# Design for integrated monitoring Systems for REDD+ in the SADC region

## Background

The development of monitoring systems to measure, report and verify changes in forest cover and related carbon emissions (MRV systems) is one of the first steps that developing countries in Southern Africa and in other parts of the world should take in order to participate in a global mechanism that rewards them for Reducing Emissions from Deforestation and Forest Degradation (REDD+).

The Intergovernmental Panel on Climate Change (IPCC) has published guidelines for MRVs that shall ensure that data is collected in a transparent and consistent way and that it is comparable and accurate (IPCC, 2006; IPCC, 2003). A main recommendation is that countries combine Remote Sensing technique with ground-based forest inventories to monitor changes of forest cover and related emissions.

However, there is a large variety of Remote Sensing and forest inventory systems that can be combined in different ways that are all in line with the IPCC guidelines. Which way is best depends on national circumstances like dominant forest ecosystems, main drivers of deforestation and forest degradation, days of cloud cover and existing forest inventory systems. Hence, developing MRVs requires a lot of expertise, which is limited in most countries of the Southern African Development Community (SADC) region. Furthermore, most countries have limited technical, institutional and human resource capacities to maintain MRVs.

Against this background, the German Federal Ministry of Environment, Nature Conservation, Building and Nuclear Safety (BMUB) commissioned GIZ to support the SADC Secretariat in a REDD+ MRV project from 2011 to 2015.

The regional scale of the project has the advantages to correspond to the transboundary nature of the ecosystems and to be resource efficient. Furthermore, it contributes to implementing the SADC support programme on REDD, component 4, to harmonize and standardize the methodologies used by Member states, to enable collaboration among states and the comparability of data across and between countries.

The technical development of the MRV system, its testing in five pilot countries and several parts of the training measures have been awarded in a tender to a consortium of GAF AG Consultant for Geo Information services, DFS Deutsche Forstservice and Geo-Terra Image South Africa.

As was verified by an independent auditor, the MRV design tested on a site in Botswana is in line with the IPCC requirements. It can now be adopted or used as a model by all 15 SADC Member States.

## Selection of pilot sites

The SADC Technical Forestry Committee had approved a transparent catalogue of criteria for the selection of pilot sites. According to the catalogue, pilot sites were to be established preferably in countries with the most common forest types, high deforestation rates and up to 26,000 km2 contiguous forest. Consequently, the project implemented one pilot site for Baikiaea woodlands in northern Botswana, two for Mopane forests in Mozambique and Namibia and one site spanning the border between Malawi and Zambia for Miombo woodlands.

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## Design aspects

The development of the MRV design was guided by the decisions of the international climate negotiations, the IPCC guidelines and the GOFC GOLD source book (2012/13). As mentioned above these guidelines had to be interpreted in a regional and national context. For example, in dry forests of the region the vegetation structure is open enough to measure tree characteristics in circular sample plots. Usually circular plots are established
easier than rectangular plots that are typically set up in forests with dense understorey. Special emphasis was given to the use of open source products like freely available satellite images to avoid additional costs in the future.

**A forest inventory team is testing the MRV design in Baikiaea woodland in Botswana.**

## Carbon pools

Forests can be divided into different carbon pools: aboveground biomass, belowground biomass, soil organic carbon, dead wood and litter. So far, in the region there have been few studies to determine forest carbon. In contrast, inventories that focus on the standing volume stock of forests are more common. At three test sites of this project accurate measurements of the aboveground biomass carbon pool were carried out.

It is estimated that a large amount of the region's forest carbon is stored belowground. Therefore, the project calculated this pool through utilizing default values. The estimations of the carbon pools improve the data basis of the region. Methodologically the measurements reach a Tier 2 level for aboveground biomass and a Tier 1 level for belowground biomass.

To estimate carbon stock changes, the IPCC guidelines propose the use of a hierarchical structure (Tier 1, Tier 2 and Tier 3) where higher tiers represent greater methodological accuracy but also costs. At the moment only few countries are able to reach Tier 2 accuracy, which is the prerequisite for financial compensation from REDD+. However, IPCC encourages countries to steadily improve their methods and to combine Tier 1 and Tier 2 methods in the meantime.

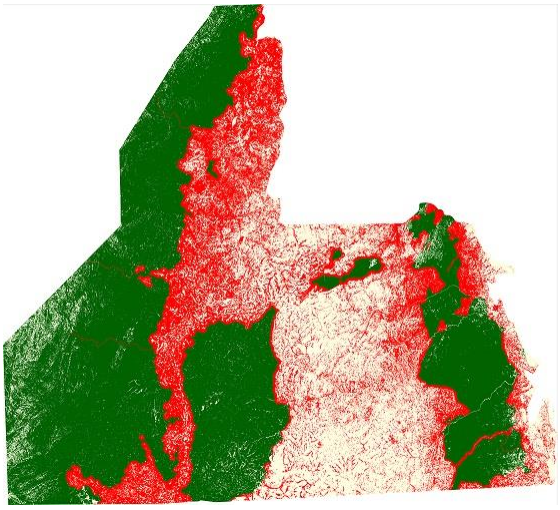
## Remote Sensing

The project processed high resolution satellite images to map areas of deforestation and forest degradation at the pilot sites. Based on a comparison of images from different years, areal changes, "Activity Data" (AD), were identified. For documenting the changes in forest degradation, areas were stratified into intact and non-intact forest. The resulting maps were the basis for the ground-based inventories.

IPCC recommends the use of Landsat images that cover the historic epochs of 1990 and 2000, because it lasts 20 years until carbon stocks come into equilibrium after a change/disturbance.

Accordingly, the project obtained Landsat data from the years 1990, 2000 and 2010.

0.5 ha was chosen as the Minimum Mapping Unit (MMU) of the MRV system, because it is the minimum size in FAO's forest definition and is a suitable standard across countries. The chosen MMU was achieved with a 30 m resolution of cost-free Landsat images. However, mapping areas of 1 to 5 ha would still be sufficiently accurate and is recommended by GOFC Gold (2012/13).



**Processed satellite image showing changes from intact to degraded forest (dark red) between 2000 and 2010.**

The project aimed at using cost-free optical data in the beginning. However, since 2003 the Landsat 7 data have regular line drops due to sensor defects and could not be used as the single source. Thus, also RapidEye satellite data was bought. Future MRV REDD+ monitoring systems may consider the Landsat 8 and Sentinel 2 data that will be freely available.

### Forest inventory

The forest carbon inventory took place in areas that had been stratified either as intact- or as non-intact forest. Belowground biomass and carbon stocks of deforested land and of land without forest were calculated with the aid of IPCC default values. In the forested areas the following tree characteristics were sampled to determine tree biomass and carbon stocks: species, diameter at breast height and tree height. Apart from living trees, dead wood standing and on the ground was measured. Biomass of living and dead trees was calculated by equations, specific for the region and the country. Using a stratified restricted random sampling design, tree characteristics were measured in fixed size, concentric, circular sample plots. Clustering of sampling plots helped to save working time and costs, while at the same time it did not diminish the coverage of stand structure variability.

Forest inventory data was used to determine Emission Factors (EFs) that refer to emissions/removals of greenhouse gases per unit area. EFs were then multiplied by Activity Data to estimate the actual emissions/removals from the pilot sites (EF X AD = emission/removal). These estimates provide a solid basis for continuous reporting. On condition that further data will be collected, they can be used for national or sub-national reporting under REDD+.

### Quality Control and Assurance

Sampling and analysing data of forest cover changes and carbon stocks always involves uncertainty or error and is only an approximation to reality. "Uncertainty" can refer to statistical variability, lack of knowledge or to the variability in the use of measurement instruments. Uncertainties exist for Remote Sensing, forest inventory and the combination of the two.

The project reduced uncertainty as much as possible through implementing Quality Control (QC) and Quality Assurance (QA) procedures.

For example, to assess the accuracy of the Remote Sensing results, 1 % of the results were validated with independent reference data that was derived from very high resolution images.

Some QC procedures for the forest inventory were as follows: completeness checks of field recording sheets, plausibility checks of diameter-height relations of sample trees and re-measurements of randomly selected sampling points.

One main error was the sampling error of the inventory. The project established 300 sample plots per test site to keep the sampling error at 5 % or less. However, an independent auditor group stated that this is too laborious, too expensive and not necessary and recommends a sampling error of 10 %.

QA was the Verification conducted by an independent third party group that was registered with the United Nations Framework Convention on Climate Change (UNFCCC) as certified auditors. The auditors checked whether the processing of satellite data and the measuring of relevant carbon pools had been in accordance with the system design and the IPCC guidelines. To insure integrity of the QC/QA procedures, QC managers passed QC recording sheets to the auditing group.

Since, in the future external reviewers shall be from both, developed and developing countries, SADC member states are highly encouraged to support national experts to obtain UNFCCC accreditation.

## Template for standards

In November/December 2014 SADC country representatives consulted on regional standards for REDD+ MRV. They used the tested MRV system as a template for formulating the standards, because of the positive auditing results from Botswana and because of the relatively low costs of the system.

Once the ongoing consultations on the standards are completed, they shall be submitted to SADC's technical advisory bodies and Environment/Forestry Ministers for adoption in 2015.

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