of Land and Natural Resources / Zambia – A case of the SADC REDD+ MRV mapping of degradation in the transboundary test site with Malawi

Another example of country efforts in establishing a forest monitoring system was presented by A. Siampale from the Ministry of Land and Natural Resources in Zambia.

With the technical and financial support from UNDP, FAO and UNEP, the REDD+ Readiness project is implemented by the Forestry Department with the ultimate goal of implementing a NFMS on the basis of an NFI. The NFI in Zambia is conducted as ILUA II as follow up of ILUA I (completed in 2005), but only forest points were assessed and the observations were reduced to forest vegetation assessments only. A forest cover map series for the years 1990, 2000, 2010 and 2015 has been produced on the basis of LandSat imagery. Difficulties in accuracy had been overcome using the FAO OpenForis Toolbox to assess some 5700 sampling points. The Zambian NFMS is hosted on the Web-portal http://zmb-nfms.org/portal/ making maps and data form the NFI/ILUA available to the public.

Parallel to the NFI a regional Dry Forest Biome assessment is conducted as a transboundary activity jointly with Malawi to test carbon stock and stock change assessments on eco-system basis. These activities are part of a SADC wide program supported by GIZ. Forest cover changes are assessed on the basis of LandSat for the 1990 situation and RapidEye data used for the 2010 mapping. The accuracy of the mapping ranged from 79% to 88%, the deforestation rates in the included dry forest Biomes vary from very low in Namibia (0.0058%) to higher rates in Mozambique (0.3%) and Malawi/Zambia region (0.5%). Forest degradation assessment needs to be based on the assumption of increasing forest degradation with proximity of human built infrastructure. The emission factor assessment is based on a field sampling inventory with sampling units of 3 points per unit, allocated in an unaligned systematic sampling system. A movie shown to the audience gave an impression of the sequence of working steps taken for the field inventory.

Details from the Presentation:

- The REDD+ Readiness project is implemented by the Forestry Department and is supported by UNDP; FAO and UNEP with the goal to prepare Zambian institutions and stakeholders for effective nationwide implementation of REDD+ mechanism following the REDD+ requirements of the COP decisions of the UNFCCC
- Major parts of the program implemented are the establishment of an NFMS in the corresponding Web-portal http://zmb-nfms.org/portal/, conduct of an NFI (with the support from Finland), completion of a land-cover map, also to be used in the development of FREL/FRL together with the establishment of GIS units in the provinces and the completion of a national REDD+ strategy

- For the GHG reporting and the development of REL the land-cover mapping was done for the years 1990, 2000, 2010 & 2014 Wall to wall LandSat data interpretation using a pixel based classification (maximum likelihood) with the RS software Envi 5.0
- The National Forest Inventory, conducted as ILUA II, used the Land Use Assessment Methodology in a reduced version of assessment and points covered (only forested lands, excluding bare land and crop land from field assessment) followed-up on the completed ILUA I
- To increase the mapping accuracy the country conducted an assessment of 5700 on-screen using local knowledge for the visual interpretation on the basis of Google Earth images (using the FAO – Collect Earth tool)
- Zambia was also one the selected countries to test an ecological regional based carbon stock and stock changes assessment under the Development of Integrated Monitoring Systems for REDD+ in the Southern African Development Community (SADC) Project, where the selected eco-region in Zambia was the dry forest type “Miombo”
- Reasons for selection were that Dry Forest Biome is the most threatened and least studied of the world’s ecosystems and the biome is largely neglected in the REDD+ process as focus was initially on tropical humid forests.
- The assessment was conducted as a transboundary test in a region stretching from Zambia into Malawi, reaching lake Malawi
- The project covered different eco-regions in 5 countries, Botswana, Malawi, Mozambique, Namibia and Zambia, where forest cover mapping and forest cover change assessment was conducted with mapping based on satellite image interpretation of data from 1990, 2000 and 2010, with the 2010 mapping based on RapidEye data. The accuracy of the mapping ranged from 79 to 88%, the deforestation rates vary from very low in Namibia (0.0058%) to higher rates in Mozambique (0.3%) and Malawi/Zambia region (0.5%)
- Forest degradation was also assessed, based on zoning around infrastructure and farmland/cultivation areas, with results closely correlating to the deforestation rate. Zones with high deforestation rate also show high forest degradation rates, with the highest rates found in Mozambique with 3.5% and lowest in Botswana as low as 0.006% where no actual expansion of infrastructure and farming was observed
- As the project was a test, rolling out the system over the whole region is recommended; challenges relate to financing, capacity building especially in RS and GIS technology, use of open source software is recommended and research to develop allometric equations for the Miombo Biome will be required.