Deforestation Effects on Sedimentation of Watersheds and Marine Environments: MaMaBay, Madagascar

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Study Area

MaMaBay is comprised of two parks (Makira and Masoala protected in 2009 and 1997, respectively) and Antongil Bay. The concern for this area is the effect of deforestation for agricultural purposes and illegal logging may lead to biodiversity loss and land degradation. This area maintains 1% of the earth’s biodiversity. This ecosystem is the home of several plant and animal species (including humans), and is in need of further protection to ensure the health of the land and water ecosystems are maintained.

Methodology

Deforestation
1. Developed Landsat-7 images to classify forest, non-forest and water for 2010.
3. Corrected missing values in 2010 with previous CI maps.

Soil Erosion
1. Generated 6 factors with rainfall, soil, elevation, and vegetation data.
2. Estimated of soil loss throughout MaMaBay boundary from 2000 to 2010.

Derived watershed map using DEM.

Sedimentation
1. Used MODIS Level 3-16 day product aggregated into a monthly product showing ocean color anomalies.
2. Conducted a times series analysis used to show overall variance in ocean color anomalies from 2000 to 2010.

Erosion Risk Map

Deforestation, Potential Soil Loss, and Sedimentation

In region ①, the rate of deforestation per watershed varies between 6 to 15% of the entire watershed, and is increasing non-forest coverage from 1990 to 2010. As seen in the potential soil loss image, region ① is also at risk of 36 to 140 tons per hectare per year of soil loss. The largest sedimentation plume in Antongil Bay was found in the estuary of region ①, and has a strong correlation of continuously increasing throughout 2000 to 2010. There are also high rates of deforestation occurring in region ① with 6 to 15% deforestation occurring per watershed, and this change has occurred mostly between 2000 to 2010. The second largest sedimentation plume in the bay is found here, with a comparable magnitude of continuously increasing similar to the northern plume. Throughout the entire Antongil Bay, there is an continuously increasing trend of sedimentation through 2000 to 2010.

Main Findings

Area A: This watershed area lies mostly within the protected MaMaBay boundary. Maximum deforestation of 12-15% per watershed has occurred within the protected areas between 1990 to 2010. Average potential soil erosion of 61 to 140 ton per hectare per year may occur in this area within the boundary. The largest plume discovered in the bay receives sediment from this entire area. This plume has been continuously increasing in sedimentation with only a 1% probability this happened by chance.

Area B: This watershed area is split between being inside and outside the MaMaBay boundary. Maximum deforestation of about 12-15% per watershed has occurred within the protected areas between 1990 to 2010. Average potential soil erosion of up to 61 to 140 ton per hectare per year may occur in this area within the boundary. The shallows bordering this land mass is home to shallow, fertile reef systems.

Research Objectives

- Determine the existence and extent of deforestation from 1990 to 2010.
- Evaluate the extent and quantity of erosion and sedimentation in watersheds from 2000 to 2010.
- Illustrate the rate of change of sedimentation entering the bay ecosystem related to deforestation and erosion from 2000 to 2010.

Data

[Table data]

Further Research: Examine villages and roads as driver variables to deforestation. Collect soil samples and cropping samples to validate current research.