Article

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Protecting a *Garúa* Forest in Ecuador: The Role of Institutions and Ecosystem Valuation

Garúa intercepted by forest in Colonche Hills, Ecuador. Photo: C.D. Becker

Inventing or sustaining cultural systems and institutions that provide people with an adequate standard of living while preserving forest ecosystems and their biological diversity is a great challenge facing humanity now and in the coming century. This paper describes an effort to use participatory research and environmental education to affect forest preservation by a community in southwestern Ecuador. The sustainability of lowland agriculture in this area is partially dependent on fog-capture by the hill forests. Once the community of Loma Alta understood and valued fog-capture, they used their own system of governance and decision making to preserve the forest. The case study is presented in a theoretical framework of general interest to social and natural scientists concerned with tropical forest preservation. It has particular relevance for integrated conservation and development efforts.

INTRODUCTION

Forested ecosystems in the tropics are prone to degradation and destruction under a wide variety of tenure systems (1). Estimates made by the Food and Agricultural Organization (FAO) suggest that tropical forest loss per year increased from an average of 11.3 mill. ha yr^{-1} during the 1970s to 15.4 mill. ha yr^{-1} in the 1980s (2). As a consequence, economists, conservation biologists, and social scientists have struggled to understand why so many societies have failed to thwart deforestation in the tropics (3–5).

Models of the driving forces behind tropical deforestation range from simple, single-factor explanations like human population growth to multifactored models with feedback loops linking poverty and Third World debt to local incentives for forest destruction (4). Deforestation has been analyzed at macro- and micro-economic scales. International lending and large development schemes have been shown to cause the destruction of tropical forests (6) due to market distortions and the public goods characteristics of forests (7, 8). At the micro-level, the attributes of a forest, e.g. scarcity of resource units, market value, nonmarket value, etc., interact with attributes of local users—trust, autonomy, organizational experience, knowledge, discount rates, and time horizons, etc.—to create a perception of personal costs and benefits upon which the local human agency depends (9).

In micro-economic models, institutions, incentives, and values of local users are the common explanatory variables for deforestation. Lack of land tenure by local user groups has been shown to favor tropical deforestation (10), presumably because forest users lack the long-term horizons needed for resource planning (11). Local institutions that control use of forests may constrain or facilitate tropical-forest destruction (12, 13). In some cases, when users lack the rights or incentives to design and enforce rules that control the use of forest resources, and external rules are not enforced, open-access exploitation is predictable and real (14). For example, Becker et al. (15) found that a government-managed forest in Uganda was heavily exploited by a wide range of users with very few constraints, while a family-owned parcel of similar size adjacent to the government forest was left in a nearly natural state due to traditional social arrangements made between the family and local forest users. Government ownership and control has frequently failed to save forests because local users and their traditional systems of allocating resources have been ignored by new or changing authorities (16).

Given the disappointing results of state-centered conservation and preservation efforts in many developing nations, scholars and practitioners have promoted strategies involving non-government organizations and local people (17–20). For example, at 3 sites in Samoa, local people made parks of their forests in exchange for schools or other facilities that they desired (21). But local ownership and strong local institutions do not guarantee sustainable stewardship of forest resources (17), and many of these integrated conservation and develop-ment projects (ICDPs) have proven unsustainable (22, 23). When donor funding ends, the programs often become defunct because local people and host governments cannot sustain them financially or institutionally. Boom-and-bust cycles in funding may create uncertainty and disrupt local trust and enthusiasm for externally supported forest conservation projects (22).

Carrasco (23) states "until [locals] see the relevance of conservation for themselves and the future of their children, they will only adopt and maintain technologies that donors make worth their while". Perception of value or relevance has been frequently cited by economists as a prerequisite for conservation of a diverse array of natural resources (5). In accordance with the concept of total economic value (TEV) (8), forests should be less likely to be destroyed when user groups have more complete knowledge of alternative direct uses (e.g. specialty timber products and nontimber forest products); value for indirect use benefits (e.g. ecosystem services like watershed protection, climate control, wildlife habitat); option values (e.g. potential revenues from tourism or medicinal plants); and existence values (e.g. passion for the songs of local birds).

In 1995, People Allied for Nature (PAN), a nonprofit conservation organization, collaborated with the International Forest Resources and Institutions (IFRI) research program (24) to study local values, rules and incentives influencing the condition of a low-elevation cloud forest in western Ecuador. PAN used the results of the IFRI project to design a conservation strategy with the local community of Loma Alta. This paper presents a brief summary of the results of the IFRI study followed by an overview of PAN's research and conservation strategy to enhance local value for ecosystem services of the forest. PAN researchers measured fog interception and disseminated qualitative and rough quantitative results to villagers. The community's response to the information about ecosystem services and an interpretation of the general lessons for sustainable care of forest resources are presented as a conclusion.

HISTORY AND USE IN LOMA ALTA'S *GARÚA* FOREST

In 1937, the Law of the Comunas established land-tenure rights for rural peasant communities throughout Ecuador. The Comuna of Loma Alta was given legal title to a 6842 ha watershed, ranging in altitude from 50 to 830 m (Figs 1 and 2). The northern third of the property includes 1650 ha designated as Bosque Protector (25). Here a premontane moist tropical forest forms between 400 and 800 m, harboring endemic plants (26) and birds (27). It is critical habitat for species endemic to the Tumbesian region of southwestern Ecuador and northwestern Peru (28). The lush highland forests in the Colonche Hills result from a positive feedback loop created by their interception of coastal fog and mist. With a decline in forest cover, less *garúa*, as the coastal fog and mists are called locally, is trapped and contributed to the western slopes. As a consequence, both the hills and lowlands are becoming more arid.

Following consultations with Ecuadorian botanists, conservationists, and community leaders, PAN began collaborating with the community of Loma Alta. Their aim was to establish a community ecological reserve in the hill forests to protect flora and fauna endemic to the region. PAN gathered information about the community of Loma Alta and its land use history in the highland *garúa* forest using the International Forestry Resources and Institutions (IFRI) research protocol (24). Combining methods of social and natural sciences, IFRI research teams gathered a standardized set of data (29) on the social norms and rules that shape people-forest relationships at Loma Alta.

The community owned the forest under study, and they possessed strong local institutions; e.g. a history of making and enforcing their own rules for a variety of goods and services in their community. These factors, often found to be critical stumbling blocks for conservation of common pool resources (9), could be eliminated as causes of the deforestation in the watershed.

IFRI research identified 3 mutually exclusive user groups in the *garúa* forest of Loma Alta (17).

(*i*) Members of the comuna with land-holdings awarded to them by the Comuna (Allocatees).
(*ii*) Members of the comuna with no land allocations in the highland forests.
(*iii*) Outsiders with no legal rights to use the forest (Invaders).

The direct uses of the *garúa* forest differed by group. Of the allocatees, 95% grew Panama hat fiber (*Carludovica palmata*) on small plots in the forest allocated to them by the *asamblea*, the community governing body. After slashing and burning the forest to create clearings of 1–5 ha, landholders planted seedlings of the hat fiber, which is locally called *paja toquilla*. Only one family harvested timber to supply the regional market. This family had learned to make boards during the 1960s and 1970s, when the highland forest had been selectively cut by timber companies. An inventory of their property suggested a strategy of sustained yield and selective harvesting (17). Nearly all forest allocatees grew plantains, oranges, and bananas for household consumption, but fruit tree abundance declined with distance from the villages.

Comuneros without land allocations in the *garúa* forest rarely used it, relying more on irrigation of agricultural plots in the lowlands. Still, two families purchased trees from allocatees, which they sawed into timber for regional marketing. Others collected tagua nuts (*Phytelaphus aequatorialis*) for external markets, hunted 5 local mammals, and 2 bird species for subsistence, and harvested bamboo and thatch for housing.

The most destructive impact on the highland forest came from outsiders. Between 1985 and 1996, cattle ranchers from Manabi, a province to the north, had converted at least 200 ha of the Comuna's highland forest to pasture and scrub. Consistent with agrarian reform policy of the 1970s, these ranchers claimed ownership of the Comuna's property because they put the land to productive use by clearing the forest. In 1987, the national courts reconfirmed the Comuna's tenure rights, the community established a nationally recognized Bosque Protector (25), but they failed to regain any real control over the area. As of December 1996, Loma Alta's Bosque Protector was still being cleared by families working for Manabi cattle ranchers.

Despite the institutional assets of the community and legal tenure to the forest, local owners and allocatees were not making or enforcing local rules to constrain forest destruction in the 1650

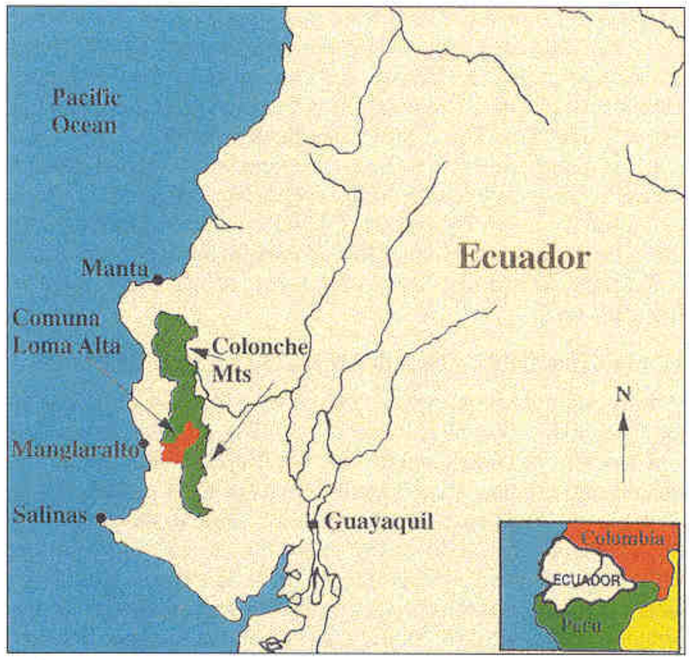


Figure 1. Location of Comuna Loma Alta (red) in the Colonche Hills of southwestern Ecuador.

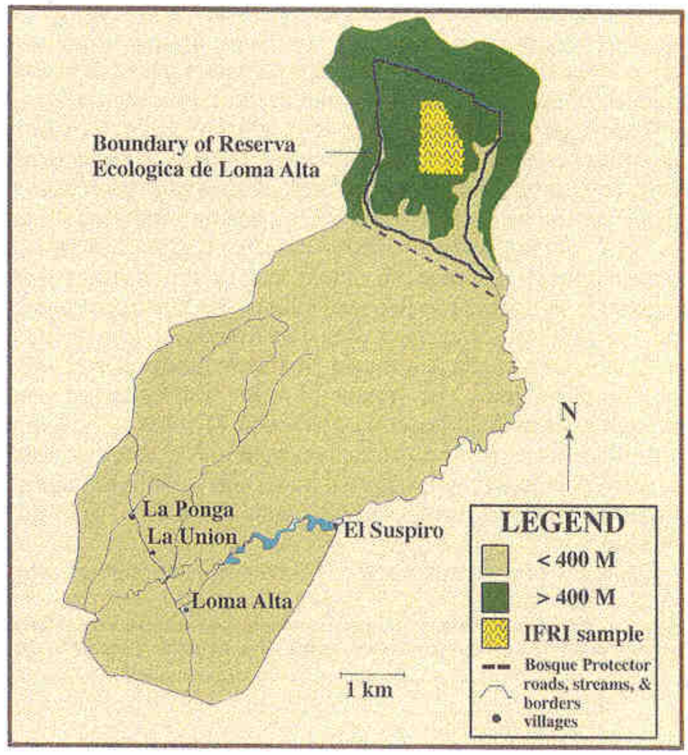


Figure 2. Location of settlements, boundaries, Bosque Protector, and new forest reserve of the Comuna of Loma Alta.

ha Bosque Protector. There were many reasons for this failure; these are discussed fully by Becker and Gibson (17). The economic interpretation was that for a majority of the comuneros the costs of planning and controlling use of the forest outweighed the perceived benefits of protecting the forest.

Local people seemed to lack an appreciation for the indirect values of their highland forest, specifically provision of water to the lowlands via fog capture. PAN decided to explore the idea that a better understanding of this ecosystem service might evoke community action to preserve the forest. What is the value of fog capture?

FOG INTERCEPTION AS AN ECOSYSTEM SERVICE

A substantial literature exists on indirect values of forests at local, regional, and global levels (5, 30–32). Besides preventing soil erosion, providing habitat for wildlife, filtering water, and moderating climate, the highland forests of the Colonche range increase the quantity of groundwater available to the people living on the western side of the range by intercepting moisture from fog and mist. Horizontal precipitation from coastal fog banks is an important source of water for sustaining human settlements along the arid Pacific coast of South America between 1° and 4° S (33). This ecosystem service is extremely important because it has potential to reverse desertification caused by deforestation. Interception of *garúa* by vegetation secures water above that contributed by rain alone (34). In the absence of interception by trees or man-made structures, horizontal precipitation in the form of fog and fine mist continues inland or evaporates, resulting in less input of water to local watersheds (34).

Coastal *garúa* is prevalent in the Colonche Hills from June to November each year. To estimate the amount of *garúa* intercepted by Loma Alta's highland forest, throughfall was collected on leeward slopes at 400 m and 600 m, and on windward slopes at 700 m. Throughfall is defined as moisture that reaches the soil surface through spaces in the canopy, and as drip intercepted by vegetative surfaces. Similar to methods described in Weaver (35), 15 to 30 metal cylinders, each with a receiving area of 223.6 cm^2, were randomly positioned in forest, pasture, and *paja toquilla* plantations. The volume of water (ml) collected from throughfall during 24 hours was recorded 14 times in June and July 1996. Water loss as a consequence of deforestation was estimated by comparing throughfall under forest with throughfall under the competing land uses at the same altitude and slope orientation.

Estimates of the percentage of horizontal precipitation associated with *garúa* events were derived by comparing water volumes collected in cylinders mounted with Hohenpeissenberg collectors (36) with water collected in control cylinders and in rain gauges. Collectors and control cylinders were placed on platforms 2 m above the ground at two windward sites at 700 m and at two leeward sites at 600 m and 400 m. The fog collectors were cylinders of aluminum window screen, 24 cm tall by 12 cm in diameter with a mesh size of 1.5 mm.

From June 27 to December 27, 1996, vertical precipitation (mist and rainfall) was recorded in control cylinders and rain gauges at the 4 highland sites and at one lowland site (50 m). Precipitation during the 14 days of throughfall measurement was compared with daily estimates for the 23-week period to determine if the short experimental session was representative of the whole season.

RESULTS OF FOG INTERCEPTION STUDY

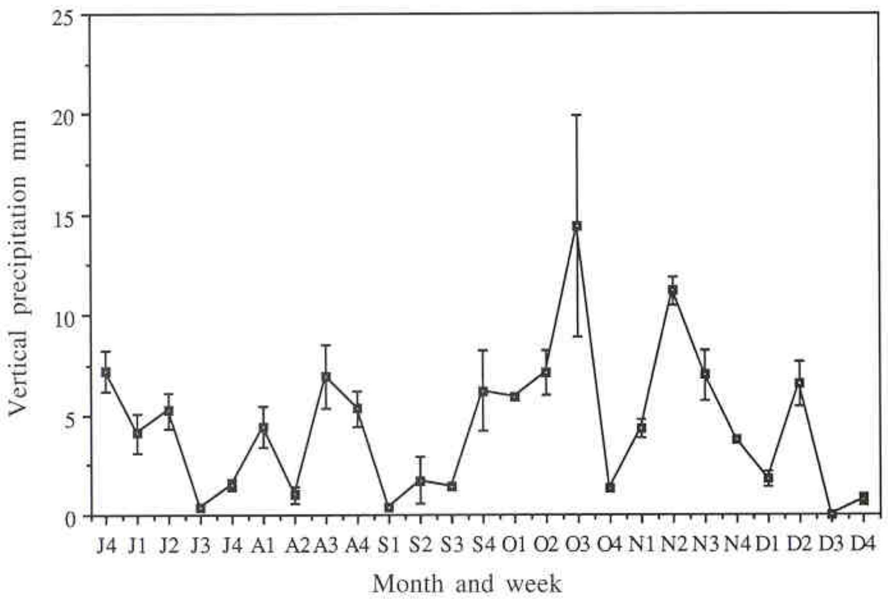
Throughfall measurements combine vertical and horizontal inputs from *garúa* interception, so these components must be separated to better evaluate fog capture alone. Accumulation of vertical precipitation in the highland rain gauges (Fig. 3) varied greatly. A sum of these weekly averages indicates that 102 mm were contributed by vertical precipitation. There were no significant differences in vertical precipitation by altitude or slope position in the highlands (ANOVA $_{[3, 76]}$; P = 0.704). The daily mean and standard error of vertical precipitation in the 4 rain gauges monitored during the fog event study was $0.72 \pm .06$ mm (N = 58). There was no significant difference between mean daily precipitation during the 14 fog events and the mean calculated from the 23 week data set (t-test; P > 0.2). Thus, a second estimate of 108 mm for vertical precipitation during the 6 month *garúa* season is derived from these data. In contrast, vertical precipitation in the lowlands during the 23-week study totalled 1.9 mm, less than 2% of the contribution from heavy mist in the highlands.

Throughfall varied significantly by vegetation type, altitude, and orientation (ANOVA $_{5, 71}$; P < 0.05). In forest at 700 m throughfall was 6 to 11 times greater than in the pasture (Sheffe-test; P < 0.05). At 400 m, throughfall from forest was 3 to 4 times higher than that recorded for Panama hat-palm fields, but these differences were not statistically significant. Throughfall in forests at high elevations on the windward side of the mountain was nearly 3 times greater than in the leeward forest at 400 m (Sheffe-test; P < 0.05).

Since vertical precipitation did not vary by vegetation type, altitude or slope orientation, interception of horizontal *garúa* clearly explains the variation in throughfall. Estimates of the horizontal input as a proportion of vertical precipitation varied greatly by altitude and position on the mountain (ANOVA $_{[3, 126]}$, F = 5.97, P = 0.0008). In 32 duplicate cases, in which horizontal capture was noted (fog catcher > control), fog and mist interception was more likely at high elevations and on the windward sides of the mountains (Table 3). Averages for horizontal input were as high as 200% on windward slopes at 700 m, while much lower values were typical on the leeward hillside at 400 m. A grand mean of means suggests that about 40% of the throughfall in the forest above 400 m comes from interception of horizontal precipitation, but local variation is high.

During the 14 *garúa* events for which throughfall was estimated, 11 measurements were made when rain gauges were empty (vertical input was zero). Using a mean of

Figure 3. Weekly means and standard deviations of vertical precipitation from *garúa* (coastal fog and mist) on La Torre mountain, Loma Alta, Ecuador June 27 to December 27, 1996.



means from these samples, fog capture (horizontal input) was estimated to be 0.42 ± 0.31 mm per 24 hours of *garúa*, or 58% of the average daily value of precipitation.

When the values from Table 1 are used to estimate the contribution of water per ha, the amount of water lost due to land conversion can be estimated (Fig. 4). Assuming 120 days of *garúa* per year, 1 ha of forest at 400 m on the leeward side of the hills collects on average 800 000 L ha^{-1}. This value can be considered a minimum estimate for fog and mist drip by the hill forests. In contrast, an average maximum estimate of 2.24×10^6 L water ha^{-1} can be derived from throughfall values for forest at 600–700 m on windward slopes. Clearing the forest to make a pasture on highland slopes with a windward (towards the Pacific Ocean) orientation results in an estimated loss of about 1.9×10^6 Lha^{-1} yr^{-1}. Clearing the forest to put in 1 ha of *paja toquilla* on the leeward slopes above 400 m may reduce annual input of water to the watershed by as much as 540 000 L (Fig. 4).

Table 1. Comparison of throughfall during 14, 24-hr fog and mist (*garúa*) events on Torre Mountain, Loma Alta, Ecuador, June–July 1996.

Altitude (m)	Cover (slope)	grand mean (ml)	SE	L m^{-2}	mm day^{-1}
400	Forest (lee)	15	4	0.67	0.67
400	*C. palmata* (lee)	5	2	0.22	0.22
700	Forest (wind)	42	8	1.9	1.9
700	Pasture (wind)	7	2	0.31	0.31

Table 2. Throughfall collected in different habitats during a 7-day period of *garúa* on Torre Mountain, Loma Alta, Ecuador, 4–10 July, 1996.

Altitude (m)	Cover (slope)	Mean (ml)	N	SD	Range (ml)	mm	Control (ml)
400	Forest (lee)	120	15	78.5	35–320	5.4	56
400	*C. palmata* (lee)	34	15	45	2–174	1.5	56
700	Forest (wind)	369	25	313	74–1493	16.5	58
700	Pasture (wind)	35	25	24	5–84	1.5	66

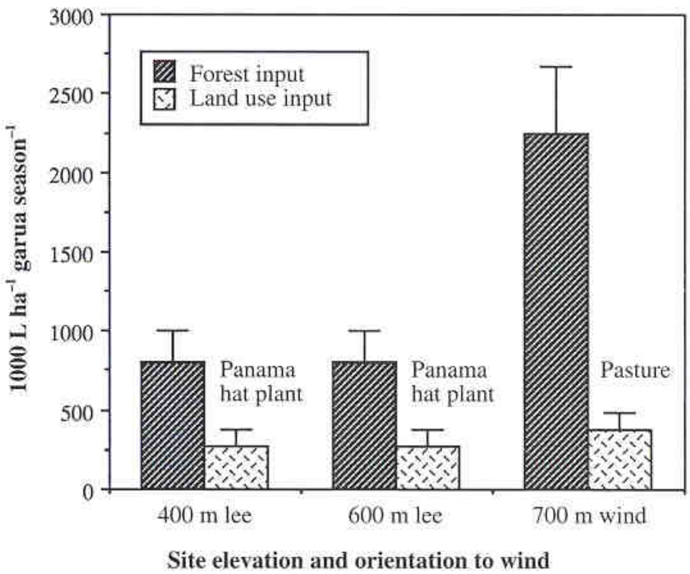
Table 3. Estimates of net fog capture (net horizontal precipitation) by altitude on La Torre Mountain, Ecuador. For each site the number and percentage of cases in which fog collectors contained more water than control cylinders is given. Number of cases differ due to disturbance of cylinders by domestic animals and local people; e.g. the 700 m peak site was in the contested pasture where invaders purposely destroyed equipment. Each site had duplicate fog collectors (sets).

Site	Fog > Control	%	Set 1 Mean % ± SE	Set 2 Mean % ± SE
400 m (lee)	1/31	3	1 n/a	17 n/a
600 m (lee)	6/35	17	19 ± 21	85 ± 46
700 m (wind)	17/35	49	95 ± 21	200 ± 28
700 m (peak)	9/15	62	66 ± 41	33 ± 11

SE = standard error of the mean

According to estimates based on air photos and ground surveys, at least 200 ha of forest located on windward slopes above 600 m have been converted to pasture in the past 2 decades. Thus, an estimated 380 mill. L of water are currently lost each year due to forest conversion to such pastures in Loma Alta's Bosque Protector. If one makes the overly conservative estimate (37) that only 10% of the drip-fall actually becomes available as groundwater for use by villagers (38, 39), they are losing at least 38×10^6 L yr^{-1} ($\approx 10 \times 10^6$ US gallons yr^{-1}). Water sells locally for 50 Sucres per US gallon (1997 price). Thus, the value of water lost per year can be estimated at 500 mill. Sucres. At 3900 Sucres per dollar (1997 exchange rate) this loss is about USD 128 000. When divided among the 200 households in the community the loss of USD 640 is roughly equivalent to half a local family's annual income. The value of fog capture alone (just interception of horizontal precipitation) averages 40 to 58% of this value, or USD 256–371 per household.

Figure 4. Liters of water intercepted from coastal fog and mist (*garúa*) by different vegetation communities on La Torre mountain, Loma Alta, Ecuador. Data from 14 days in June and July 1996. Water loss due to deforestation can be calculated by subtracting land-use input from forest input at the same altitude.



COMMUNICATING ECOSYSTEM VALUE TO THE VILLAGERS OF LOMA ALTA

In July, 1996 PAN directors met with the 5 elected leaders (*Cabildo*) of Loma Alta to present preliminary results of the fog capture study and its implications. The Cabildo quickly organized a special *asamblea* (decision-making gathering), inviting PAN to present its proposal for a forest reserve and to justify the idea before the community at large.

Research teams collecting data on fog capture made a video about the ecosystem services provided by the community-owned cloud forest. The video emphasized the following:

- Soil erosion and drying caused by conversion of the forest to pasture.
- Visual differences in the quantity of water intercepted and dripped into cans in the forest and pasture. They were told that the windward forests collected 10 times more water than pasture.
- The fact that community forest was not endless (a commonly held view of villagers), but was shrinking due to land conversion by comuneros and outsiders.
- That recent deforestation and conversion to pasture could have contributed to recent declines in the village water supply.
- That water is very important to daily life and agricultural pursuits of the villagers.
- That the forest was a beautiful place with many plants and animals relying on it.

Throughfall and *garúa* interception on epiphytes. Photo: C.D. Becker.

- That the community was ultimately responsible for the forest and its ecosystem services because they owned it.

After the 1-hour proposal by PAN, including presentation of the video, a community rebuttal took place. Opinions were voiced by villagers, a vote was taken, and a substantial majority of the attending comuneros (83%; N ≈ 120) were in favor of establishing a forest reserve. Despite the large community support for protecting a specific portion of forest, the *Cabildo* tabled the final vote until the next regularly scheduled meeting, stating that they wanted to hear concerns of landholders in the proposed ecological reserve.

Of the 24 landholders, 15 in the proposed reserve convened to discuss their concerns with PAN and the *Cabildo*. At this meeting, they unanimously supported establishing a reserve and agreed to stop any further deforestation as long as they could retain their current uses (e.g. small *paja toquilla* plantations). At the following *asamblea* (August 3), half these landholders had changed their opinion. They presented an organized oral protest against PAN's proposal, based mainly on distrust of outsiders, suggesting that PAN was trying to steal the community's land. The *Cabildo* called for another community-wide special *asamblea* (August 10) to make a final decision. This 3-hour gathering was extremely emotional with speeches for and against the reserve. The *Cabildo* president threatened to resign if the community refused to make the reserve. A majority spoke in favor of the reserve and then a very strong majority in attendance (≈ 95%; N ≈ 110) voted to form the reserve. On August 24th, the official agreement drafted by the *Cabildo* and PAN was read paragraph by paragraph detailing rules of use and location of the reserve boundaries. A final vote was made in favor of the agreement, and an area of about 1000 ha was officially declared as Reserva Ecológica de Loma Alta (Fig. 2). It is currently guarded and managed by the local community with technical and financial assistance from PAN.

DISCUSSION

Innovative approaches have been repeatedly called for to solve environmental problems associated with human land-use decisions (20). Uhl et al. (40) suggest that successful environmental problem-solving requires *(i)* a long-term commitment to resolving the problem under study and to "go where the problem leads"; *(ii)* a willingness to produce information in a variety of forms for a diverse audience; and *(iii)* a cross-disciplinary research approach. In retrospect, PAN's experience in Loma Alta echoes Uhl et al. and provides a few additional suggestions.

- Start with and repeat social science research about local people and their relationships with a forest or resource of concern.
- Use methods that are participatory so that local people become more informed and interested in the resource of concern.
- Use findings from social and natural science research to guide strategy appropriate to your organization's mission. Design strategy after such studies, not before.
- Conduct research on resource condition and total economic value of the resource with as much participation by local users and decision-makers as possible.
- Use local institutions and appropriate media to inform adult decision makers and users about indirect and option values of resources.

In this case, a local understanding of the indirect values of fog capture appeared to facilitate the community's support for forest protection. Local people based their decision to preserve forest mainly on qualitative concepts about the role of the forest in securing water. Families living in the lowlands pay for water during droughts and thus experience a direct loss of family income due to declining groundwater. Families that reside higher up in the watershed expend additional labor to dig their wells deeper as the water table falls. Lowlanders with more to gain from forest protection and less to lose from constraints on land use in the highlands were all in favor of the new reserve, while nearly half the families with land allocations in the reserve opposed it until the last vote.

During our interviews, residents of Loma Alta reminisced about the 1970s, i.e. before large-scale deforestation in the highlands. They claimed that the Rio California, the eastern boundary of the community (Fig. 2), flowed year-round, and that they enjoyed catching large fish and crayfish from the river. Older residents stated that until the 1980s, the river had dried completely only one other time in this century (in the 1930s) when the *garúa* season failed. Timber harvesting and conversion of forest to pasture and hat-fiber plots may partially explain why the Rio California has become drier over the past 15 years, but regional climate change related to regional-scale deforestation and even global climate change cannot be excluded as contributing factors.

When people have successfully organized to preserve forests, they have typically done so because the values of the intact forest to their society or user group are perceived to exceed the value of forest destruction by individuals. A change in perception of societal value may stem (a) from ecological understanding (e.g. Tukano Indians in the Amazon protect riparian forest because they understand that fish feed on the fruits from trees (41); (b) from financial incentives created externally (e.g. forest protection for tourism); (c) from experience with costly ecological disasters due to deforestation (e.g. many montane forests in the world); or (d) from a critical mass of people acting upon existence value for forests (e.g. establishing the Children's Rainforest in Costa Rica). Thus, a broader or more complete perception of the total economic value (42) of forests appears to be a prerequisite for creating local rules and institutions that sustain these woody ecosystems and their biological diversity. PAN has now turned to researching and developing option values for nontimber forest products (tagua nuts) and ecotourism (bird watching and mountain trekking) to further enhance the forest's value for local people.

Results of the throughfall study suggest that there is a significant horizontal component to the *garúa*, and that the large surfaces provided by a mature forest intercept significant quantities of these small water droplets, providing an important input of water to the drainage basin. While more precise and accurate estimates of fog-capture are desirable and feasible (34), rough estimates made with very simple equipment at extremely low costs permitted the justification for forest preservation on windward hill-tops in the Colonches. As discussed by Schemenauer and Cereceda (34), fog-catcher cylinders fail to provide a precise estimate of horizontal precipitation due to evaporation from the mesh, deflection of wind-blown droplets off the mesh, and adhesion of droplets to the mesh. Models for fog capture could be refined and improved, but more exact values would be unlikely to change the local political impact of the information.

A policy-oriented lesson from this case is that radical decentralization efforts may be overly optimistic. Expecting communities in developing nations to organize and to cover the costs of sustainable stewardship of natural resources on their own is unrealistic, especially when the costs of doing so are high, and the benefits of doing so are not apparent to local users. To focus local values and action towards protection of the *garúa* forest an external institution (PAN) was required to cover social and technical transaction costs. The community had no tradition of conducting research to solve environmental problems, facilitating environmental education, or planning for stewardship of their forest. While ensuring that local users have more control and autonomy over resources may be a step towards encouraging responsibility and long time-horizons, it is not a guarantee of sustainable forestry, conservation planning, or preservation of critical ecosystem services.

CONCLUSION

An ecological reserve was established in the Colonche Hill forests by the Comuna of Loma Alta. Tenure rights to a forest interacted with a strong tradition of stable local governance to facilitate the success of making the community ecological reserve. Without the compliance of the *Cabildo* and the community's *asamblea*, an attempt to make a functional protected area of 1000 ha would probably have required more time and more institutional crafting. Still, the role of an external agency can not be underplayed. Until an outside interest group (in this case the charity organization PAN) provided the community with relevant data on the ecosystem value of their forest, villagers lacked sufficient motivation to constrain deforestation. Until external funds arrived for demarcating the reserve, training reserve guards and guides, the community made no substantial organization to control forest use in their new reserve. Is Loma Alta's new reserve more sustainable than incentive-based integrated conservation and development projects? Given that fog capture as an ecosystem service justified forest preservation for the majority of community members, it may be, but it is too early to judge.

Tropical forests provide a large number of renewable goods and ecosystem services at local, regional, and global levels (43), but their benefits to society continue to be rapidly sacrificed for more immediate uses. Forests are undervalued (13, 16) regardless of whether they are in public or private ownership, stewarded by self-organizing institutions, decentralized, or included in integrated conservation and development schemes. If we hope to sustain forests, then people everywhere must come to value the ecosystem services, option, and existence values of forests more than they do currently. Wild forests will continue to disappear unless we nest our institutional strategies (9) and incentives effectively at many scales with the specific goal of preserving forests and the biological diversity within them.

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