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Modelling deforestation trends in Costa Rica and predicting future forest sustainability

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Deforestation in Costa Rica has historically varied between the original degradation of primary forest due to land-based industries, followed by secondary regrowth. The regeneration of forests largely came into effect with incentive based programs such as payments for ecosystem services, creation of large protected areas, and a new industry of ecotourism in the country. Given the changes that have occurred within the last 50 years from heavy deforestation pressures to regeneration patterns, and a correlation between deforestation and policy/economic influences, it is important to understand the historical changes that have occurred and how the forests will change in the future, which provides the objective of this study. Future projections are increasingly important given changes in the global socio-political structure, climatic change, and the ever increasing globalization of capitalistic endeavours. The trajectory of the forest in the country can also serve as a way to track both these global pressures on the natural landscape in Costa Rica, and as a proxy for how to manage deforestation in other similar political and geographic areas of the tropics.

To determine the historical deforestation trends and link them to the different biogeophysical and socioeconomic variables, forest maps from 1960-2013 were used in the Dinamica Environment for Geoprocessing Objects (Dinamica EGO) to create deforestation models for Costa Rica. Dinamica EGO is a cellular automata model which utilizes Bayesian statistics and expert opinion to replicate both patterns and quantities of land cover change over time with both static and dynamic variables. Additional legislative variables can be used to track how political pressures shift deforestation both spatially and temporally. The historical model was built and analyzed for changes in landscape metrics such as patch size and distance between 1960 and 2013. After validation of the model's ability to replicate patterns, first between 2005 and 2013, and then back to 1997, a future model was created to determine future country wide changes.

There was a significant decrease in patch size between 1960 and 2013 in forests and a non-significant decrease is patch size for non-forests. The historical model validated at 85% accuracy within 600m for both the 2005-2013 and 1997-2005 iterations. Future scenario building determines the point in time and area at which the forest area equilibrates, indicating the approximate maximal forest extent under extreme scenarios. None of the scenarios were sufficiently damaging to decrease the forest area below present day levels. The Puntarenas province is the only region which had deforestation in the most extreme scenario. Using the inclusion and exclusion of protected areas within the model, it was determined which of the parks suffers from high pressure of deforestation should there be policy removing protected area status. These parks are predominantly limited to small areas on coastal regions, while the large central parks suffer relatively little pressure from deforestation. This indicates that even under the most extreme scenarios, the secondary forests are likely to remain permanently and continue to regenerate as time progresses.