

Stakeholders' Perceptions of the Negative Drivers of Ecosystem Change: The Case of El Yunque National Forest in Puerto Rico

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Introduction

Paradigm shifts in applied ecology and conservation science emphasize the importance of including multiple stakeholders and different types of knowledge in the development of conservation and resource management practices (Berkes, 2004). Identifying and comparing stakeholder knowledge about ecosystem services and processes that drive ecosystem change are needed to identify gaps and fulfill information needs among groups (Carpenter and Folke, 2006). It is also important to identify such knowledge and topics groups have in common to identify potential for partnerships and collaboration aiming at developing participatory conservation initiatives and actions that support ecosystem services (Sheil and Lawrence, 2004).

Understanding stakeholder knowledge of the proximate causes and drivers defining change in ecosystem services is key to ecosystem management (MEA, 2003). This becomes particularly important in areas where intensive human activity threatens ecosystems and the services they provide. In Puerto Rico, this is the case for El Yunque National Forest (EYNF), the largest protected area in the northeastern portion of the Island. EYNF provides many ecosystem services to society. Rapid increases in urban and built-up areas in its periphery, however, have been identified as a major threat to the forest and its services (e.g., Lugo et al., 2004). In 1983, a regional zoning plan was

put into place to minimize the potential negative effects of urban expansion on forest functions and services (Lugo et al., 2000). Unfortunately, this mechanism has been less successful than expected. Due to poor enforcement of the zoning plan, approximately 85% of the new urban/built-up expansion during the last two decades has occurred in "non urban" zoning districts (e.g., in agricultural, forest zoning districts) (López and Villanueva, 2006; Lugo et al., 2004).

The failure of top-down zoning plans as a conservation tool calls for the development of alternative conservation approaches; ones that are developed from "the bottom-up" and that are more inclusive and participatory in nature. In the case of EYNF, a first step towards developing such alternative conservation approaches aiming at minimizing the negative effect on ecosystem services change requires understanding what stakeholders know about these drivers, and how they understand the processes of change. There is, however, a lack of studies about stakeholder understanding of the drivers of ecosystem change and how this knowledge compares among groups. This study helps to fill this gap by:

- Assessing stakeholder knowledge of the negative drivers affecting EYNF and its ecosystem services.
- Identifying areas of agreement and disagreement in regard to this knowledge.

- Assessing stakeholder knowledge and perception of the spatial distribution of urban/built-up expansion.

Methods

Focus groups and individual interviews were the main forms of data collection in this study. Four groups of stakeholders participated in the study: scientists that have worked in EYNF (14 participants), EYNF forest managers (9), municipal planners from five municipalities that surround EYNF (9), and community leaders from 10 nearby EYNF communities (14). When possible, data gathering techniques were applied with groups of participants; otherwise these were carried out individually. Data collection was carried out between August 2008 and August 2009.

Participatory listing and scoring techniques were used to elicit participants' knowledge about the negative drivers affecting EYNF. First, the concept of "negative drivers" was discussed and defined as related to the objective of the study. Negative drivers of change were defined as those factors affecting ecosystem and its services both directly or indirectly either through natural processes or through human action (MEA, 2003). Participants were asked to brainstorm regarding all the possible negative drivers affecting EYNF and the services it provides. All mentioned benefits were written on a large piece of paper, so that participants could see all of them and add any missing ones. Then they were asked to score the perceived level of impact of each driver; ranging from 1 (least impact) to 5 (most impact). Mean values were calculated for each driver.

Participatory sketch mapping was used to further understand participants' knowledge about urban/built-up expansion – which was

identified by all groups as one of the most negative driver of change. A large sheet of paper was used to conduct the mapping activity. The paper had already delineated geographic references of the study area – its delimitation (which is composed of eight municipalities surrounding the forest), municipal and neighborhood boundaries, major roads, major rivers, and EYNF boundary. Participants were asked to delineate the areas they thought urban/built-up expansion was occurring within the periphery of EYNF. All maps from each group of stakeholders were then combined, and a "composite map" for each group was digitized into a Geographic Information System (GIS) for representation and comparison.

Finally, aerial photos from 1998 (1.0 m resolution) and 2007 (0.3 m resolution) were analyzed using a GIS to assess actual urban/build-up land cover change in the periphery of EYNF. Vector data layers were created by on-screen digitizing urban/built-up areas. To determine the spatial distribution of urban/built-up expansion during the two years, an overlay analysis was conducted.

Stakeholder knowledge about EYNF negative drivers of change

The majority of the identified drivers of ecosystem change were identified by all groups of stakeholders (Table 1). These included direct drivers (such as land cover change, unsustainable waste disposal, forest over use, species removal, and species introduction) as well as indirect drivers (such as lack of knowledge, illegal activities, and institutional factors). Land cover change (specifically urban/built-up expansion) and lack of knowledge (about the ecosystem services of EYNF and the cause-and-effect factors that influence the services

it provides) had the highest impact values (4.4 mean values in each case, in a scale of 1 to 5).

Table 1. Negative drivers affecting EYNF and its ecosystem services: all groups of stakeholders

Negative driver	Mean impact
Land cover change	4.4
Lack of / limited knowledge	4.4
Poor land use plan enforcement	4.1
Institutional factors	4.1
Lack of funds	4.0
Unsustainable waste disposal	3.9
Forest over use	3.1
Species introduction (exotic, domestic species)	3.0
Illegal activities	2.9
Species removal	2.8
Natural disturbances (short term effects)	2.7

Other drivers of change were identified by some of the stakeholder groups (Table 2). These included climate change, research, hydromodification, lack of a regional and up-to-date land use plan, and the presence of telecommunication towers. These last two drivers had the highest mean impact factor (5.0), but were mentioned by just one group of stakeholders in each case.

Table 2. Negative drivers affecting EYNF and its ecosystem services: some groups of stakeholders (Sc = Scientists, FM = EYNF Forest managers, MP = Municipal planners, CM = Community leaders)

Negative driver	Group	Mean impact
Lack of regional and up-to date land use plan	Sc	5
Telecommunication towers	CL	5
Climate change	Sc, FM	3.9
Water over use	Sc, FM, CL	3.6
Hydromodification	Sc, FM	2.3
Scientific research	MP, CL	2.0

Stakeholder perception about the spatial distribution of urban/built-up expansion in the periphery of EYNF

There was a general tendency for stakeholders to identify the northwest, north, and northeastern portion of the periphery of EYNF as the areas experiencing rapid increase in urban/built-up land cover (Figure 1). Scientists and forest managers identified broader areas of increase (Figure 2a and 2b), whereas community leaders identified areas closer to their locations (Figure 2c). Municipal planners identified areas of “medium extent” compared to all the other groups and tended to put emphasis on the western part of the study area (Figure 2d).

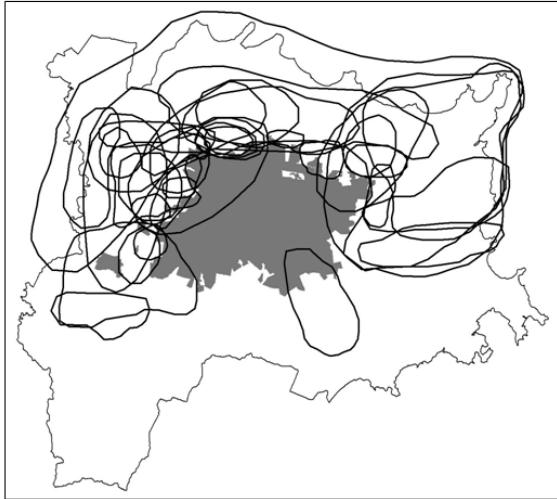


Figure 1. Composite map of perceived areas of urban/built-up expansion in the periphery of EYNF: all groups of stakeholders. The solid gray area represents the extension of EYNF.

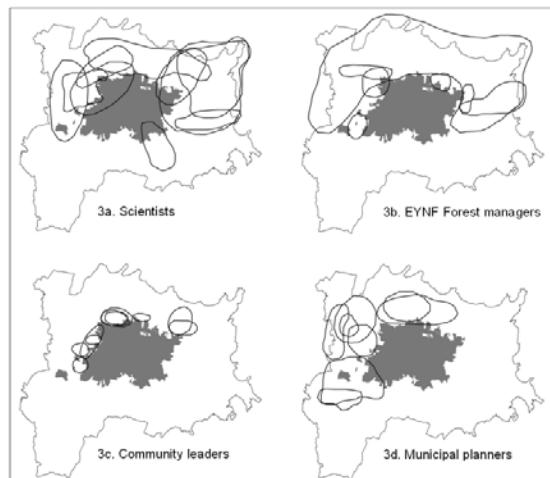


Figure 2. Stakeholders' spatial delineation of perceived areas of urban/built-up expansion in the periphery of EYNF. The solid gray area represents the extension of EYNF.

Urban/built-up expansion in the periphery of EYNF between 1998 and 2007

The analysis of aerial photographs revealed a 15.6% increase in urban/built-up areas during 1998 and 2007; from 8,814.1 ha in

1998 to 10,189.7 ha in 2007. As correctly identified by some participants, some of this expansion (about 54% of the total of 1,375.6 new hectares) occurred north of EYNF; while another portion (about 41%) has been sprawling south of EYNF (Figure 3). Municipal planners identified some of this “south of EYNF” increase while conducting their sketch map (a portion on the south western part), and one group of scientists identified a portion on the southeastern part. However, this tendency of expansion south to EYNF was generally missed by participants.

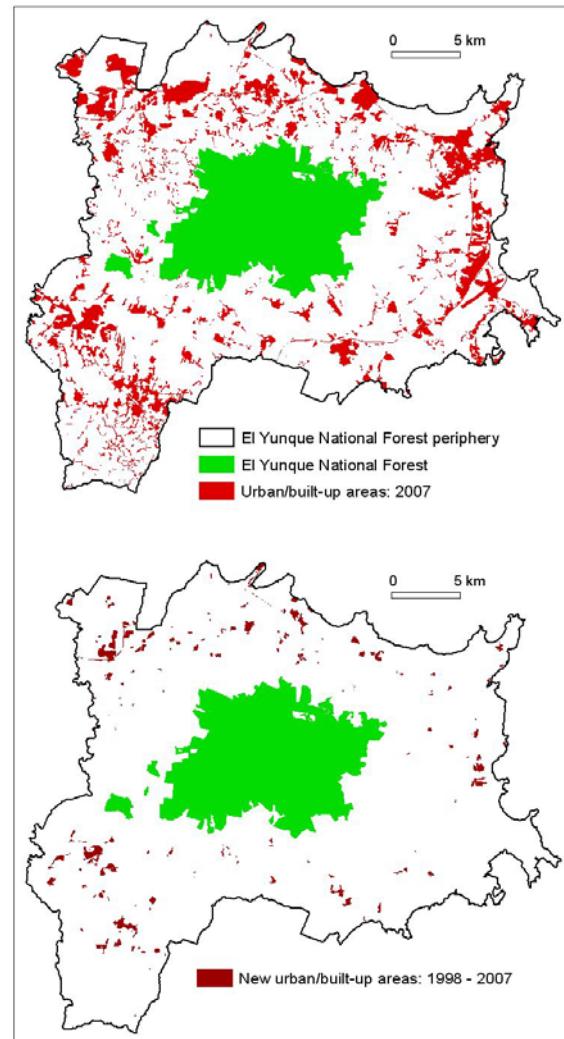


Figure 3. Urban/built-up land cover in the periphery of EYNF in 2007 and increase from 1998 to 2007

Engaging stakeholders on the conservation of EYNF and its ecosystem services: recommendations and concluding remarks

The analysis revealed many opportunities for engaging stakeholders, promoting dialogue, encourage social learning, and increase knowledge and awareness about the factors influencing EYNF and its services. Ultimately, the goal is to encourage actions at different levels, from the individual to the collective, to minimize the negative drivers of ecosystem change, to promote forest conservation within the periphery of EYNF, and to encourage the wise use forest of ecosystem services.

Stakeholders rightly identified and agreed on several negative drivers of ecosystem change. The fact that these drivers were acknowledged provides an opportunity to bring stakeholders together and initiate a dialogue as of what could be done to minimize negative impacts. Acknowledging a driver, however, does not necessarily mean people understand the process of how that driver influences ecosystems and their services. Here, there is a need for information exchange and increased knowledge about process-related mechanisms.

There were several drivers of change which were expressed only by some of the stakeholders. This was the case, for instance, of climate change, which was mentioned by scientists and forest managers. This is an example of a driver taking place at coarser spatial and temporal scales. Local inhabitants often have a weaker understanding of such coarser spatio-temporal processes (Chalmers and Fabricius, 2007). Here again, providing information and knowledge about coarser processes and how they might affect ecosystem services is imperative if the aim is to engage people in

initiatives minimizing negative effects. This information should be accessible in an “easy-to-read” way and be transferred in a way that makes sense to people; i.e., that are situated in a wider context of human well being. In fact, lack and poor knowledge about EYNF ecosystem services and drivers of change was identified by all stakeholders as having high impact on EYNF and its services. This confirms that increasing knowledge is needed to promote action.

Knowledge transfer must occur in all directions. For instance, scientists and forest managers should take into consideration and include in their discussions community members and municipal planners’ views of the negative drivers of change, such as the potential impact of some of past research activities conducted in EYNF and the presence of communication towers. Acknowledging and tackling such concerns can increase confidence between groups, which is needed for establishing transparent and constructive partnerships and collaborations.

Finally, the fact that most participants missed areas of rapid urban expansion in the southern portion on the forest periphery suggests that there is a need for providing information about such spatial processes and patterns. This lack of knowledge could affect intervention, policy, and decision making regarding land use around the forest. In spite of the relatively large amount of information in the form of aerial photographs, satellite images, and land use/land cover maps available for the region, and for Puerto Rico in general, people do not necessarily know about it, are neither aware of the sources (many which are public domain), nor do they use them.

References

- Berkes, F. 2004. *Rethinking Community-based Conservation.* Conservation Biology 18(3):621-630.
- Chalmers, N and C. Fabricius. 2007. *Expert and Generalist Local Knowledge about Land-cover Change on South Africa's Wild Coast: Can Local Ecological Knowledge add Value to Science?* Ecology and Society 12(1): 10 [online].
- Millenium Ecosystem Assesment (MEA). 2003. *Ecosystem and Human Well-being: A Framework for Assessment.* Washigton, DC: Island Press. 245p.
- López Marrero, T. and N. Villanueva Colón. 2006. *Atlas Ambiental de Puerto Rico.* San Juan, Puerto Rico: University of Puerto Rico Press.
- Lugo, A.E., López Marrero, T., Ramos-González, O.M., and Vélez, L. 2004. *Urbanización de los terrenos en la periferia de El Yunque.* General Technical Report WO-66. USDA Forest Service, Washington, DC. 29p.
- Lugo, A.E., López Marrero, T., Ramos, O. 2000. *Zonificación de terrenos en la periferia de El Yunque.* General Technical Report IITF-16. International Institute of Tropical Forestry, USDA Forest Service, San Juan, Puerto Rico. 12p.
- Sheil, D. and A. Lawrence. 2004. *Tropical Biologists, Local People and Conservation: New Opportunities for Collaboration.* Trends in Ecology and Evolution 19(2):635-638.

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