Course reading assigned during

# WCS Workshop on Land Change Modeling for REDD

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Hosted by

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# IDRISI Focus Paper

## Modeling REDD Baselines using IDRISI's Land Change Modeler

Reducing Emissions from Deforestation and Forest Degradation (REDD) is a climate change mitigation strategy gaining momentum with conservation organizations, project developers and governments in developing countries. Forests play a major role in the sequestration of carbon, and the conservation of tropical forests, in particular, yields the greatest potential for reducing greenhouse gas emissions. This paper will provide a general overview of modeling REDD baselines, one of many components required for REDD implementation.

### ESTIMATING EMISSIONS

Initiatives to implement REDD at the national or regional level require the development of a scenario of greenhouse gas emissions that would occur in the reference region if a project were not to happen. The calculations for the reference region must include the proposed project area as well as the surrounding *leakage* area, adjacent land where displaced deforestation may likely occur as a result of the REDD project. This estimate of emissions helps determine whether the potential carbon offset project will provide *additionality,* carbon offset that would not have occurred if a "business as usual" scenario were maintained. When a project is implemented, the actual emissions are compared to the calculated emissions in the reference scenario to calculate the creditable emissions reductions.

Several methods for estimating reference emissions levels have been proposed to the Voluntary Carbon Standard (VCS) Program, and all require modeling future emissions based on historical trend rates and relationships between deforestation patterns and drivers of deforestation. One of the first methodologies submitted to VCS for review is the mosaic methodology, put forth by the World Bank BioCarbon Fund.

The mosaic methodology is utilized for estimating emissions for mosaic deforestation: that which occurs in forests that are accessible to external pressures, as opposed to frontier forests. The Government of Madagascar, with the support of Conservation International and the BioCarbon Fund, used the Land Change Modeler application within IDRISI to develop a REDD project along the Ankeniheny-Mantadia Corridor employing this methodology. The overall objectives were to reduce greenhouse gas emissions, increase protected areas, and reduce the loss of biodiversity by reconnecting forest fragments and reducing future forest fragmentation.

### BASELINE MAPPING

The development of land cover and land use change maps guides a REDD project. This historical mapping analysis is termed baseline mapping. Baseline mapping is comprised of three stages:

1. A review of the historical land cover change of the area.

2. Interpretation and analysis of the historical trends and locations of deforestation, particularly the identification of the agents, drivers and conditional factors (hereafter referenced simply as drivers) of deforestation.

3. Incorporation of such drivers in map form into a model to determine potential future scenarios.

The IDRISI software offers a complete land analysis toolkit for the REDD Project Manager. This paper outlines a typical REDD mapping scenario with IDRISI's Land Change Modeler application.

### STAGE ONE: UNDERSTANDING HISTORICAL TRENDS

The REDD Project Manager must first understand the historical trends of land use change in the study area. For the Madagascar case study, three dates of land use data were used -- 1990, 2000, and 2005. The figure below shows the historical deforestation pattern from 1990 to 2005. The dominant land use in and around the project site is slash and burn agriculture. This land use category is the prime cause of deforestation and degradation in the case study region.
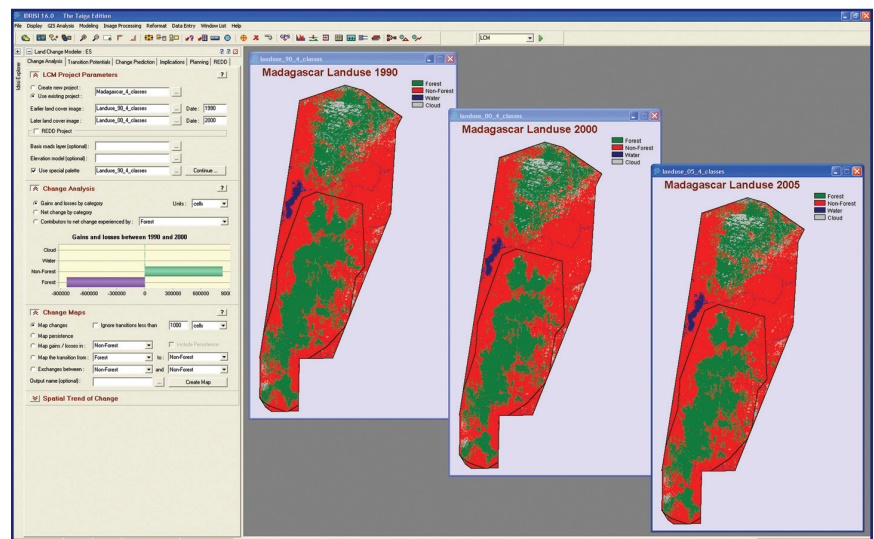
With the Land Change Modeler, a REDD practitioner can utilize a set of tools to rapidly assess change, generate a series of evaluations of gains and losses, net change, persistence and specific transitions both in map and graphical form. This rapid assessment allows for an understanding of the dynamics of change.

### STAGE TWO: IDENTIFYING DRIVERS

In the next stage, the REDD Project Manager must identify the land use and land cover transitions, e.g., from forest to non-forest, that are thought to have occurred from the same underlying forces in that particular location. For instance, distance to roads is quite often a strong indicator of potential deforestation, as is proximity to markets or population density. Since drivers may be environmental and/or socio-economic in nature, a project manager must consider multiple in-country factors and influences: infrastructure developments, the topography of the land, agricultural expansion and others.
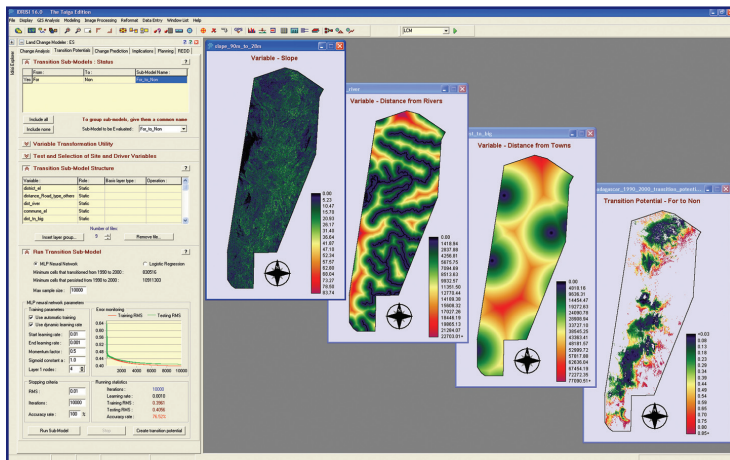


Once these drivers have been rendered as spatial data, e.g, slope and distance maps, they are aggregated within the Land Change Modeler to produce transition potential maps for each transition being modeled. The maps that are generated are based on the historical land use change, as well as the relationship and importance of the drivers, and illustrate the areas that are more likely to be converted. The figure above shows a few of the driver variables used in this particular case study, including elevation, slopes, distance to rivers and streams, distance to roads, and distance to population centers. The transition potential maps become the basis for modeling future land change scenarios.

### STAGE THREE: MODELING FUTURE SCENARIOS

The final stage for the REDD Project Manager is to estimate future change. Land Change Modeler provides the controls for a dynamic land cover change prediction process. Future scenarios are modeled based on the transition potential maps. Both hard and soft predictions are produced. The hard prediction map represents a specific scenario. The soft prediction output is a continuous map of vulnerability to change and provides a comprehensive assessment of all plausible scenarios.

In our case, forest to non-forest land cover change was modeled over three historical time periods, with the last period used to validate the model. Once a proper model was developed, it was used to run a 30 year scenario to simulate the entire project implementation period. Scenarios were developed for 5 year intervals to coincide with specified reporting and assessment requirements. The image below shows both hard and soft prediction scenarios with the transition probability matrix of change for the year 2035.

Baseline mapping and scenario modeling are only two aspects of an entire REDD project. If the REDD project in Madagascar is successful as planned, it is expected that this scenario will produce a total amount of Voluntary Carbon Units (VCUs) equivalent to 44,355,616 tons of carbon dioxide equivalent (tCO2e).

The Land Change Modeler toolkit in IDRISI provides a comprehensive modeling environment to guide the REDD analyst through the steps of baseline mapping and prediction. This tool can greatly reduce the time and cost in the development of a deforestation baseline, which currently is delaying the finalization of project development for many prospective REDD projects.