The System Dynamics of Forest Cover in the Developing World: Researcher vs. Community Perspectives

Abstract

Efforts to increase forest cover in the developing world will only succeed if the root causes of deforestation are addressed. It is therefore important to know if the researchers designing reforestation initiatives and the local people who implement them have similar views of how and why forest cover changes over time. In this study, I compared causal loop diagrams of forest cover dynamics on Negros Island, Philippines generated by researchers working for the World Wildlife Fund with causal loop diagrams generated by community members in upland Negros. The diagrams were significantly different, with very few variables in common, indicating the presence of a gap between researcher perception of declining forest cover and local perceptions of the same issue. A group model-building exercise involving both researchers and community members could help to bridge this perception gap and generate a more holistic view of the causes of declining forest cover.

Keywords: deforestation; development; group model-building; reforestation; Philippines

I. Background

Global efforts to promote reforestation in the developing world are gaining prominence, due to increasing interest in carbon sequestration as a tool to combat climate change (Houghton, Unruh, and Lefebvre 1993; Gibbs et al. 2007). The success of reforestation initiatives will require an understanding of the most appropriate scale of governance at which reforestation initiatives should be implemented—whether local, regional, national, international, or all of these. Recently, local and community-based reforestation initiatives have become popular with funding agencies and development organizations (Ye 2006; Walton et al. 2006). However, the literature also suggests a wide array of macro-level causes of deforestation, such as global trade regimes, poverty, population dynamics, and agricultural expansion (Colchester and Fay 2007; Geist and Lambin 2002; Allen and Barnes 1985). Clearly, if these large-scale causes are not addressed, local attempts at reforestation will be overwhelmed by a broader trend towards deforestation. Deforestation and reforestation may therefore be seen as alternate states of the same variable, forest cover (Roque et al. 2000). Some researchers have attempted to synthesize the different scales at which reforestation and deforestation operate, but few have delved into the *dynamic* interactions among scales and drivers (Kummer and Turner 1994; Lambin et al. 2001). Obviously, the particular driving forces that affect forest cover are highly dependent on the geographical location and scale of the study area (Geist and Lambin 2002).

In the Philippines, community-based reforestation projects have been attempted for several decades, with mixed success (Balbarino and Alcober 1999; Walton et al. 2006; Shively 1999). Meanwhile, deforestation in the Philippines—including inside of protected areas—remains a concern (Sheeran 2006). The complex and dynamic behavior of forest coversuggests that a modeling exercise may reveal important and unexpected insights for decisionmakers (Vennix 1996; Meadows 2008). Furthermore, the need for reforestation initiatives to take into account both local context, scientific knowledge, and economic dynamics suggest that a group model-building exercise involving both researchers and community representatives could be beneficial (Vennix 1996; Van den Belt 2004).

Group model-building has been used in a wide variety of resource management contexts, including water systems and wildlife management (Pahl-Wostl and Hare 2004; Beall and Zeoli 2008). Although it can be costly and time-consuming, the process of building a system dynamics model with a group of participants allows for social learning among stakeholders, as they share opinions, information, and perspectives on a given problem (Van den Belt 2004). Group model building also can provide a space for stakeholders to reach consensus on difficult or contentious issues. By bringing together participants with different types of knowledge, a group model-building process can take advantage of the maximum potential range of qualitative and quantitative information relevant to the problem being addressed (Vennix 1996). Finally, comparative studies have demonstrated that problem solving teams who use group system dynamics modeling generate more structured discussions and a more complete critical analysis than groups using more traditional facilitation methods (Dwyer and Stave 2008). For all of these reasons, group model-building may be an appropriate tool for designing reforestation initiatives in the Philippines.

My goal for this study was to determine if an analysis of deforestation's causes and options for reforestation in the Philippines could benefit from a group system dynamics model building approach. If the researcher-generated and community-generated local models of forest cover decline are significantly different, insight into the problem of decreasing forest cover may be gained by bringing researchers and local community members together to learn from one another in a model-building exercise (Vennix 1996). Identifying and modeling the causes of forest cover decrease is a critical first step in halting deforestation and promoting regrowth of deforested areas.

The study objective was therefore to compare an 'expert', or researcher, view of the causes of deforestation and potential for reforestation in the Philippines with a local or community view to determine the potential for a participatory model building exercise to advance understanding of the problem. Specific questions to be answered include: (1) Are there significant differences between the researcher view and the community view of the causes of a decrease in forest cover? (2) Do both researchers and community participants identify causes of forest cover decrease operating at multiple spatial scales? (3) Do researchers and community members identify

different ‘leverage points’ where policies or incentives might be used to generate an increase in forest cover?

II. Methodology

In this study, I compare a researcher-generated causal loop diagram of forest cover dynamics on an island in the central Philippines with a community-generated causal loop diagram of forest cover dynamics, to determine if there are significant differences between these two groups’ views of the issue. For this study, I am taking the view that the variable of interest is ‘forest cover’, which may decline (through deforestation) or increase (through reforestation) over time. This is the view taken by the researchers who created the causal loop diagram I am using in the analysis (Roque et al. 2000).

Negros island, located in the central Philippines, has historically been a region of high terrestrial and coastal biodiversity (Alcala 2001). However, the island’s landscape, which was predominantly tropical seasonal forest as recently as the 1950s, has been changed dramatically through deforestation and intensive agriculture, with adverse consequences for the island’s biodiversity, water quality and forest resources. By some estimates, 95% of the island’s original forest cover has been removed (Lopez-Gonzaga 1994). The Philippine government has identified reforestation of the country’s mountainous regions as a development priority (National Economic and Development Authority 2004). Local non-governmental organizations working in the uplands of Negros are also promoting reforestation projects for controlling erosion and protecting water supply.

Three prominent socio-economic patterns characterize Negros Island: a distribution of agricultural lands that disadvantages the poor; a high rural poverty rate; and a high population density (Roque et al. 2000; Riedinger 1995; National Statistics Office of the Philippines 2009). Negros served as a center of Philippine sugar production beginning in the mid-1800’s, during which time land-grabbing by Spanish nobility was sanctioned by the colonial government for the purpose of building the country’s sugar export industry. Many large-scale landowners on Negros today are the descendents of these Spanish nobles, leaving the island’s poorer residents to practice marginal subsistence farming in steep mountainous areas (Lopez-Gonzaga 1987). Negros also has a higher incidence of families living in poverty at 22%, compared with the national poverty incidence of 17% (National Statistics Office of the Philippines 2009).

The World Wildlife Fund published a study of Negros Island’s deforested condition and a causal loop diagram of the deforestation problem in 2000(Roque et al. 2000). I used this diagram as a benchmark to compare and contrast this researcher view with a community-based view of deforestation. The WWF research team conducted sectoral studies of Philippine biodiversity, demography, economy, and politics, and generated several causal loop diagrams specific to key points of concern for the organization (Figure 1). Accompanying text detailed the reasoning

behind each diagram. The WWF's goal was to identify the root causes of biodiversity loss in the Philippines, and forest cover was used as a proxy for biodiversity, given limited data availability on indigenous species.

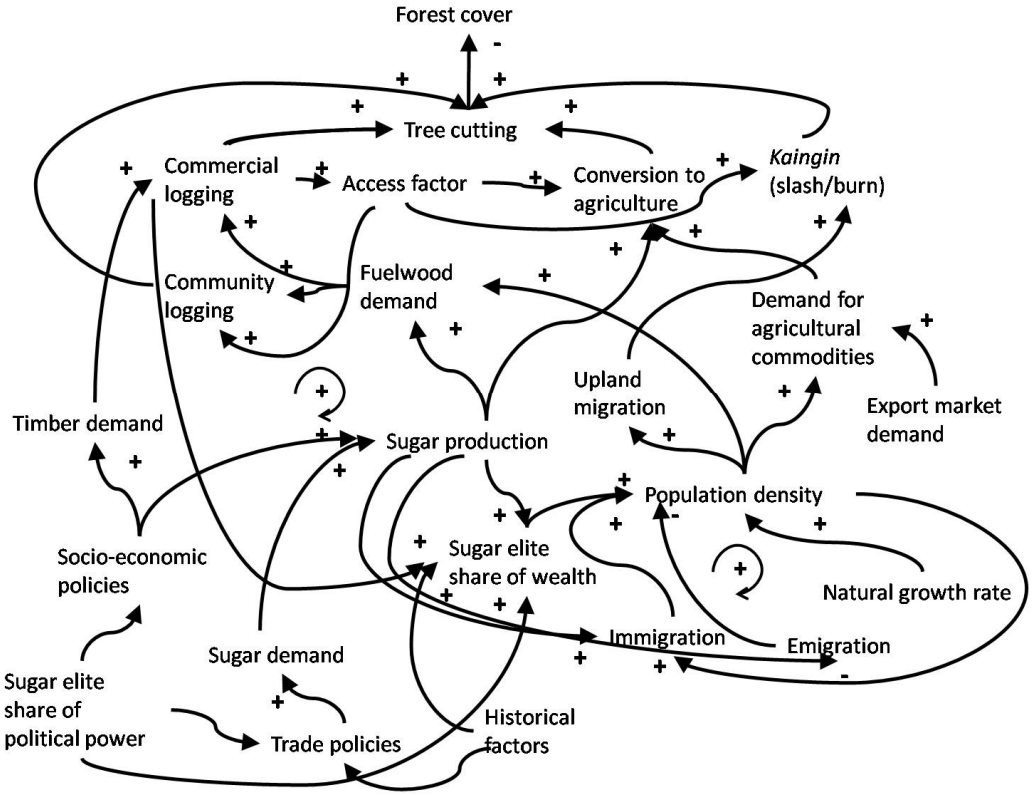

Figure 1: Causal loop diagram depicting forest cover decline on Negros Island, generated by researchers from the World Wildlife Fund (Roque et al. 2000, p. 296). Two main positive feedback loops are embedded in the model; these are discussed in the text below.

To generate a causal loop diagram reflecting a local community's view on the causes of deforestation on Negros, I traveled to the municipality of Canla-on, near one of the island's remaining forest reserves and its highest peak. I attended a community workshop conducted by a local NGO, the Negros Institute for Rural Development (NIRD). The goal of this workshop was to identify risks facing the community, and to analyze the community's vulnerability to and ability to mitigate these risks. Forest cover was an integral component of community risk vulnerability and was discussed extensively; multiple inter-related causes of forest cover change were agreed upon by the workshop participants. I supplemented the workshop material with follow-up interviews with NIRD staff, who have worked in the Canla-on region for over fifteen years. The causal loop diagram constructed from the workshop and interviews is included below (Figure 2). The participants in the workshop were not aware of the researcher-generated view of forest cover loss, so the second causal loop diagram was generated completely independently.

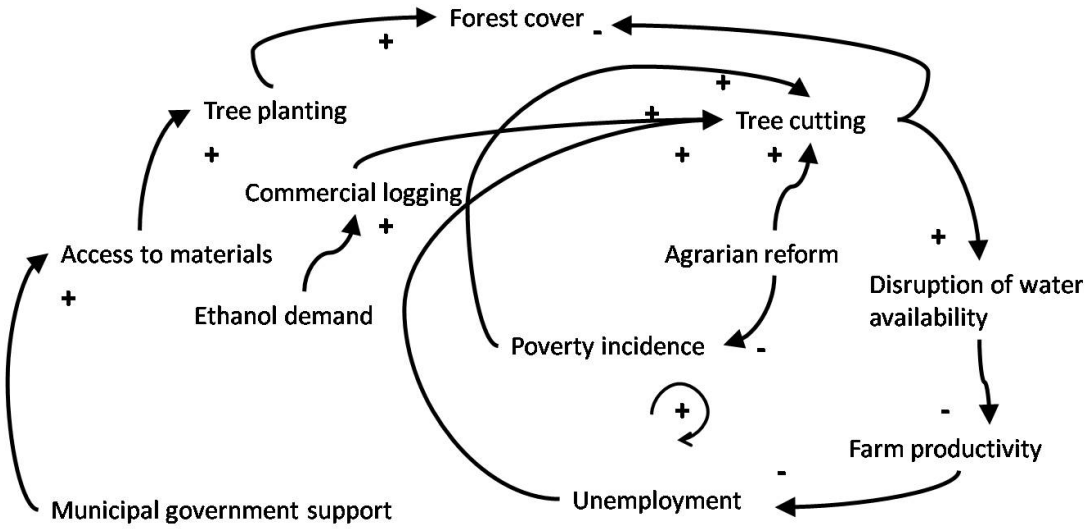

Figure 2: Causal loop diagram depicting forest cover dynamics on Negros Island, generated through workshop discussions and interviews with community members in Canla-on, Negros. The positive feedback loop in the model is labeled.

III. Results and Discussion

The researcher-generated and community-generated causal loop diagrams were substantially different, containing almost none of the same variables. One of the prominent differences was the number and nature of feedback loops in the two diagrams. The community-generated diagram contained only one positive feedback loop, in which tree cutting by farmers leads to a disruption of water availability (especially during drought), which in turn leads to lower farm productivity, which spurs farmers to cut even more trees to put more land in production. The positive feedback loops in the researcher-generated diagram pertained mainly to population and to elite capture of resources on Negros Island. According to the researchers, population density spurs immigration to Negros, as more people create more employment opportunities for those from neighboring islands (as housekeepers, farmworkers, shop owners, etc.). Immigration, of course, increases population density, in a classic 'attractor' type of situation. Another feedback loop involves the sugar elites' share of monetary wealth, which is increased through commercial logging, which they control (according to the researchers). Sugarcane landowners' wealth increases population density, as the landowners hire more workers for the sugarcane fields. Population density increases demand for fuelwood, which sugarcane laborers must purchase from the commercial loggers/landowners, thereby increasing their wealth. All of these positive feedback loops help to explain the extreme state of deforestation that Negros Island has suffered historically.

Another difference between the researcher-generated and community-generated diagrams was the community's identification of local governments (municipality scale) as having the most leverage to promote reforestation efforts. It is logical that the community would identify the

municipal government as having a large influence on forest cover, as this is the scale of government the community deals with most directly in their daily lives and with which they are most familiar. The researcher-generated diagram left out the municipal scale of government altogether, possibly overlooking a critical leverage point for affecting forest cover.

The researchers' diagram included only tree harvesting and deforestation, not reforestation, which might lead to a positive trend in tree cover. This is likely because they were concerned with the biodiversity effects of deforestation, so primary forest was seen as non-replaceable with second-growth forest. However, there is some evidence from the field that agroforestry systems consisting of a mix of planted trees such as cacao and old-growth forest can maintain high levels of insect and soil biodiversity (though rare plants tend not to thrive in these environments) (Steffan-Dewenter et al. 2007). It is therefore helpful to consider tree planting and agroforestry as a strategy for biodiversity maintenance.

It was not surprising that the community-generated causal loop diagram tended to emphasize on-farm or community decisions, while researchers identified macro-level drivers affecting forest cover, such as Philippine agricultural trade policy and population dynamics**.** Community participants identified poverty and unemployment in rural areas as key factors leading to tree cutting and a decrease in forest cover, while researchers mentioned poverty and unemployment only as effects of forest cover decline, not as causes of this trend. The explanation for the causal relationship given by community members was that cash-strapped farmers may resort to cutting and selling any trees that remain on their property, even if they see these trees as beneficial in providing soil stabilization, water protection, and fruit or fiber. A second mechanism related to laborers employed in paid agricultural work on neighboring farms. If facing unemployment, they are likely to find a patch of land to cultivate with subsistence crops, even if the land is inside of an ostensibly protected forest area.

The researchers' causal loop diagram had more variables than the community-generated diagram, perhaps because the researchers took a longer time to develop their diagram and performed more background research on the issues. If the community were able to re-visit their diagram over time, more variables might be added. One prominent variable mentioned in the researcher diagram as a driver was rural population density, which was absent from the community diagram. The Philippines has one of the highest population growth rates in Southeast Asia, and this may contribute to demand for farmland and deforestation in rural areas (UNESCAP 2006).

The community-generated diagram referenced the Philippines' agrarian reform program, which was intended to remove land from large plantations and put it in the hands of small-scale farmers. Reviews of the program have called it anything from a complete failure to a mixed success (Riedinger 1995). The community participants in this study agreed that farmers who are recipients of land under this program benefit from it financially. However, they also identified a critical unexpected consequence of agrarian reform; namely, that it can encourage deforestation.

As land passes from large-scale owners to the direct control of small farmers, many of these farmers make the decision to maximize the productive capacity of the land by cutting down the trees and planting rice, corn or vegetables instead. These individual decisions have negative collective consequences for the water regime and soil erosion in the watershed.

Another difference between the community and researcher-generated diagrams had to do with the drivers of commercial logging on Negros. The community identified ethanol production, which has several private investors on the island, as driving tree harvest in the Canla-on area. Presumably, the trees are being used to make cellulosic ethanol. According to the community workshop participants, these trees are plantation-grown (not primary growth), but are not being replaced or harvested in a sustainable manner. In contrast, the WWF researchers cited lumber demand as the driver behind commercial logging on Negros. This probably has to do with the ten-year time gap between the two studies. The WWF book came out in 2000, before ethanol production had begun on Negros.

In summary, the researcher-generated diagram emphasized large scale drivers, historical trends, and political decisions made at the national and international scale as the drivers of deforestation. In the researcher model, individual farmers and rural residents are helplessly caught in a system not of their own making, which almost compels them to engage in activities that reduce, rather than increase, forest cover. In contrast, the community-generated diagram identified some trends over which residents had no control, but placed a lot of emphasis on landowners' individual decisions, and the ability of the local, municipal government to influence these decisions through regulations and incentives.

The degree of difference between the two diagrams was striking. The researcher diagram was generated using an analysis of the historical context behind current deforestation patterns, so it is logical that there would be some differences between this diagram and the community diagram, which focused on current trends and dynamics. The patterns and causes of deforestation on Negros have shifted over the past decades, and the WWF researchers did not intend all of their variables to reflect the current situation. However, they used their causal loop diagram to draw policy conclusions, so they clearly believe it to be relevant for current decisionmaking around forest resources. Both researcher and community perspectives undoubtedly have merit, and could generate significant learning through their interaction. In fact, the perspectives may be complementary, as they emphasize actions occurring at different scales.

IV. Conclusions and Next Steps

The community-based assessment of deforestation's root causes yielded substantially different variables, feedbacks, and leverage points compared with the researcher-generated assessment. This implies a fairly serious perception gap between researchers who design reforestation initiatives and communities on the ground who implement them. However, both the researchers

and community participants agreed that deforestation is driven internally on Negros Island by positive feedback loops; any balancing feedbacks are introduced by exogenous forces (for example, agrarian reform). This indicates that promoting reforestation on Negros will almost certainly require external intervention. A group model-building exercise, involving both researchers and community members, could potentially enhance systemic understanding of the deforestation issue and generate more robust reforestation initiatives.

It is instructive to note that the community identified local government units as the scale at which the maximum leverage to promote reforestation could be applied, while researchers did not mention this governance scale at all. This implies that local solutions that promote reforestation might be overlooked by researchers in favor of initiatives that operate at a higher level of governance. Community participants also identified an important feedback that has not been considered yet in either the agrarian reform literature or the reforestation literature; namely, that land redistribution could potentially encourage deforestation by giving farmers the right to cut trees on redistributed land. The process of redistributing land to small-scale farmers might therefore provide an opportunity to present these farmers with incentives to keep part of their land in forest. A group model-building exercise that integrates the community-generated model with the researcher-generated model could help both groups to learn from one another and to understand the multi-scalar nature of the reforestation challenge more clearly.

Although this study generated some insights into mechanisms of reforestation in the Philippines, a purely qualitative model in this case is probably not sufficient to generate robust conclusions on policy directions. For example, in the community-generated model, agrarian reform has both a positive feedback to forest cover (through decreasing poverty), and a negative feedback to forest cover (by allowing farmers to cut trees on land they now own) (Figure 1). Without a quantitative component to the model, it is impossible to know which of these feedback loops is dominant. Parameterizing the model with quantitative data is therefore a critical next step in the model-building exercise.

This study demonstrated that a group model-building exercise to integrate researcher and community views on forest cover could yield important insights into points of leverage for policymakers. Such an exercise could improve the success rate of reforestation initiatives by designing these initiatives in a way that takes a systemic and dynamic view of forest cover in the Philippines. Previous reforestation efforts in the Philippines have had mixed success (Fujisaka 1994), so incorporating a promising new tool like group system dynamics modeling could move the policy discussion forward in a meaningful way.

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