CD REDD

Capacity Development for Reducing Emissions from Deforestation and Forest Degradation

Forest Area Change Assessment: The Experience of Existing Operational Systems of non-Annex I Parties

4-6 February 2009
Sao Jose Dos Campos, Brazil

Summary

The REDD Capacity Development project held the second of three workshops on “Forest Area Change assessment: the experience in non-annex I countries”. The meeting was organized by the Coalition for the Rainforest Nations (CfRN) and the Brazilian National Space Agency (INPE) with the support of German Technical Cooperation (GTZ) and the German Federal Ministry for the Environment. Delegates from 37 Countries attended the workshop and top level scientists and all major international and national space agencies (European, American, Japanese, Brazilian, and Indian) provided their technical contributions.

This second workshop, discussed land cover and land use change detection by using remote sensed data. The objective of the workshop was to introduce developing countries’ experts to techniques and scientifically sound practices of detection and tracking of forest land cover changes due to changes in land use (deforestation) and in carbon density (forest degradation, including forest fires).

The workshop showed that remote sensing techniques are mature and reliable and may be applied for monitoring and reporting in an operational manner under the expected UNFCCC-REDD mechanism. Medium resolution data satellites such as Landsat and Cbers already guarantee a sufficient time frequency and quality of data for the needs of a monitoring system of forest lands all over the world. Workshop participants stressed that the accessibility of data from some of these systems such as Spot, Irs is still an issue because of costs.

Moreover, important outcomes were reached in the last session regarding:

- The opportunity of building a free internet network for sharing: 1) raw data that can be freely provided by space agencies (a wealth of data is already freely accessible by various websites and additional data are going to be available); and 2) operational open-sourced software, documents and guidelines on experiences.
- The strengthening of trilateral cooperation based on south-south technical capacity building activities. It should be noted that INPE is building a dedicated facility in Belem for training on forest monitoring methodologies related to remote sensing applications. The center should start its activities next autumn and several participants have expressed their strong interest in participating in planned training activities.
- Furthermore, some donors like World Bank, UK, GTZ, ESA, Brazil (through its Rainforest Fund) have reaffirmed their interest in supporting ongoing capacity building activities and further planned actions. In particular GTZ has shown its interest in supporting the planned training activities of INPE by means of a working agreement between German and Brazilian government on trilateral cooperation.

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Acronyms

ALOS	Advanced Land Observing Satellite
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATSR	Along Track Scanning Radiometer
CATHALAC	Centro del Agua del Tropico Humedo para America Latina y el Caribe
CATIE	Centro Agronómica Tropical de Investigación y Enseñanza
CBERS	China-Brazil Earth Resources Satellite
CfRN	Coalition for Rainforest Nations
CIRAD	Centre de coopération internationale en recherche agronomique pour le développement
COMIFAC	Commission des Forets d'Afrique Centrale
CONAFOR	Comisión Nacional Forestal
COP	Conference of Parties to UNFCCC
DETER	Deteção do desmatamento em Tempo Real
DETEX	Deteção de Exploração Seletiva
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
EROS	Earth Resources Observation and Science
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
GEOSS	Global Earth Observation System of Systems
GMES	Global Monitoring of Environment and Security
GHGs	Greenhouse gases
GOFC-GOLD	Global Observation of Forest and Land Cover Dynamics
GPG	Good Practice Guidance
GSE	GMES Service Element
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IMAZON	Instituto do Homem e Meio Ambiente da Amazônia
INPE	Instituto Nacional de Pesquisas Espaciais

IPCC	Intergovernmental Panel on Climate Change
IRS	Indian Remote Sensing Satellite
JAXA	Japanese Aerospace Exploration Agency
JRC	Joint Research Centre
LANDSAT	Land Remote-Sensing Satellite
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NDVI	Normalized Difference Vegetation Index
NFMA	National Forest Monitoring and Assessment
PALSAR	Phased Array type L-band Synthetic Aperture Radar
PRODES	Projeto de Estimativa do Desflorestamento da Amazônia
REDD	Reducing Emissions from Deforestation and Forest Degradation
R-PIN	Readiness Plan Idea Note
SDSU	South Dakota State University
SFM	Sustainable Forest Management
SPOT	Système Pour l’Observation de la Terre
STAR	Center for Satellite Applications and Research
UMD	University of Maryland
UNFCCC	United Nations Framework Convention on Climate Change
UNEP	United Nations Environmental Programme
USGS	United States Geological Survey
VIRS	Visible and Infrared Scanner
WB	World Bank

Introduction

Data on land use changes are crucial to assess changes in carbon stocks. Many Annex-I countries have adopted field survey systems and only a few national monitoring systems based on remote sensing methodologies currently exist. The remote sensing techniques represent a good solution for countries with few data sets and little information on land activities. For many years, Brazil and India have operated forest land monitoring systems based on remote sensing. During the workshop, these experiences will be presented and experts will explain how to integrate these methodologies in national GHGs monitoring and reporting systems. The workshop will be an important opportunity to discuss the feasibility to monitor forest area and forest area change through satellite remote sensing systems in the context of UNFCCC and its ongoing negotiation on REDD.

Day 1

Welcome Messages

Prof *Gilberto Camara*, INPE Director, welcomed participants that at the INPE facilities. He noted that the aim of the workshop is to review activities and capabilities currently in place for forest monitoring and to anticipate challenges for REDD monitoring. Prof Camara then detailed the current situation of Brazil which has a 21-years timeseries of deforestation activity data and has an open access policy for data, methodologies, tools and softwares on deforestation. The objective of an open access policy is to ensure timely progress of reviews of their monitoring system by the international community. This enables effective implementation of the needed technical and scientific capacity. Moreover, the open access policy ensures the integrity of data under international agreements. http://www.inpe.br/ingles/

Mr *Ulrich Krammenschneider*, GTZ Director for Brazil, welcomed and informed participants that the CD REDD programme of workshops is funded by the German Climate Initiative of the Federal Ministry of the Environment within the scope of the post-2012 agreement under the UNFCCC. Then, Mr Krammenschneider stressed the power of the south-south cooperation instrument for capacity building and reaffirmed the willingness of GTZ in supporting it. http://www.gtz.de/en/

CD REDD: Capacity Development for Reducing Emissions from Deforestation and Forest Degradation

Dr *Danilo Mollicone*, CfRN Head of Technical Unit, noted that although the Coalition for Rainforest Nations is a negotiation actor, it also supports technical education to improve the comprehension of scientific issues discussed during negotiations in order to build consensus. Most important of all technical activity is capacity building on GHGs Inventory. Indeed, a fundamental requirement of any REDD mechanism is the capacity to provide estimates of GHGs emissions and removals from forest lands compliant with methodologies approved by the UNFCCC. Therefore, the first three workshops of the CD REDD programme are focused on GHGs Inventories (Berlin: The National System for GHGs Inventory; Sao Jose Dos Campos: Activity data monitoring by remote sensing techniques; Dehradun: Carbon stocks monitoring by inventory techniques). Planned workshops for the second phase of the programme are: Readiness for REDD, how to coordinate ongoing efforts; REDD reference levels; and SFM in REDD.

Dr Mollicone explained that the first and second sessions of the workshop agenda are dedicated to current capabilities and data availability for forest area detection while the third is focused on ongoing monitoring systems in non-Annex I Parties. The fourth session was dedicated to potential requirements of REDD and how remote sensing data and techniques could be used to cope with them.

Finally, Dr Mollicone defined elements to consider during the workshop:

- Land cover vs land use; remote sensing detects cover elements that allow countries to build land cover classifications, to pass land use classifications rules that link the cover elements to human activities (i.e. the use) and/or whether ground confirmation is needed.
- IPCC approach 3 for land uses and land-use changes detection and tracking; geographically explicit data (both wall-to-wall and sampling) and a coherent system of definitions and rules for land uses classification.
- Availability and characteristics of remote sensed data and their use for large scale monitoring and hotspots analysis.

REDD under the UNFCCC and relation with the monitoring objectives of the workshop

Dr *Thelma Krug*, Head of International Affairs Office of INPE, started her presentation with an overview of the REDD negotiation process under UNFCCC, from COP 11 (Montreal, 2005) to COP 15 (Copenhagen, 2009), pointing out that tools, methods and data are available and the science is robust enough to monitor and estimate emissions from deforestation with an acceptable level of certainty. However, the availability of appropriate financial, technological and human resources, including capacity-building is crucial because of current limits, among which is the particularly high cost of and access to high resolution data. Dr Krug then detailed the progress reached under the negotiation process emphasizing that, as agreed, estimates of reductions or increases of emissions should be results based, demonstrable, transparent and verifiable, and estimated consistently over time; furthermore estimates should be subject to independent expert review. Indeed, comparable inventories, within the IPCC flexibility (tiered approach), are the fundamental instruments for evaluating the effects of implemented policies and measure for halting deforestation; although definitions of forest, deforestation and forest degradation has not been agreed till now. Finally, Dr Krug reminded participants that for non-Annex I Parties reporting under the UNFCCC the 1996 IPCC Guidelines has been adopted although the use of 2003 IPCC GPG is now encouraged (Brazil is going to apply IPCC GPG for providing GHGs estimates in its Second National Communication to UNFCCC).

Landsat Data for Global Land Monitoring

Dr *Thomas R. Loveland*, Director of USGS Land Cover Institute, illustrated the Landsat mission that is the acquisition, archival, and distribution of global, synoptic, and repetitive coverage multi-spectral imagery of the Earth's land surfaces at a scale where natural and human-induced changes can be detected, characterized, and monitored over time. Landsat mission has been operative since 1972 with a continuous evolution of technical characteristics of sensors, so that it represents the widest collection of long-term observations of the Earth surface. Current problems (approximately 22% of each scene is missing)[1] are due to the failure of ETM+ Scan Line Corrector of Landsat 7 and will be solved by the launch in 2012 of Landsat 8. More than 2,100 TB daily (260 GB daily for Landsat 7 and 40 GB daily for Landsat 4 & Landsat 5) data are available in the Landsat archive, and the access policy is free downloading for newly acquired Landsat 5 and 7 data with <30 percent cloud cover and, via on-demand ordering, free downloading for all other Landsat scenes (over 2 million). Moreover, USGS freely provides to users 4 Global Land Survey images (1975, 1990, 2000, 2005).

NASA and USGS expect an increased response to their free-data policy in terms of:

- Requests in January 2009 to Landsat data was 50 times higher than before the free-data policy was adopted;
- Research applications, since historically most Landsat data users were limited to the data they could afford rather than the data they needed;
- Operational applications, since remote sensing research has shown that the use of additional temporal data improves the accuracy and utility of land cover data sets, which will lead to expanded acceptance of applications.

Finally, Dr Loveland informed participants that within the GOFC-GOLD Regional Network Data Initiative a training pilot for Africa, which involves 5 regional networks, will be held at USGS-EROS and SDSU next April. Network representatives will receive data and training over 2 weeks; support has been provided by STAR, USGS, NASA, UNEP, SDSU and the University of Maryland.

Responding to questions from the audience Dr Loveland clarified that: the algorithm applied for filling gaps in Landsat 7 images will be freely delivered next June as the service at USGS has been stopped; the 2005 Global Land Survey image completion is approximately at 90%; the policy data of ground stations is totally independent from NASA and USGS even if the USGS expectation is that all of them adopt a free-data policy. http://landsat.usgs.gov/products_data_access.php

ESA activities and satellites related to REDD

Dr *Olivier Arino*, Head of ESA Earth Observation Projects Section, completed an overview of all ESA activities relevant for a REDD mechanism. The GMES programme, with its satellite system, and the REDD pilot cases under development in Cameroon and Bolivia within the GSE Forest Monitoring programme seem to be the more relevant. The GMES is a multipurpose, long duration (20 years) programme that combines different sensors loaded on a constellation of satellites (Sentinelle series). Sentinelle 2 mission will start in 2012 and will be composed of 4 satellites in order to ensure the operation of the satellites over 15 years. Satellites will be furnished with multi-spectral sensors (13 bands)

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[1] It shall be noted that such a problem is totally not relevant in case a sampling approach for land-use changes detection is applied

with a 10 day repeat period[2] (5 days for the twin configuration) and a resolution of 10-60m, so it qualifies as a candidate for continuity of past data streams (Landsat and SPOT). The ongoing pilot projects are based on national coverage, the use of remote sensing combined with sample based inventories (biomass). Pilot activities will be shortly extended to Congo Brazzaville, Gabon, and Laos. Moreover, Dr Arino illustrated other ESA products such as the GlobCover Land Cover, a Global Land Cover Map 2005/2006 by using MERIS data at 300m, accessible at http://www.esa.int/due/ionia/globcover and l'ATSR World Fire Atlas, near real time detection of active fires since 1996, accessible at http://dup.esrin.esa.int/ionia/wfa.
Responding to questions from the audience, Dr Arino clarified that SPOT data are owned by a French private company. Until now only radar-data are property of ESA and can be freely received for scientific purposes. Information about coming data from Sentinelle constellation data policy has not yet been forthcoming.

CBERS: A partner for controlling deforestation and degradation
Dr *José Carlos Neves Epiphanio*, Coordinator of the CBERS Program Applications Segment, described the CBERS programme and its ongoing applications related to forest land monitoring. CBERS programme consists in a constellation of satellites, the first launched in 1999, with multi-spectral sensors at medium resolution. Many applications have been developed by Brazilian scientists that use CBERS data for mapping and land control (detection of land cover elements and their variations in time and space). A new constellation of satellites (Amazonia) is under development, in a joint programme with the UK, which together with CBERS-3 will allow INPE to deliver global land imaging every 3 days.
Responding to questions from the audience Dr Neves Epiphanio reaffirmed that CBERS data are totally free for South-America and Africa and downloadable from the INPE website and that new receiving antennas are going to be set in Africa and Central America in order to widen the coverage. www.dgi.inpe.br/CDSR

Japanese project and research activities toward REDD from detection of forest change to estimation of biomass change
Dr *Yasumasa Hirata*, Group Leader at Forestry and Forest Products Research Institute, led an interesting presentation on experimental methods for extrapolating carbon stock changes from detected changes in forest cover. Two lines of research (forest degradation index and feasibility to estimate emission reduction by REDD using PALSAR data) and three project activities (detection of illegal deforestation in Amazon, forest resources management in Indonesia, and JAXA Kyoto & Carbon Initiative) relevant for REDD have been presented. For remote sensing applications to contribute to a potential mechanism there are four main technical constraints to be eased: seasonality (change of radiative property of vegetation in response to seasonal changes of climate); cloud cover (so that the use of radar sensor); topographic effect on radiative property of vegetation, mainly due to shadowing (it affects both spectral and radar data); and comparability among different sensor data. All activities depend on the integrated use of radar and

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[2] Expected cloud-free revisit of 15-30 days on most of the lands

spectral remotely sensed data at medium and high resolution with ground truth in order to remove bottlenecks of remote sensing applications. The main methodological outcome presented is a regression among crown diameter and tree biomass that can be applied using satellite images and the higher the resolution of images the higher the correlation (r^2) found between crown diameter and tree biomass. For instance, regression could be applied for estimating forest degradation net emissions so that it is possible to say that technology already exists for monitoring forest degradation and many countries have been using such technologies to develop forest carbon inventories (for example, remote sensing technologies). There is a need to expand these technologies for monitoring forest degradation and associated GHGs emissions and changes in carbon stocks, but waiting for replacement by another promising technology will be a time-consuming process. To strengthen that point Dr Hirata did a comparison of methods for change detection in satellite images pointing out pros and cons of each method and the resulting accuracy of detected changes. In conclusion, each case should start from an analysis of circumstances (as data availability due to spatial and temporal acquisition, data accessibility due operating facilities, property and related cost, seasonality of vegetation, ground resolution and typology of sensors – optical vs. radar [vs. dimension] – causes of forest cover loss and overall monitoring cost) and should use the most appropriate methodology to build a system which ensures the highest accuracy of estimated results.
Responding to questions from the audience Dr Hirata clarified that the stratification of vegetation (crown overlap) impacts the performance of found regression but considering that the main portion of stand biomass is concentrated in higher trees the resulting error is not big enough to invalidate the approach. Even if remote sensed data and Earth observation techniques are used in estimating GHGs emissions and carbon stock changes in forest land they always need to be complemented by ground truth. Ground data are fundamental for validation of methodologies and subsequently for verification of provided estimates. A wealth of ground data is available but a systematic collection in a coherent database is still lacking. Often information on methodologies applied for data collection and their geographical identification are not available, making data useless. http://ss.ffpri.affrc.go.jp/e_version/index-e.html

GEOSS, the Global Earth Observation System of Systems

Dr *João Vianei Soares*, General Coordinator of Ground Observation of INPE, presented to participants the Global Earth Observation System of Systems. This system will link existing and planned observing systems around the world and support the development of new systems where gaps currently exist. It will be a global network of content providers allowing users to access an extraordinary range of information at their desk. Furthermore, it will promote common technical standards so that data from existing different instruments can be combined into coherent data sets. The importance of this system is the fact that any single problem requires many data sets and any single data set serves many applications, so that observation systems should be made coherent, between them, and shared across disciplines. The free access to data is another important policy of GEOSS but is limited to research scope. The 'GEOPortal' offers a single Internet access point for users seeking data, imagery and analytical software packages relevant to all parts of the globe. For users with limited or no access to the Internet, similar information is available via the 'GEONETCast' network of telecommunication satellites. http://www.earthobservations.org/geoss.shtml

An outline of the EC Joint Research Centre's TREES project 1992-2013

Dr *Hugh Eva*, researcher of JRC, detailed the assistance projects founded by the European Union on sustainable forest management (including forest resource monitoring) under the Regulation (EC) No 1905/2006. Dr Eva then illustrated the results of the first and second cycle of Tree project, which is undergoing its third cycle. Tree project was aimed to map distribution of pan tropical forests (extended to global forests in 2000 – GLC2000), to highlight areas of rapid change and to the quantification of pan tropical forest change for the period 1992 to 1997 using a sample of high resolution satellite data. The project is based on the involvement of regional experts that guaranteed the needed knowledge of different biomes since the image analysis is done via visual interpretation (therefore Tree was a labor intensive project). For the third cycle of Tree, primary improvements in the methodology include: absence of stratification since at this scale there are no driving variables which can be used for stratification; instead of visual interpretations, automatic segmentation is implemented in order to obtain standard and repeatable delineations and resulting segments are automatically assigned to classes and corrected by visual interpreter if any. Regional experts carry out quality control. Finally, experts (FAO) add forest and land use dimension. The Tree approach is based on a global sampling (in the tropics sample sites at the confluence of the geographic [lat/long grid, 1 degree]; outside the tropics a reduction of samples – due to over sampling) since the wall-to-wall coverage is extremely resource demanding [images / processing / storage] which is more difficult and therefore more prone to errors. On the other hand clouds may have a larger negative impact on estimates in case of sampling approach since they are very often placed over the forested areas[3]. The project will be based on medium resolution satellite images, mainly from Landsat. To ensure a high accuracy of estimates the project has to face bias due to rapidly changing areas (a high frequency of change analysis minimizes it). A verification exercise done with PRODES data showed a difference between estimates smaller than the standard error of Tree estimate. The Tree project will work in partnership with FAO for the completion of the Global forest change assessment (1990 – 2000 – 2005 – 2010) which will be published by FAO as part of the 2010 Global Forest Resource Assessment. Finally, Dr Eva showed another project aimed to quantify the forest changes occurring over the French Guiana territory between 1990 and 2006 by means of remote sensing; and to verify their accuracy by reference to the official NFI survey (16,000 photo-interpreted points on a stratified basis). The results show a very small difference between estimates done with remote sensing and NFI (around 0.1%). Responding to questions from the audience Dr Eva pointed out that the vegetation classification scheme is not based on canopy density; many signatures are collapsed in the same class. Therefore, expert supervision is fundamental for the classification.

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[3] Because sampling approach analyzes only a portion of the total area, the impact on the sample-estimates due to the exclusion of portions of territory covered by clouds (land uses have not an equal probability to cover those portion of territory discarded from the sampling because of cloudiness. Indeed, forest use has a higher probability) is then propagated to the whole estimate.

Figures on accuracy of Global forest change assessments could be calculated only with a post-validation done with ground truth data. Such a validation exercise has not been planned. Radar data will be used to solve problems caused by cloud presence in the sampled areas.

The Global Forest Resource Assessment FRA2010 and Remote Sensing Survey

Mr *Adam Gerrand*, Forestry Officer at FAO, informed participants that FRA2010 Remote Sensing Survey (RSS) is part of FAO Global Forest Resource Assessment (FRA). The scope is to have a global forest cover dataset (for 1975, 1990, 2000 and 2005) consistent over time and space (i.e. realized with same methods and forest definition) thus complementing (not replacing) the national reports for the Global Forest Resources Assessment 2010 and giving a better picture of land use dynamics such as rates of deforestation and expansion of forests, further disaggregated at biome level. The area change statistics will come mainly from Landsat images at 30 m resolution. Steps of the programme, which is currently in its pilot phase, are illustrated and for validation, the data coming from independent sources that could be used include those reported at www.confluence.org. JRC, SDSU, Jena University and GOFC-GOLD are partners. The whole imagery (http://globalmonitoring.sdstate.edu/projects/fao/index.html) database will be on-line and accessible by countries. Land-use changes will be validated by countries based on the highlighted polygons of detected changes by satellite. FAO encourages countries to actively participate in this initiative so that the interpretation and validation can take full advantage of the local knowledge of national teams. The sampling grid (1 degree) has been designed for global reporting and so it is not appropriate for national estimates. However grid spacing can be intensified to get more plots and better confidence of estimates at the national level in order to be used for reporting under a potential REDD mechanism. Mr Gerrand then illustrated the National Forest Monitoring and Assessment programme of the FAO. The objective is to help countries which have limited information on their forests, to develop and implement national forest monitoring and assessment systems. This programme uses the same systematic sampling design as the global remote sensing survey, but with a higher sampling intensity. For instance every half degree x half degree is needed in order to obtain statistically valid information at the national level. At each of these points, there will be a series of field measurements, complemented by interviews and direct observations aimed at capturing a broader range of variables than traditional forest inventories. This is an affordable, robust approach which, in addition to generating information on climate change related variables also generates information needed for forest planning and policy development and FAO advocates that any national carbon monitoring system be incorporated into or closely linked to existing forest inventory and monitoring systems. Mr Gerrand concluded by saying that there are a number of positive spin-offs of these projects: capacity building for forest monitoring; preparing countries for informed management of their forest resources giving them the opportunity to benefit from REDD mechanism. Responding to questions from the audience Mr Gerrand stressed that RSS will deliver statistics related to tree cover, not to forest cover and the land use element will be introduced by national experts. http://www.fao.org/forestry/fra2010-remotesensing

Global forest cover loss, 2000 to 2005

Dr *Matthew Hansen*, Co-Director of Geographic Information Science Center of Excellence at SDSU, presented a study based on MODIS images of tree cover loss over the period 2000-2005. The applied method takes advantage of the high temporal frequency of the image detection to account for the gross loss of trees. Problems due to the moderate spatial resolution of MODIS data have been solved by using a probability-based stratification of polygons derived from MODIS images analysis and then sampling with high spatial resolution Landsat data. Indeed, the method developed a sampling frame that employs the MODIS outputs to stratify each biome into regions of high, medium and low probability of forest loss thus concentrating sample plots in areas with higher deforestation rate. The good correlation of MODIS-derived pixels with high probability of tree cover loss and Landsat sample plots shows clearing of tree cover. From the Landsat samples, calibrated tree cover and tree cover loss estimates per stratum have been derived. By applying regression estimators, the sample-based estimates have been refined thus lowering the uncertainty. By comparison, a MODIS change analysis verification exercise with PRODES data shows a very good correlation of estimates (r^2=0.97). Furthermore it demonstrates that the targeted sampling and the use of regression estimators create efficiencies in deriving tree cover loss estimates and that the resultant estimates are more accurate than those got by a systematic sample. In conclusion, synoptic methods are important, as MODIS can detect new forest cover loss in frontier areas. Results disaggregated at biome and regional level have been demonstrated. With respect to further improvements, Dr Hansen said that this tree lost estimation method can be inverted to assess tree cover gain in order to derive net tree cover change. Responding to questions from the audience Dr Hansen repeated that MODIS-related products are used to make a general survey, flagging areas where tree cover losses are occurring. These areas will be then targeted by sampling with Landsat images. This method is particularly useful for tropical regions where regrowth is very fast and therefore a frequent assessment (at least annually) is needed to capture all changes. Strips in Landsat 7 images are not a cause of bias as there is no correlation with changes in tree cover. Stratification of samples also ensures that areas where no changes occur are analyzed with Landsat data, avoiding a potential source of bias. During the discussion following the presentation it was noted that the presented method is able to provide a gross estimate of tree cover losses. In order to assign those losses to a land-use change (deforestation) or to a decrease in carbon stocks in forest land or in other wooded lands (forest degradation) a further step is needed that analyzes causes of losses. http://globalmonitoring.sdstate.edu/faculty/hansen/modis_landsat_method/congo.pdf

Burned Area Mapping: The MODIS Global Burned Area Product

Dr *Luigi Boschetti*, UMD, presented a monitoring system for mapping of burned areas based on the MODIS sensor data. For fire detection, the major technical problem is due to cloud cover as clouds cover ~50% of the globe. However, due to the high overpass frequency (4 times per day) of MODIS, a 60% probability of no cloud cover is ensured at the global level. For the burning area mapping, The algorithms are difficult to implement reliably because spectral, spatial, temporal characteristics of burned areas differ as a function of the fire regime/ecosystem, pre-fire state, and the fire behavior. Moreover burning can be confused spectrally with non-burning phenomena (cloud & relief shadow, wet and flooded surfaces, agricultural harvesting, etc.). An effective algorithm tested on Landsat data is the NBR (Normalized Burn Ratio). NBR is able to discriminate between unburned and burned pixels according to their NBR pre-/post-fire difference values (dNBR), with good accuracy. For MODIS, a different algorithm based on the expected change of Bidirectional Reflectance Distribution Function (BRDF) has been applied. Indeed, in a timeseries, the BRDF value of a pixel image oscillates within a range of values (along a sinusoidal path). If a burning event occurs then the value moves out of the predicted path (out of the range) and therefore it is possible to detect the location and the approximate day of burning. The algorithm is applied independently per pixel to daily gridded MODIS 500m land surface reflectance time series and the resulting detection of burned areas is totally automated and does not need training data or human intervention. A comparison exercise with data on areas where active fires have been detected shows a good correlation even if active fire products cannot be used directly for mapping burnt areas at fine resolution (i.e. because of fire size, clouds and sampling issue). Preliminary data of a validation exercise (still ongoing) based on Landsat data analysis and ground truth in Southern Africa showed very good correlation. Also, a frontier research on estimate of GHGs emissions from forest fires based on the monitor of fire radiative power (FRP) has been presented. Indeed, the amount of radiant heat energy liberated per unit time is related to the rate at which fuel is being consumed. Measuring FRP and integrating it over the lifetime of the fire provides an estimate of the total Fire Radiative Energy (FRE), which for wildfires is proportional to the total mass of fuel biomass combusted. Another way could be the use of dNBR as a severity index that is well correlated (non-linear asymptotic) with the Composite Burn Index (CBI), even if the correlation varies with sensor spatial resolution and environment. Finally, Dr Boschetti developed some considerations on the use of satellite data for monitoring fire for REDD pointing out that carbon assessment requires the characterization of fires. Indeed, crown fires and understory fires have different implications in terms of GHGs emissions both as quantity and as accountability (crown fires usually lead to forest – non-forest transition while understory fires can lead to forest degradation). A hybrid approach could be a way forward. Ideally, REDD requires the high accuracy and the fire characterization of visual interpretation where the systematic coverage of global products, hotspots, location, time of burning and approximate extent can be determined (and in future, fire radiative energy for characterization). Then, using high resolution images and visual interpretation on stratified sampling, the high accuracy (and in future, fire radiative energy for characterization) could be reached. A hybrid approach could combine the strengths of global products and local high resolution visual mapping. Responding to questions from the audience, Dr Boschetti said that the VIRS sensor will soon replace the MODIS in an operational manner thus ensuring the continuity of the service and the applicability of proposed methodologies in the next future. http://modis-fire.umd.edu

Activities in relation to monitoring land cover changes in Africa

Dr *Hugh Eva*, researcher of JRC, illustrated 4 actions of JRC in Africa. The first is the monitoring of net land cover changes at continental scales (sub-Saharan Africa) from 1975 to 2000. The project aim was to obtain a first 'guess' at the main land cover changes over the last 25 years in order to understand main drivers and pressures to determine how appropriate satellites are to estimate of land cover change. The methodology consisted of a stratified sampling of circa 1% of area using high resolution satellite data. Conclusions show that: in certain biomes the use of 30m to 80m resolution data was not sufficient; the seasonality in arid zones creates major difficulties; major problems (and bias) in quantifying area changes between Landsat MSS (80m) and Landsat ETM (30m) – i.e. consistency in data compared should be ensured. The second action is the monitoring of net forest cover changes in the Congo Basin from 1990 to 2000. The third (as already seen in the previous presentation) is the coverage of Africa in the global forest monitoring (TREES – FRA) exercise. The fourth is the contribution to the Observatoire des Forêts d'Afrique Centrale (OFAC). The observatory mission is to become a reference point for the monitoring and archiving of forest-related information in the region, in order to provide needed information to decision-makers for implementing sustainable forest management. A wealth of information could be accessed via internet at the following webpage: http://www.observatoire-comifac.net

Day 2

Satellite Monitoring of the Brazilian Amazon

Dr *Dalton De Morrison Valeriano*, Coordinator of the Amazonia Program at INPE, recounted the history of the deforestation issue in Brazil. Deforestation started during the European colonization and was historically concentrated along the coast of the southern part of the country (where bigger cities are) thus accounting for the dramatic reduction of the Mata Atalantica biome. Therefore, in Brazilian culture the good land was the tree-free land. Indeed, in the Seventies the colonization of Amazonia was promoted by the government which funded new settlements in the forested areas in order to clear those areas and make them productive. To control the money spent for the colonization and ensure efforts were effective, a monitoring programme of the Amazon basin by remote sensing was started. In the 1990s the increased technical capability made the programme autonomous and fully operational. Now, two major projects (PRODES and DETER) monitor Amazonian forest resources. The PRODES relies mainly on Landsat data but because forest is often obscured by cloud, also it draws on images from other satellites such as CBERS-2, a joint project between Brazil and China, to get an uninterrupted view of what is going on (i.e. multi-data approach, each single block is composed by a collage of different satellite images). The segmentation and classification is done with an open source software (TerraAmazon) which is based on a linear model that synthesizes in a unique layer the information contained in three bands (soil, shadow, green vegetation). The software has been produced by INPE and will be soon freely downloadable on web. The end result is an annual map which is then visually interpreted in order to have a wall to wall, spatially explicit yearly deforestation assessment. All the data and elaborations are freely accessible by web at http://www.obt.inpe.br/prodes/. The second programme is called DETER, an acronym that means "to detain" in Portuguese. It started in 2004 as a way to spot deforestation while it happens, activating as an alarm system. For instance, there is an automatic e-mail service that inform authorities in charge of conservation policies about spots of detected deforestation. It produces data every 15 days, using MODIS data. DETER follows same methodological approach of PRODES; http://www.obt.inpe.br/deter/index.html. Finally, Dr Valeriano reported about a research activity on the use of radar data for deforestation detection. A primary positive element is that clouds are transparent to radar thus increasing the coverage and the monitoring capability during the rainy season. However, because of stumps and laying logs, fresh deforestation detection could be hard.

Nationwide Biennial Forest Cover Monitoring: India's Experience

Dr *Subhash Ashutosh*, Joint Director of Forest Survey of India, presented the study his institution conducts biennially on the monitoring of forest cover and other Earth observation applications. He first stressed the importance of having staff permanently involved in that field since the continuous experiencing increases effectiveness. The biennial forest monitoring effort is aimed to provide reliable primary data about the national forest resource to national and sub-national level planning, research projects, verification of implemented forestry policies and official reference for the courts in numerous cases related to forest loss and diversion. It detects a forest definition of 1 ha with tree coverage of 10% at least and does not refer to the use of land so that any kind of tree is assigned to the forest cover class. A comparison exercise done in 4 States between the recorded forest areas by the forest departments and the cover map shows a discrepancy of circa -10%. Moreover only 63.5% of forest cover lies inside the recorded forests. It is a Boolean map, i.e. forest and non-forest classes with a disaggregation of the forest class in sub-classes based on density of tree coverage. The methodology is based on unsupervised classification aided by on-screen interpretation that is guided by 'considered changes' in the forest cover polygons of the previous cycle. Extensive ground truth by means of field verification of the change polygons by the State Forest Departments is done before finalizing the maps. The verification system of the Indian Forest survey is the widest in the world since each single location that requires verification is visited. More than 2000 spots are visited in 3 months and the causes of detected change are registered. Nevertheless, the need of a stratified random sampling on areas unequivocally classified, in order to guarantee a complete verification of the product, remains. Problems to cope with are: linear strips and elements smaller than the satellite resolution (LISS-III sensor on IRS has a resolution of 23.5 m); young plantations and species having less chlorophyll contents in their crown cannot be delineated as forest cover; considerable details on ground may be obscured in areas having clouds and shadows; gregarious occurrence of bushy vegetation and certain agricultural crops, such as sugarcane, cotton, lantana, etc., often poses problems in delineation of forest cover, as their reflectance is similar to that of tree canopy. However, the timeseries of forest cover maps helps in increasing, map by map, the overall accuracy since the study of the land cover dynamic of each pixel gives increasing information, along the timeseries, on its real land cover. On the basis of the Forest cover map, ecological information and ancillary data coming from forest districts, the Forest Typology map of India has been elaborated. Dr Ashutosh then presented the Forest Fire Detection at the National Level service that it is based on data delivered by the Web Fire Mapper of the University of Maryland. The applied methodology overlays the point coverage of the detected fire spots on the forest cover map in order to select forest fire spots. Details of latitude-longitude, district and State are generated in GIS for all the detected forest fire spots and disseminated through fax/e-mail to the concerned State Forest Department for control measures and successively ground validation. The analysis of historical data (last 4 years) has helped in identifying sensitive areas and understanding of forest behavior. Finally, a project for carbon stock and carbon stock changes estimation in forest areas was presented. The methodology produces a forest-type map of India showing 200 forest types of the country on 1:50,000 scale that will be overlapped to the Forest cover map with 3 cover density classes giving a total of 600 strata (of homogeneous forest type/floral composition and canopy density) that are further aggregated within 100 strata. To those strata a value of carbon content to each carbon pool is assigned using data coming from the Indian Forest Inventory. Considering that Forest Survey of India has institutional activity on training in the field of application of Remote Sensing, GIS & GPS in forestry and inventory methods and that it can freely access to Indian satellites data, several participants requested Dr Ashutosh participate in capacity building efforts and assist countries by granting free access to Indian satellite data. http://www.fsi.nic.in/

The Role of the Mesoamerican Regional Visualization & Monitoring System (SERVIR) in Monitoring Deforestation and Forest Degradation

Mr *Emil A. Cherrington*, Manager of Applied Research and Scientific Development Division at CATHALAC, presented the SERVIR (Mesoamerica's Operation Earth Observation Information Platform) and its potential application for forest land monitoring. SERVIR is a Regional Monitoring and Visualization System for Mesoamerica that intensively utilizes satellite imagery and other data sources for environmental management and disaster support (such as forest fires, tropical storms, floods, drought, and volcanic eruptions). The SERVIR provides free and open access to: Satellite and other spatial data sets via MesoStor; Interactive online maps; Thematic decision support tools (fire detection, red tide detection, and climate change); 3-D interactive visualizations. The computational architecture of SERVIR also hosts data from regional initiatives such as the Mesoamerican Environmental Information System (SIAM), the Inter-American Biodiversity Information Network (IABIN), and the United Nations Environmental Programme's Global Resource Information Database (UNEP-GRID) for Latin America and the Caribbean. SERVIR will also support the regional capacity building efforts. Mr Cherrington then illustrated land cover evolution of Belize by pointing out differences among different sources of data due to image resolution. Finally, he presented a project on practical applications of remote sensing for monitoring REDD in Panama. Currently CATHALAC is conducting the assessment of 2008 forest cover for Panama, as well as its GHGs inventory combining satellite-based monitoring with field validation. The approach consist of comprehensive mapping every 5 years to be complemented by monthly / bi-weekly assessments of change, applying for instance DETER methodology developed by INPE as well as exploring possibility of implementing wall-to-wall mapping with LIDAR and aerial photography. http://www.servir.net/

Indonesia and Democratic Republic of Congo

Dr *Matthew Hansen*, Co-Director of Geographic Information Science Center of Excellence at SDSU, presented a study on tree cover change analysis, over 2000-2005, using MODIS and Landsat data sets images. For Indonesia, the methodology aggregates MODIS change over the 5-year interval at 20km block scale to develop a stratified sampling frame for Landsat-scale analysis. Then it uses MODIS change and Landsat change in regression estimator approach to derive final change estimate. For Democratic Republic of Congo, the methodology uses MODIS tree cover maps to drive high-resolution mapping of forest change (given the fine pattern of deforestation that characterizes the region). Methods have been automated to allow for repeatable, comparable product generation through time. In conclusion, targeted sampling has been proved efficient in quantifying tree cover and cover-change estimates at national and regional scales by means of the automatic processing per pixel assessments at Landsat-scale. Responding to questions, Dr Hansen clarified that the cloud problem is solved by patching portion of different images so that the global annual map is composed of a patchwork of data taken at different times. Statistically, detected changes among annual maps are reported by annual time-frame. The classification algorithm is based exclusively on spectral attribute so dry forests are not detected because of seasonality. http://globalmonitoring.sdstate.edu/projects/gfm

Central America Regional Approach to REDD Monitoring

Dr *Jeffrey R. Jones*, researcher at CATIE, presented a project of this institution which demonstrated land use change in Central America by means of the review of alternative data sets, the enrichment with existing regional map data and collection of ground truth information. Following a stratified sampling, the system will improve accuracy of land classes with the aim of providing replicable methodology for the region taking into consideration the high variability in terms of landscape (as a result of ecological and socio-economic differences) and consequent carbon contents among and within land use classes. The research outlined the inconsistency in data (each country has maps produced at different time) and definitions (inconsistency in definitions even within maps of the same country) and problems of shifting cultivation, permanent crops and mixed uses on same land. Finally, a tool developed by Colorado State University and the US EPA complemented the project providing GHGs estimates for the AFOLU sector. Responding to question from the audience Dr Jones said that his institution, together with the US EPA, is going to organize training courses. Moreover, the applied software could be freely downloaded at the Colorado State University website.

Monitoring of vegetation cover: the Mexico experience

Dr *Carmen Meneses Tovar*, CONAFOR, presented the Mexican monitoring project for detection of yearly changes of vegetation cover to understand degradation causes thus helping the Administration take required actions to guarantee the permanence of the forest resources for current and future generations. The project has a mixed approach. Data coming from different sensors with different geometrical and spectral characteristics are used in a two-phase system: the first, which guarantees the national coverage, with low resolution, but high frequency, data (4 MODIS images since 2000); the second, which consists of a stratified sampling of hot spots detected within the first phase, with medium and high resolution data (LANDSAT & SPOT). In the first phase an algorithm of classification is applied based on the NDVI values calculated from MODIS data. Based on both the NDVI magnitude and its behavior over the year pixels are classified under several vegetation classes. Nevertheless the field visits remain fundamental due to the additional unpredictable variability of the NDVI due to climatic condition (like ENSO, hurricanes, etc). In the second phase LANDSAT and SPOT images are visually interpreted for checking and for assigning the proper classification to hotspot of changes in NDVI detected by the timeseries analysis of MODIS data. Finally the ground truth works as verification of detected and interpreted changes. A further step of the project is the elaboration of an algorithm that uses as input data geographical and ecological information and remotely sensed data and socio-economic variables. This is done to ensure accurate forecast of the evolution of deforestation and forest degradation country-wide. Finally, Dr Tovar reported results of a project on causes of deforestation from 1993 to 2002 that shows that deforestation is positively linked to food and feed production and presence (or accessibility) of humans and negatively linked to availability of alternative (other than wood) sources of energy. The audience was impressed on how big and detailed job was done by a team using only two elements. www.cnf.gob.mx/emapas

Forest cover change assessment in Nepal
Mr *Pem Kandel*, UNFCCC National Focal Point, presented a project to assess changes in forest cover in Nepal in the time period 1978-1991 and to 2005. Remotely sensed data hass been coupled with aerial photographs and ground surveys to produce and verify land cover maps and land-cover change matrices. Mr Kandel then stressed the need to have access to databases (mainly satellite images) and to receive the needed financial and technical assistance in order to make current project activities operational.

Day 3

Methodological aspects for forest area change assessment through remote sensing
Prof *Martin Herold*, GOFC-GOLD Land Cover Office at Friedrich-Schiller-University of Jena, started his presentation by delineating the steps that REDD-countries have to follow in the coming months in order to build a national forest carbon monitoring: 1) Assessment of existing national capacities and available data (methods and guidance already exist i.e. IPCC – UNFCCC); 2) Capacity building should be a key factor for "readiness phase" in order to raise national technical monitoring capabilities; 3) Countries should start conservative (i.e. start with low accurate data and resulting estimates with a low probability of overestimating reduction in net emissions) with motivation to improve monitoring system over time (the higher the accuracy of estimates, the higher the claimed benefits). To help countries to follow this path, the GOFC-GOLD Land Cover Office is drafting a Sourcebook for REDD that provides transparent methods designed to produce estimates of changes in forest area and carbon stocks from deforestation and degradation in a format that is user-friendly and fully IPCC-compliant, thus supporting REDD early actions, capacity development and readiness mechanisms on national level. The book's arguments stress that applied scientifically-sound methodologies shall be transparent (full description of procedures, assumptions and datasets), consistent (no changes in estimates along the timeseries should be the result of changes in methodologies or assumptions for data collection and estimates calculation), comparable, complete and accurate (lowest uncertainty). To ensure that the 5 abovementioned principles are correctly applied, the verification phase has paramount importance. Verification could be assessed by means of a sample of higher quality data as anintegral part of national monitoring/accounting system. It should build confidence on

provided estimates and improve knowledge of potential errors so that applied methodologies (and resulting estimates) can continuously be enhanced. Prof. Herold concluded by saying that successful national examples of satellite-based operational monitoring systems indicate feasibility for other countries' development of similar systems. During the discussion several questions and answers addressed same issues: A) it is not needed to have standardized methodologies since each different national circumstance requires a different methodology. Moreover science is continuously improving and the rigidity of standardized methodology is an impediment for having the best science applied over time in the monitoring system; B) for large countries, remote sensing is crucial because of cost and access to land issues. Moreover it is potentially high frequency (e.g. MODIS has 4 overpasses per day) and helps in understanding the dynamic of processes; C) the forest definition should be selected by the country ensuring that the monitoring system is consistent with the adopted forest definition and that other relevant datasets are referred to using that definition or could be converted by means of mathematical procedures; D) forest degradation means a decrease in carbon stocks but to be distinguished by forestry activities the decrease should be considered persistent. The persistence could be evaluated by integrating carbon stock changes either over time (e.g. an average decrease in a certain period, 20 years) or along space (e.g. an average decrease over a wide area where all the successive status of a managed forest are present). Consequently, considering the need to have an annual accounting and considering that at country level a sustainable forest management activity results in losses of carbon stocks either lower or equal to gains due to forest growth, then the net decrease of forest carbon stocks at national level during the reported period could be considered as a degradation of forest (on the other hand, the net increase would be considered as a forest enhancement). Therefore, deforestation could be accounted for as the sum of IPCC categories Forest land converted to other uses and the forest degradation/enhancement as the IPCC category Forest land remaining Forest land; E) the conservativeness, i.e. the discount of probability to overestimate benefits, allows any country to access the REDD mechanism since it makes estimate with low accuracy comparable with the accurate ones; F) the IPCC guidelines could be universally applied under any national circumstance in order to provide scientifically sound estimates. Furthermore the reporting system built by UNFCCC to which IPCC guidelines give the needed technical and scientific support is based on a learning-by-doing philosophy. That is, everybody could start providing estimates at a simpler level (e.g. tier 1) and then, following the routine procedures of uncertainty analysis, key categories analysis and independent review and accruing skills from any repetition of those procedures, improving the accuracy of estimates. http://www.gofc-gold.uni-jena.de/redd

DEGRAD and DETEX: Monitoring the State of the Forest

Dr *Dalton De Morrison Valeriano*, Coordinator of the Amazonia Program at INPE, discussed the deforestation process that is commonly a continuous degradation process of forest cover resulting in the change in the use of land. The DETER system is able to detect early phases of the deforestation processes (the decrease of tree coverage of land) while the PRODES only detects the final change in the use. However, a dedicated project, DETEX, has been implemented by INPE in order to distinguish forest areas selectively logged from degraded forest areas. The Monitoring Strategy of DETEX is to provide, within PRODES, yearly detection and mapping of selective logging areas in public forests in the Amazon Region and, within DETER, monthly detection and mapping of selective logging areas with high resolution data in areas designed for concessions. The methodology is based on the combined use of spectral images, from CBERS, and radar data from PALSAR. The project should be able to detect illegal logging thus monitoring the impact of implemented policies and measures.

Monitoring Forest Degradation through Remote Sensing: direct approach

Dr *Carlos Souza Júnior*, researcher at IMAZON, presented methods for mapping forest degradation with remote sensing data saying that it is more challenging than mapping deforestation because the degraded forest is a complex mix of different land cover types (vegetation, dead trees, soil, shade) and the spectral signature of the degradation changes quickly (i.e., < 2 years). High spatial resolution sensors such as Landsat and SPOT have been mostly used to address this issue. However, very high resolution satellite imagery, such as Ikonos or Quickbird, and aerial digital imagery have been used as well. Methods for mapping forest degradation range from simple image interpretation to highly sophisticated automated algorithms. Because the focus is on estimating forest carbon losses associated with degradation, forest canopy gaps and small clearings are the feature of interest to be enhanced and extracted from the satellite imagery. Detecting forest degradation with satellite images usually requires improving the spectral contrast of the degradation signature relative to the background. However, at high spatial resolution, histogram stretching is not enough to enhance the image to detect forest degradation due to logging. At fine/moderate spatial resolution, such as the resolution of LANDSAT and SPOT images, a spectral mixed signal of green vegetation (GV), soil, non-photosynthetic vegetation (NPV) and shade is expected within the pixels. That is why, the most robust techniques are based on fraction images derived from spectral mixture analysis (SMA) which is able to cope with the mixed pixel problem (i.e. in degraded forest environments, the reflectance of each pixel can be decomposed into the abovementioned 4 fractions through Spectral Mixture Analysis whom outputs are fraction images of each pure material found within the degraded forest pixel, known as endmembers). A new spectral index obtained from fractions derived from SMA, the Normalized Difference Fraction Index (NDFI), enhances even more the degradation signal caused by selective logging. The interpretation of NDFI data is facilitated by a contextual classification algorithm (CCA) that enables accurate mapping of logging and fire-derived canopy damages. The CCA utilizes detected log landings, which are the spatial signature of selective logging, as starting locations for searching the NDFI image for canopy damage. This process separates canopy changes due to logging and associated forest fires from those caused by other natural disturbances. Next, a decision tree classifier (DTC) has been used to define a set of rules to separate forest/vegetation subcategories (as forest typologies) using the fraction images. Because the degradation signatures of logging and forest fires change quickly in high resolution imagery (i.e., < one year), annual mapping is required. There are limiting factors to all methods described above that might be taken into consideration when mapping forest degradation. First, it requires frequent mapping, at least annually, because the spatial signatures of the degraded forests change after one year. Additionally, it is important to keep track of repeated degradation events that affect more drastically the forest structure and composition resulting in greater changes in carbon stocks. Second, the human-caused forest degradation signal can be confused with natural forest changes such as windfall and chorological changes. Third, all the methods described above are based on optical sensors which are limited by frequent cloud conditions in tropical regions. Finally, a higher level of expertise is required to use the most robust automated techniques requiring specialized software and investments in capacity building. Experience to date on assessing the accuracy of interpretation of selectively logged and burned areas has shown that it is possible to obtain an accuracy ranging from 86 to 95%. Finally, in order to estimates carbon stock changes inventories data are crucial even if, for the first year after harvesting, a good relation (0.7134) has been found between the NDFI and the aboveground biomass.

Monitoring forest area changes to assess forest degradation under the expected REDD mechanism: the indirect approach

Dr *Danilo Mollicone*, CfRN Head of Technical Unit, started his presentation defining forest degradation as a net carbon loss in forest land remaining forest land (i.e. all national forest areas not subject to land-use changes since the start of the reference period), and the negative approach as a classification procedure that classifies per exclusion (e.g. areas with absence of detectable elements are classified under the intact forest category). By means of the intact forest delineation the approach is able to distinguish among areas with undisturbed level of carbon stocks and areas where their degradation occurred. Further stratification in e.g. forest typologies, degradation severity etc. could enhance the accuracy of estimates. Dr Mollicone concluded saying that carbon stock changes due to forest degradation during a hypothetical REDD assessment period, will result as the difference between two measurements of the whole forest carbon stock, one performed at the beginning and the other one at the end of the period, minus the carbon lost because of deforestation. By the way a conversion from intact to non-intact forest equals to a degradation of forest land.

Round table: Capacity building needs for REDD

Chairman: Mr Kevin Conrad -Special Envoy and Ambassador for Environment & Climate Change for Papua New Guinea-;

Participants: Prof Gilberto Camara -Director of INPE-, Dr Olivier Arino -Head of ESA Earth Observation Projects Section-, Mr Adam Gerrand -Forestry Officer at FAO-, Dr Thomas R. Loveland, Director of USGS Land Cover Institute, Dr Jim Penman – United Kingdom Department of Energy and Climate Change-, Dr Thelma Krug -Head of International Affairs Office of INPE-, Mr. Werner Kornexl- World Bank, Mr. Ulrich Krammenschneider- GTZ, Brazil.

The roundtable was split in two sessions, one addressed technical issues and the second attended to financial needs. The discussion was opened by the Chairman who stressed the importance of south-south cooperation. Common problems and similar socio-economic conditions make it more likely that policies and measures experienced by one developing country have already been instituted. Moreover, Mr. Conrad stressed the need for coordination of ongoing capacity building efforts both on financial and technical issues. Indeed, the cooperation of all developing countries is still an issue and the full compliance of implemented training activities to UNFCCC principles and IPCC guidelines is still to be reached. Finally, he asked participants, as homework, to start immediately a gap analysis in order to determine the most relevant needs, to be followed by an in-country visit of an expert team in order to enable countries set up a national system for GHGs monitoring and reporting which will then continuously improve because of improvements in methodologies and increasing experience, and skills of national staff.

<u>Technical session</u>

Because of short time and several requests, the roundtable was transformed into a question-session introduced by some brief statements. All statements reiterated the need for further progress in capacity building activities to enable countries to fulfill requirements of a national monitoring and reporting system of GHGs.

<u>Ecuador</u>: The current status is quite problematic: the LANDSAT ground station is no longer operating and CBERS station in Brazil does not fully cover the Ecuadorian territory, so that the only available data are from ASTER and are costly. The national forest inventory has been planned with the FAO assistance but because of fallen of oil prices the needed resources are no longer available. Consequently, no monitoring system has been set up so far.

Prof Camara answered by saying that INPE is committed to cover all of Central and South America with ground stations for CBERS so that starting from 2010 all countries could have free access to complete coverage of their territory. Making the Ecuadorian ground station able to download CBERS data could be an option. However, according to Prof. Camara a full operational system able to produce accurate data on forest cover changes needs medium or high resolution data (at least 20 m) with a frequency of overpass no lower than 4 days (three times the LANDSAT frequency). Finally, he stated that all data and software owned by INPE are freely accessible on web and that INPE is going to start training courses, on remote sensing data application to Earth observation activities, open to experts of other countries.

Mr Gerrand answered that the FRA programme of FAO does not have the money for ground data collection while the Remote Sensing Survey could be used for processing the data of additional plots selected within a national scheme. Under the NFMA programme of FAO there is the opportunity to find technical and financial (depending on donors) assistance for ground data collection.

<u>Suriname</u>: An assessment of needs and gaps is ongoing and should be delivered by March 2009. A partnership with CIRAD is under study. Ground truth is very expensive since accessibility to areas is only by helicopter. The need for hardware and software were already identified.

Prof Camara answered saying that at INPE website CBERS and LANDSAT data for Suriname (only 13 scenes for covering the whole country territory) are freely accessible.

<u>Nepal</u>: Is currently using LANDSAT data downloaded by the Bangkok ground station, but western portion of country is not covered. Indian satellite data are very costly even if they cover the whole country. Training in data elaboration is needed.

Prof Camara answered saying that Chinese ground stations cover the Nepal area for CBERS but current policy does not allow free download. Nevertheless China could be asked.

Mr Gerrand answered that the FRA programme of FAO is going to organize a training workshop in the region (Dehradun) that could be accessed by Nepalese experts.

Mr Ashutosh answered saying that in Dehradun there is an international training centre of United Nations on space science that can be used for organizing training sessions. Moreover, the cost of IRS data is decreasing but (maybe for free) a request to the Indian space agency shall be addressed.

Democratic Republic of Congo: Is already working with FAO in AFRICOVER using LANDSAT data, so that DRC is already operative in remote sensing applications. However, DRC has strong interest in being trained on INPE instruments.

Dr Arino answered saying that ESA is supporting several projects in the Region on land cover mapping with already delivered products.

Uganda: Started in the Nineties using SPOT data for land cover assessment. Now for consistency Uganda would like to use the same data source but it is very expensive. Assistance for forest inventory is under discussion with FAO but additional resources are needed.

Central African Republic: Proposing to involve the COMIFAC in an official partnership with Brazil in order to have a ground station for CBERS in the region and an operating monitoring system like DETER and PRODES.

Prof Camara reaffirmed the willingness of Brazil to cooperate saying also that an international partnership is even more interesting.

Tanzania: Stated that the dissemination of data to communities is crucial for a REDD policy. There is in the country very low capacity for remote sensing applications; moreover, needed hardware and software are also an issue. A forest inventory is ongoing under the framework of the NFMA programme of FAO, and a database for storing forest inventory data and related information for REDD has been set up.

Ghana: Problems with internet connection (no broadband availability) make the access to free on-line data quite impossible. Ghana has a long timeseries of inventory data in forest reserves that is now expanding on other forest land. FAO assistance has been solicited.

Mr Gerrand answered that under FRA and NFMA programs capacity building efforts are already ongoing depending on donors support. However, as showed in the workshop by several speakers, methods and services, within current availability of data, are already available and implementable by developing countries.

Belize: Stressed that even if within the country there are a huge amount of data available, very few people can use the data because of financial and technical constraints. Capacity building efforts are not currently implemented in the country and financial international cooperation is not providing resources.

Mexico: Stressed the importance of having an antenna for downloading CBERS data and expressed its interest in setting a real time monitoring system like DETER.
Kenya: Has access to ASTER data from USGS thanks to the UNEP assistance and NASA assistance for setting up the remote sensing office. Nevertheless, Kenya asked assistance for training in new methodologies of analysis of remotely sensed data.

Prof Camara reaffirmed availability of Brazil to cooperate and stated that capacity building is a multi-year activity aimed at building an international network of trained experts.

Costa Rica: Had forest cover maps of its territory completed within the last 20 years with LANDSAT data, but it lacks a systematic monitoring of land cover. Therefore, it asked for INPE cooperation in order to set up an operational system. Costa Rica has already completed a national forest inventory and a repetition is planned for 2010.

Dr Loveland remembered that NASA is working to reactivate the Mexican and Kenyan antennas of LANDSAT. Moreover, NASA is supporting the installation of the active fire monitoring software in the antenna computer station.

Financial session

Because of short time and several requests, the roundtable was transformed into a question-session briefly introduced by some statements the whole discussion has been succinctly summarized.

Dr Krug stressed the fact that capacity building should focus on both principles: capacity now and continuity of assistance for the future. The regulation of the Brazilian fund for REDD provides for a quote (20% of the fund) to be devoted to international cooperation (up to now circa 20 millions dollar). The fund is managed by the Development Bank of Brazil (not by the government) and has two steering Committees, one for analyzing policies and measures and one for accounting performance.

Mr. Werner Kornexl detailed the World Bank initiative related to REDD: the FCPF has selected 25 countries in its Participants Committee and other 5 countries have been added for the readiness phase under which a readiness plan (R-PIN) with a gap analysis for each selected country has been published. The FCPF is directly managed by donors and developing countries (WB has no voting rights) and money for the implementation of agreed REDD plan will be transferred to an executing agency in the assisted country which will manage the entire programme. Moreover, some international NGOs can fund starting activities on REDD.

Mr. Ulrich Krammenschneider informed participants that GTZ has bilateral programs in several developing countries that can be used as framework for initiatives aimed at capacity building in REDD, so he invited participants to talk with local representative of GTZ. Moreover, a special programme with the Brazilian Foreign Office on trilateral cooperation (i.e. South-South technical cooperation funded by a third Party) that can be used for funding Brazilian cooperation on REDD.

Dr Penman informed participants that the UK is investing 100 million pounds in this issue, half in the FCPF and half in other instruments like the Congo Basin Forest Fund or a financial instrument like the forest bond (currently under consideration). Moreover, Dr Penman said that the developing countries needs of past, present and future data could be ensured by the readiness phase of FCPF, but also by other bilateral agreements with one of the several players (e.g. European countries, USA, Developing countries like Brazil which have capacity to assist).

Several participants stressed the need to be included in either FCPF or UN-REDD in order to receive the appropriate technical and financial assistance. They fear that being excluded from such programs means to be left out of present and future secured sources of assistance. Finally, the creation of a Coalition Trust Fund was proposed with the scope to secure for each developing country equitable access to capacity building activities and funds.

Annex I: Provisional agenda

REDD Capacity Development Workshop on:

"Forest Area Change Assessment: The Experience of Existing Operational Systems"

INPE, Sao Jose dos Campos, Brazil
4-6 February 2009

1st day 4.02

Workshop opening

8:45 Welcome addresses
- Ministry of Foreign Affairs
- INPE's Director, Dr. Gilberto Camara
- BMU-GTZ, Mr. Ulrich Krammenschneider, GTZ Director for Brazil

9:15 "Workshop introduction" (Danilo Mollicone, Univ. Alcalà – Coalition for Rainforest Nations)
9:30 "REDD under the UNFCCC and relation with the monitoring objectives of the workshop" (Thelma Krug,
INPE)
10:00 to 10:30 Coffee break

1st Session "Earth observation satellites: current status and future plans"

10:30 USGS/NASA (Thomas R. Loveland)
11:00 ESA (Olivier Arinò)
11:30 INPE (José Carlos Epiphanio)
12:00 "Japanese project and research activities toward REDD from detection of forest change to estimation of
biomass change" (Hirata Yasumasa, Forestry and Forest Products Research Institute)
12:30 Global Earth Observation System of Systems – GEOSS (João Vianei, INPE)
12:45 to 14:00 Lunch break

2nd Session "Monitoring at global and regional scales"

14:00 "The Trees project: the JRC experience since 1992" (Hugh Eva, JRC)
14:45 "The FRA 2010 Remote Sensing Survey: forest area and change assessment under
the FAO Global Forest Resource Assessment 2010" (Adam Gerrand, FAO)
15:30 "Global quantification of forest cover loss from 2000 to 2005" (Matthew Hansen, SDSU)
16:15 to 16:45 Coffee break
16:45 "MODIS Burnt area products" (Luigi Boschetti, UMD/NASA)
17:30 "FORAF: Forest Monitoring in Central Africa" (Hugh Eva, JRC)

2nd day 5.02

3rd Session "Monitoring at national scale"

9:00 Brazil “the PRODES and DETER projects” (Dalton Valeriano, INPE)
10:00 to 10:30 Coffee break
10:30 India (Subhash Ashutosh, Joint Director, Forest Survey of India)
11:30 Panama (Emil A. Cherrington, Cathalac)
12:30 to 14:00 Lunch break
14:00 Indonesia (Matthew Hansen, SDSU)
15:00 Central America Land Use / Land Cover mapping (Jeffrey R. Jones CATIE/EPA)
16:00 – 16:30 Coffee break
16:30 to 17:30 Mexico (Carmen Meneses Tovar, CONAFOR)
17:30 to 18:00 Open discussion

3rd day 6.02

4th Session “Meeting the potential monitoring requirements for REDD under the UNFCCC”

9:00 Methodological aspects related to forest area change assessment through remote sensing : views from
GOFC-GOLD Sourcebook on REDD (Martin Herold, GOFC-GOLD Office)
10:00 – 10:30 Coffee break
10:30 – 11:30 Highlights on forest degradation
- Monitoring forest degradation through remote sensing
o Direct approach (Brazil)
 INPE (Dalton Valeriano)
 IMAZON (Carlos Souza)
o Indirect approach (PNG)
 Univ. of Alcalà (Danilo Mollicone)
11:30 – 12:30 Technology transfer and capacity building for forest monitoring systems
INPE, FAO, JRC
12:30 to 14:00 Lunch break
14:00 – 15:00 Bali indicative guidelines and SBSTA guidance on REDD monitoring systems and future capacity
development actions
o Round table
Coalition for Rainforest Nations, Brazil, FAO, World Bank