Measurement, Assessment, Reporting and Verification (MARV)
ISSUES AND OPTIONS FOR REDD

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1. Background and Purpose

This paper provides an overview of, and considerations for Measurement, Assessment, Reporting and Verification (MARV) actions within the developments towards a post-Kyoto mechanism for Reducing Emissions from Deforestation and Forest Degradation (REDD). It is an output of the International Support Functions component of the UN-REDD Programme. The paper is intended to guide UN-REDD Country Programmes and similar efforts (e.g. within FCPF and FIP) in preparing countries for a REDD mechanism.

The paper first introduces MARV and reviews key issues for its implementation. It continues with a set of country level options and considerations. Further, it defines a core set of key international actions to support REDD developments, as addressed by the UN-REDD Programme, and finally reviews major current initiatives related to MARV for REDD.

For more information regarding the UN-REDD Programme, please consult www.un-redd.net.

UN-REDD Programme actions on MARV are guided by decisions and conclusions of UNFCCC including its subsidiary bodies and meetings, following the "Bali Action Plan" (Decision 2/CP.13). The UN-REDD Programme also takes guidance from requirements expressed by countries participating in the Programme, as well as needs and complementarities expressed by a wide range of partners, including at the UN-REDD Programme expert meeting 17-18 September 2008. The UN-REDD Programme includes MARV actions that support future mandatory reporting requirements related to the intended REDD agreement, as well as MARV actions that support wider information provisions for national and sub-national implementation of REDD, as expressed and defined by countries.

2. MARV – Introduction and Elements

2.1. What is MARV?

The current use of key concepts in the various meetings and documents on REDD illustrates that the terminology is not yet consolidated, leading to potential misunderstandings. This paper adopts the following:

Measurement	Processes of data collection over time, providing basic datasets, including associated accuracy and precision, for the range of relevant variables. Possible data sources are field measurements, field observations, detection through remote sensing and interviews.
Assessment	The application of measurement data in mathematical/ statistical/expert methods and models to obtain results for a given geographic area (e.g. country or subnational) and a given time period (e.g. the state and change of carbon stock, the impact of land use change on biodiversity, or evaluations of other forest benefits relevant to REDD), including accuracy and precision estimates. Assessments normally also include analyses of data quality and gaps.
Reporting	The process of formal reporting of assessment results to the UNFCCC, according to predetermined formats and according to established standards, especially the IPCC Guidelines and GPG. It builds on the principles of transparency, consistency, comparability, completeness and accuracy.

Verification	The process of formal verification of reports, for example the established approach to verify national communications and national inventory reports to the UNFCCC.

Note that the term "Monitoring" has sometimes been used to describe one or several of the above four concepts in the UNFCCC process and related events and papers, but not in a consistent manner. This paper therefore draws from wording used in the Bali Action Plan: "measurable, reportable and verifiable [mitigation commitments or actions]" (paragraph 1b).

Note also that the accounting of carbon credits is not covered by the MARV concept.

2.2. Carbon stocks and changes

From a climate change mitigation and a carbon accounting perspective, this is obviously the core deliverable and highest priority for MARV under REDD, noting that accounting will be required at different scales from national to local, with potentially different requirements at different scales and locations.

At the national level, key outputs include:

- Regular national communication and potentially national reporting of GHG inventories to UNFCCC, using the IPCC Good Practice Guidelines. The submission of national inventory reports (NIR) is already an obligation for Annex I Parties, and may become a basis for national level accounting even for non Annex I Parties, given that it is an established reporting standard.

- As current reporting standards (IPCC GPG) focus on carbon stock changes in five carbon pools, an additional breakdown may be needed to determine conservative estimates under REDD. However, making requirements of reporting is currently subject to REDD negotiations and the outcome is yet unknown;

- Forest area changes, which is not a primary output, but a necessary input to the above as well as a commonly used political indicator.

Further, MARV will have to be applied at sub-national levels to determine Carbon stocks and changes for smaller land units such as mitigation projects, catchments, districts or individual properties, depending on the future and location-specific requirements on verification for payments.

2.3. Multiple benefits and other information needs

REDD includes addressing multiple benefits and livelihood issues. Achieving reduced emissions will require careful design and implementation of policies and regulations. These will depend on reliable information, including from monitoring of the environment, sustainable forest management, land use and livelihoods (i.e. including multiple benefits[1] and drivers of deforestation/forest degradation as well as land use change).

Some of these REDD parameters that go beyond carbon stocks and changes may become required in the mandatory reporting to the convention. In addition, several parameters can be expected to be

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[1] This paper uses the concept "multiple benefits" as a more generic and neutral concept, as opposed to "co-benefits" which has been used in other REDD related documents

defined and required at the national or subnational level, depending on the needs expressed by countries for efficient implementation of REDD, within the country-specific context.

Additional information needs include *inter alia*:

- information related to the drivers of deforestation and forest degradation, such as socio-economic parameters related to land use and land use change;

- information related to multiple benefits of forests, such as biodiversity, soil and water conservation, wood and non-wood products.

2.4. Synergies with requirements beyond REDD

In addition, there are considerable information requirements for policies and implementation outside the REDD specific context. These requirements to some extent overlap with the requirements for REDD. There is therefore a considerable potential for synergies if implementation of MARV for REDD is seen in a broader context. One obvious opportunity is to draw from existing national forest monitoring approaches and systems when developing MARV for REDD.

2.5. Key concepts and their implications for MARV

This section briefly reviews core REDD concepts and indicates what the implied requirements on MARV may be. For comprehensive definitions or reviews of these concepts, please consult the wider REDD literature.

Concept	Implications for MARV for REDD
Forest	The definition of forest is a standing topic for debate. Regardless of the (local) definition applied, it appears as REDD implementation may have to consider different and changing types or subsets of "forests" in different land settings depending on how the implementation is designed and negotiated. MARV approaches and methods should therefore avoid assuming any specific or fixed boundary condition for "forests", but instead generate data that allow for flexible application of the concept. In other words, MARV approaches should be able to include all types of landscapes with trees, under different land use and ecosystem conditions.
Deforestation	Deforestation is almost always the replacement of forests with another land use, normally agriculture crops or pasture, prohibiting the forest to regenerate. If forests are cut down, but no other land use enters, this would normally be forest degradation as the forest would eventually regenerate. Note that determining the actual establishment of another land use (a qualitative parameter) is not always straightforward. Under REDD, MARV needs to (a) identify areas that have been deforested, and (b) estimate the resulting Carbon emissions. Both of these are considerable challenges.
Forest degradation	Forest degradation is another concept under debate and negotiation. While it can be used as a broad measure of land decline, there seems to be an advantage in applying "reduced carbon stock" in the MARV under REDD context. This approach will (a) keep the focus on carbon emissions, and (b) provide a basis for practical MARV methodologies.
Reference	Reference Emission Levels (REL) describe the amount of emission or removals

Emission Level	for a country during a reference period, and may be a basis for negotiations of reference scenarios. This paper provides recommendations on measurements and assessments of historical trends, but not for determining REL as such.
Leakage	Capturing and reporting intra-national displacement of emission is an important and essential component for MARV. In some circumstances, international leakage may also have to be considered.
Permanence	"Permanence" of the reduction in emission or sequestration of carbon is the one of the main aims of the REDD mechanism. Therefore, any MARV –REDD system must provide and ensure monitoring of all factors that contribute to or adversely impact the permanence.

3. Key Issues and Options

Issue	Assessment
What determines accuracy and precision needs?	The quality (accuracy and precision) of MARV outputs will be one factor that determines the level of financial positive incentives. Lower quality will likely mean lower financial positive incentives. That said, it is reasonable to assume that requirements will be that (a) the MARV outputs are accurate or "emotion-free", i.e. the measurement and assessments are statistically made without adhoc judgements or negotiations and are not biased, (b) that the precision is known, i.e. the methodology allows for precision assessments, (c) that the methodology ensures desired level of precision, and lastly the (d) level of precision does not have to be extremely high, i.e. there is a relatively low premium for very high precision.
Cost-effectiveness: Accounting construction will define requirements and costs of MARV in all scales.	The cost of MARV will depend on the construction of carbon accounting and synergies with broader monitoring needs. Taken literally, REDD is a change (reduction) of change (deforestation/forest degradation), which is very costly to measure. If the requirements for accounting are less complex, i.e. based on change, or even state, of carbon stocks, the costs of MARV will be much lower. This will be particularly important to consider for crediting at subnational or local scales where the overhead (transaction cost) must be kept at a minimum. This calls for in-depth analyses of the accounting options at different scales.
Are existing technology and methods sufficient?	Yes, combinations of existing techniques and methods of field inventories and remote sensing for measurements are sufficient for MARV-REDD purposes. However, improvements to sustain cost-effective and operational methods is still needed. It can be noted that field inventories alone can be sufficient to meet needs of REDD, however remote sensing systems can be cost-effective in providing current and historical data on forest area changes. While remote sensing systems provide cost-effective opportunities

	for complete-area classification of forests and detection of forest changes, statistical field sampling is a proven tool for cost effective and robust measurements and assessments over time, as exemplified by national forest inventories.
Are there new technologies/methods to expect?	Yes, new technologies and methods are evolving, including Microwave, Radar and LIDAR systems seem to have good future potential for contributing to carbon stock measurements. They are generally not yet fully operational, but methodology development and testing over the coming years may provide new opportunities for REDD implementation.
Reporting Frequency	Reporting frequency will be negotiated under UNFCCC and if REDD will result in a financial mechanism then probably the reporting frequency will be on annual basis like all the other UNFCCC financial mechanism. Most probably the reporting will be based on the submission of national GHGs inventory that will contain standardized statistical analysis of the data provided by the monitoring system. There is an issue in that measurement cycles of forest carbon stocks and changes may be too costly to motivate independent estimates every year. Current forest monitoring systems often apply, e.g., 5 year averages in annual reports.
Institutional capacity	Most of the developing countries have poor capacity and are institutionally weak in respect of MARV-REDD. They will need capacity building and institutional strengthening for this purpose.
Varying ecological and land use conditions	The appropriate measurement technology and statistical design to capture carbon stocks and changes vary according to local conditions (e.g. from humid to dry forests, from large-scale to small-scale land use). In other words, one MARV design does not fit all circumstances.

4. Country Level Considerations

These considerations are primarily to inform the formulation and implementation of UN-REDD Country Programmes, taking into account the capacities, experiences and synergies with related programmes of the UN-REDD partner organizations (FAO, UNDP and UNEP).

Considerations	Comment
Institutional strengthening Long-term institutional arrangements for MARV to be established at the country level	REDD is a long term activity and therefore requires a long term consistent, compatible and scalable information. This calls for a long term institutional arrangement for its MARV system. Developing countries will need both technical capacity building as well as institutional strengthening in this

	respect. Needs of individual countries will vary since they are different not only in respect of their forest resources but also in respect of their size, economic and socio-cultural situations, environmental conditions, and development priorities,
	REDD ambitions and institutional capacities, will determine the needs for capacity building. However different, it is generally true that REDD countries will request to support to enhance their technical and institutional capacities for REDD monitoring, assessment, reporting and verification. At the same it will be necessary to synergise REDD needs with broader overlapping national needs in this context.
	Capacity and resources of UN-REDD are limited, therefore, there is a need for prioritising the most essential aspects at the beginning and gradually build capacities and strengthen implementation of national MARV systems. It may also be kept I mind that several countries have national monitoring systems in place, which provide an important basis for REDD monitoring efforts, meeting specific requirements of an eventual REDD mechanism;
	A very important and crucial aspect of national MARV-REDD system is its full national ownership that includes fair involvement of its stakeholder groups, the buy-in from its local levels and full engagement of its science and research. This is essential for long term sustenance, social and political acceptance and national level mainstreaming of MARV
	This political commitment and motivation must be expressed at the highest level before investment in national monitoring systems. This is because, many examples exist where national monitoring efforts have been implemented without such political support – experience shows that the efforts could not be sustained.
	International, regional and south-south collaboration have an important role to play in respect of such capacity enhancement, institutional strengthening and for developing a critical mass of national and regional competence;
Historical emissions Design and build MARV systems that include options to provide consistent,	The indicative guidance (COP 13) asks that reductions in emissions or increases resulting from the demonstration activity should be based on historical emissions, taking into account national circumstances. Therefore,

comparable and complete information on historical emissions	architecture and implementation methods of national MARV-REDD should include options to support estimations of historical emissions, if so required by the country. Remote sensing technology and methodologies are very effective and can deliver good support in this field. Ongoing efforts by countries participating in the remote sensing survey of the global forest resources assessment 2010 provides a starting point for enhanced national assessment of historical trends.
Current and future C stocks and changes Design and architecture of national MARV-REDD should include statistically representative field sampling as well as remote sensing components, considering country-specific requirements.	To comply with the higher tier levels of the IPCC GPG, the design and architecture of national MARV efforts for assessing current and future Carbon stocks should include some form of statistically representative field sampling, following broadly the principles of national forest inventories. If appropriately designed, in relation to the IPCC standards, this provides a robust and cost-effective basis for assessment of carbon stocks and changes that can be further enhanced through remote sensing approaches. When designing national level systems, the links with subnational/local requirements should be considered. Depending on the country-specific REDD strategy, there may be synergies between national and subnational MARV for REDD. National MARV-REDD efforts should also consider investing in development of models/methods for biomass measurements and assessment in all five carbon pools.
Information needs beyond Carbon accounting National MARV-REDD efforts take into account additional information needs beyond Carbon accounting as such, and consider synergies with existing forest monitoring systems	To enable MARV efforts to respond to REDD related policy dialogue, it should address data collection and assessment of parameters related to drivers of deforestatation and forest degradation, as well as a broader range of forest benefits. This means that such efforts should span biophysical, land use and socio-economic variables. Potential synergies with existing monitoring systems may be considerable and should be evaluated to avoid duplication of efforts. The broader information requirements will depend on country-specific conditions and requirements and can not be standardized at an international level, although international exchange of experiences may contribute considerably.

5. Key International Actions

This section reviews key actions that have been identified for international implementation in, or related to, the UN-REDD Programme. The actions are designed to provide additional support to Country Programmes.

Action	Comments
International capacity development efforts The COP 13 (UNFCCC - Decisions 2/COP 13,Bali 2007) asks to support capacity-building, provide technical assistance, facilitate the transfer of technology to improve, inter alia, data collection, estimation of emissions from deforestation and forest degradation, monitoring and reporting, and address the institutional needs of developing countries to estimate and reduce emissions from deforestation and forest degradation. Further the subnational approaches, where applied, should constitute a step towards the development of national approaches, reference levels and estimates.	Training and workshops that bring together stakeholders at regional/global level. Topics include National Forest Inventories, IPCC GHG. A programme for strengthening national capacities and implement national greenhouse gas inventories is being developed.
Standard setting for measurements COP 13 has encouraged countries to use of the most recent reporting guidelines as a basis for reporting greenhouse gas emissions from deforestation, noting also that Parties not included in Annex I to the Convention are encouraged to apply the *Good Practice Guidance for Land Use, Land-Use Change and Forestry*.	IPCC has provided new guidelines for monitoring, verification and reporting under UNFCCC, this guidelines are called Agriculture, Forestry and Other Land Use (AFOLU 2006) and actually they are still under the official approval process under UNFCCC. The AFOLU Guidelines could be finally approved by the next Copenhagen Conference of Parties. Although IPCC scientists are already working on future refinements and developing, once approved the AFOLU Guidelines would represent an important step forward for a more efficient and a more user friendly MARV framework reference system. In addition, the established process in SBSTA on Essential Climate Variables will be built on, especially as regards measurements of biomass.
Remote sensing data supply The efficient provision of remote sensing data, pre-processed to a high level of conformity and directly accessible over internet, will be a determining factor for the possibility of developing countries to establish effective MARV systems.	FAO is developing a collaborative programme with GEO and other partners. The overall purpose is to secure Free, Frequent and Useful satellite remote sensing data to countries and stakeholders.
Support to R&D	Research and Development activities are specially required in developing countries.

	Various initiatives are focusing on this aspect. For example, CIFOR is implementing a project "REDD: Research to Support Design and Implantation for Effectiveness, that will assess the relative effectiveness, efficiency and equity of alternative approaches to REDD" to address these issues for the benefit of the developing countries. (http://www.cifor.cgiar.org/)
Technical reviews	The international component of the UN-REDD Programme is commissioning a number of technical reviews in 2009, covering topics where knowledge gaps and/or additional needs have been identified. These include: 1. Multiple benefits assessment 2. Local, small-scale MARV 3. Forest degradation monitoring 4. Biomass measurement 5. Institutional aspects of MARV 6. Review of possible REDD constructions and implications for MARV 7. Assessment of historical trends Items 3 and 7 provide direct inputs to international consultation processes

6. Other relevant initiatives on MARV for REDD

A number of initiatives currently seek to guide the development and implementation of MARV under REDD. Some are listed below.

Initiative	Comment
GTOS ECV	FAO (http://www.fao.org/gtos/) through GTOS is supporting development of guidelines and specification for 13 terrestrial Essential Climate Variables (River discharge, water use, groundwater, lake levels, snow cover, glaciers and ice caps, permafrost and seasonally-frozen ground, albedo, land cover (including vegetation type), fraction of absorbed photo-synthetically active radiation (fAPAR), leaf area index (LAI), biomass, fire disturbance). This activity makes substantive contribution to harmonised data collection and use on ECVs some which like land cover and biomass are directly related to REDD.
GOFC-GOLD source book	GOFC-GOLD Sourcebook on REDD (http://www.gofc-gold.uni-jena.de/redd/index.php) aims to provide transparent methods that are designed to produce estimates of changes in forest area and carbon stocks from deforestation and degradation, complement the IPCC GPG-LULUCF (2003) and IPCCGuidelines-AFOLU (2006) by providing additional explanation, clarification and enhanced methodologies for obtaining and analyzing key data, and to support REDD early actions, capacity building and readiness mechanisms
Clinton initiative	The Clinton Global Initiative (http://www.clintonglobalinitiative.org/) is a project of the William J. Clinton Foundation that brings together a community of global leaders to devise and implement innovative solutions to some of the world's most pressing challenges.

Terrestrial Carbon Group	The objective of the Terrestrial Carbon Group (http://www.terrestrialcarbon.org) is for terrestrial carbon to be effectively included in the international response to climate change. It is attempting to provide guiding principles to do so in support of: (a) ongoing global negotiations on reducing emissions from deforestation and degradation (REDD) under the United Nations Framework Convention on Climate Change and Kyoto Protocol; and (b) emerging national, bi-lateral, and multinational efforts to maintain and enhance terrestrial carbon.
International Forest Carbon Initiative	Australian "International Forest Carbon Initiative" replaces Global Initiative on Forests and Climate, responds to Bali decision and plans to demonstrate that REDD can be part of an equitable and effective international agreement on climate change and that market mechanisms can be used to address REDD. The initiative is supporting development of national carbon accounting and monitoring systems. It is working closely with the Clinton Climate Initiative and Group on Earth Observations (GEO) to develop a global carbon monitoring system.
Brazil	Government of Brazil (http://www.sfb.gov.br) has initiated its National Plan on Climate Change and the Amazon Fund. The plan focuses on seven areas; Low carbon development, Renewable electricity, Biofuels, Deforestation, Forest cover, Vulnerability and adaption, Research and development. Brazil's National Institute for Space Research (INPE), a research unit of the Brazilian Ministry of Science and Technology (MCT) is also contributing to this effort. INPE main goals lie in fostering scientific research and technological applications and in qualifying personnel in the fields of Space and Atmospheric Sciences and Applications and Space Engineering and Space Technology.(http://www.dpi.inpe.br/).
GEO	It is coordinating international efforts to build a Global Earth Observation System of Systems (GEOSS). The requirements of GEO (http://www.earthobservations.org/) are embodied largely within its nine identified Societal Benefit Areas (SBAs), which it expects will be meaningfully addressed by its Global Earth Observation Systems of Systems (GEOSS). These areas are: 1. Reduction and Prevention of Disasters, 2. Human Health, 3. Energy Management, 4. Climate Change, 5. Water Management, 6. Weather Forecasting, 7. Ecosystems, 8. Agriculture, and 9. Biodiversity. Recently, the G8 Heads of State have also underlined the importance of such actions during their July 2008 summit in Tokyo: "To respond to the growing demand for Earth Observation data, we will accelerate efforts within the Global Earth Observation System of Systems (GEOSS) in priority areas, inter alia, climate change and water resources management, by strengthening observation, prediction and data sharing".
CD-REDD	The Coalition for Rainforest Nations (http://www.rainforestcoalition.org) is carrying out capacity development initiative "Capacity Development for Reducing Emissions from Deforestation and Forest Degradation (CD REDD)" with the support of the GTZ (German Technical Cooperation Agency), the BMU (German Ministry of Environment), the FCPF (Forest Carbon Partnership Facility) of the World Bank, the GEF (Global Environmental Facility), the INPE (Brazilian Space Research Agency), the Indian Forest Service and GOFC-GOLD (Global Observation of Forest and Land Cover Dynamics). The CD REDD will work at the international level: global workshops and training courses will be organized on topics of common interest and will provide the opportunity for information sharing among countries.