New tools and methodological framework to study spatial drivers of deforestation, degradation and regeneration and forecast possible futures in Madagascar

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Abstract

Deforestation, land degradation and land regeneration are rapid and complex processes that greatly impact climate regulation, ecosystem services provision and population well-being. Appropriate response through land use planning and intervention should be enlighten by a comprehensive drivers analysis and spatially explicit risk and opportunity information which could be easy to update as new data become available or updated. In this study we explore the use of global high resolution vegetation change, biophysical and socio-economical dataset to map deforestation, land degradation and regeneration suitability. A stratifed sampling scheme was applied to collect change/no change calibration points which were then modeled using the random Forest algorithm. The predicted change class membership was used as a surrogate of probability of land change. These potential change maps were used to draw three scenarios of quantity change for the two next decades (2015-2035) based on past trends and an alternative scenario. We finally assessed these outputs with respect to existing protected and non-protected areas.
Historical observation during 2001-2014 display clear patterns of high deforestation (1774 ha / y), high degradation (2737 ha/y) and low regeneration (302 ha/ha) over the 1,600,000 ha study area. Amongst the twelve predictors, distance to natural habitat and elevation were

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the most important for the three land transitions. Slope, aspect, and distance to villages also influence land change to a lesser extent. Validation of land change models showed satisfactory figures with ROC values above 0.8 and overall accuracy above 75%. Business as usual scenarios highlighted the large areas under deforestation and degradation threat within the western forest edge of the study area and within one of the two national parks (Midongy). Nevertheless, the neighboring and non-forested areas of this latter park showed the highest opportunity for land regeneration.
The approach was successful to provide a comprehensive assessment of driver of deforestation and potential change maps as well as expert-based prospective view that appeared to be useful for feeding land use negotiation about alternative land use trajectory. The tool is adaptive, easy to replicate and produce good suitability estimates, thus we believe it could be used in developing countries to both meet their REDD+ requirements (reference emissions levels) and used in targeting their local interventions (control in protected areas) or promote large scale sustainable land management strategies.

Keywords: Ecosystem Services modeling, Deforestation, Land degradation, Land regeneration, REDD+, driving forces