Monte Alto Reserve, Hojancha:
Community-based adaptation in response to water scarcity

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Introduction

The province of Guanacaste lies in the northwest of Costa Rica bounded by the Pacific Ocean to the west, the province of Alajuela to the east, Puntarenas to the south and sharing its northern border with Nicaragua. Though sparsely populated in comparison to the rest of the country, Guanacaste features as a popular destination for Costa Rica's growing tourism industry. Rapid urban development associated with tourism infrastructure competes with agricultural and pastoral activities as the main economic drivers for the region. These land uses are placing increasing pressure on the region's water resources. Taken in the context of a changing climate, these forces challenge communities to consider adaptation activities to both preserve ecosystem functions and create new economic opportunities compatible with a conservation ethos.

Figure 1. Guanacaste Province, Costa Rica.

This paper will present a case study of the Monte Alto Reserve in the Rio Nosara Basin in Guanacaste province. Previous government policy encouraging deforestation to make way for farming in the river basin resulted in clear cutting of the hillsides around the city of Hojancha. The resulting erosion and sedimentation of the Nosara River caused the river to dry up in the early 1990s and created a crisis for residents of Hojancha and surrounding communities. This sparked the formation by concerned residents of the Fundación Pro Reserva Monte Alto which had the goal of preserving the lands in the river basin in order to restore water flow. This intervention can be seen as a successful conservation and adaptation project however the reserve faces significant challenges to its effectiveness into the future. The unintended consequence of the project was to increase the overall water usage in the area raising questions of how to account for human behavior in adaptation plans. This case study will review the macro level factors influencing water use in the Rio Nosara Basin, outline the issues which prompted the creation of the Monte Alto Reserve, examine the results and challenges of this community-based adaptation project and discuss some of the factors behind those results and challenges.

Background

Costa Rica, though rich in water resources, faces a number of challenges in the provision of water to its citizens. These challenges include the seasonality of supplies which affect certain portions of the country disproportionately, uneven population distribution, quality issues due to sedimentation from erosion and a changing climate. Water resources in Costa Rica vary considerably from the Atlantic to the Pacific side. The Atlantic watershed experiences the most precipitation while the Pacific side is drier and characterized by dramatic reduction in flows during the dry season. Competition over water use has therefore been a fixture for communities along the Pacific coast, especially in the northwest province of Guanacaste.

Guanacaste covers a total area of 1,014,071km^2 and contains a population of 280,232 as of 2011, making it the least populated province in the country (INEC, 2012). The province has a significant tourism presence however, with many visitors flocking to beaches along the Pacific coast. As preferred ocean side lands are developed, prospective developers are moving inland in search of pristine landscapes for new tourism destinations. The central government has promoted the expansion of ecotourism as an effective revenue generator which is compatible with conservation goals. Favourable government policies encouraging tourism development are raising the price of land and putting pressure on small holder farmers operating inland to compete for both land and water resources. As the peak tourism season coincides with the dry season, lasting for at least 5 months in the province, competition over water is increasing. This competition is compounded by the overall population distribution of the country which sees the Pacific coast housing 70% of the country's population but containing only 30% of its water resources (Ballestero et al., 2007).

Though in recent years high tech industry has been gaining ground as the main contributor to GNP in the country, tourism and agriculture continue to play an important role. Guanacaste has the highest level of irrigated area in the country at 45,960 ha followed by Puntarenas with 43,991 and Alajuela with 6,077 ha (Aquastat, 2012). Irrigation is used for growing crops such as rice and sugar cane and to support pasture lands. Past government policies have encouraged small holder farmers to move up the inland valley slopes to increase cultivated area, deforesting entire hillsides. This has resulted in significant erosion problems and sedimentation of river basins in the province and has led to a decrease in water quality for communities.

The country's vulnerability to climate change poses further risks to already fragile water resources. The IPCC Fourth Assessment Report: Impacts, Adaptation and Vulnerability states that global temperatures are likely to have increased by 1.1 degrees to as high as 6.4 degrees by the end of this century relative to 1980-1999 baseline data (Summary for Policy Makers, 2007). A projected warming in Latin America of only a couple degrees translates into serious impacts on ecosystem services in the region. The IPCC predicts that Costa Rica can expect severe water stresses in the central valley and Pacific Region which will affect water supply to communities and for hydro power which supplies almost 90% of the country's energy demand (Long, 2001). Though sea level rise (SLR) has not yet been of great concern to Costa Rica, there is evidence that this is changing and SLR is accelerating up to 2-3 mm per year over the past decade (Magrin et al., 2007). The combination of SLR and predicted increases in extreme weather events such as storm surges and windstorms are likely to affect both water quality and availability for communities.

Seasonality, demographic pressure, unregulated urban growth, increased use and climate change all contribute to the vulnerability of water resources in the pacific northwest of Costa Rica. Limited central government intervention and a still largely siloed bureaucracy have meant that individual communities must take responsibility for implementing their own solutions to resource scarcity.

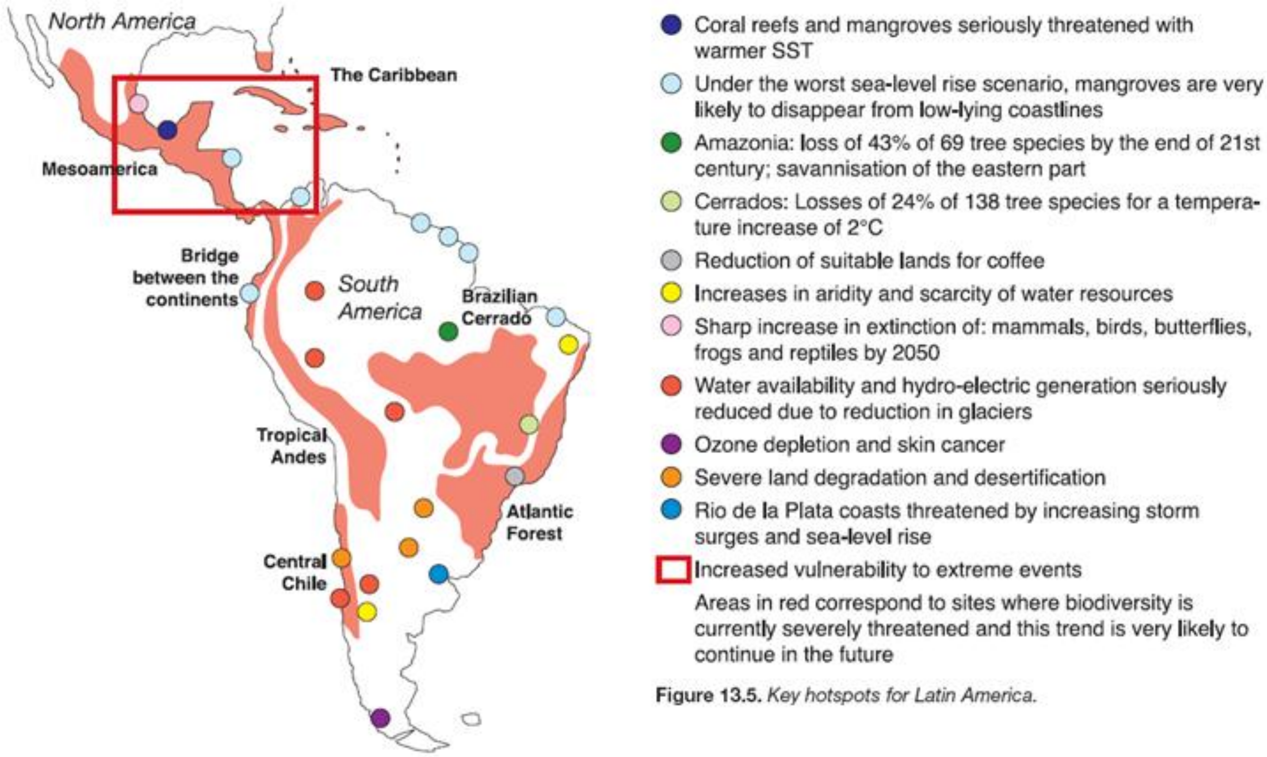

Figure 2. Climate change impacts in Latin America; from the IPCC Fourth Assessment Report – Latin America, p.26.

Water Crisis in Hojancha

The City of Hojancha is located in the southern interior of Guanacaste, within the Nosara River Basin. In the early 1990s residents of Hojancha experienced a crisis when their main water source, the Nosara River, dried up. Previous government policy had encouraged deforestation on the basin slopes to increase agricultural and pastoral lands. This resulted in the clear cutting of the hillsides around Hojancha; all of the forest except for a narrow strip running beside the river was cleared by small holder farmers (Mendez, 2012). The highly porous soils of the upper Nosara River Basin were degraded and compacted by intensive agriculture and cattle ranching. This was the area where the majority of infiltration occurred to supply water systems which communities downriver relied on. The damage to this area greatly reduced infiltration and contributed to the sedimentation of the river.

The urgency of the situation was demonstrated to residents when local schools and hospitals were forced to close due to lack of water. There is a paucity of accurate data on the potential volumes of the main aquifers in Costa Rica or the existing demand on them. Residents and officials were left to guess at whether the damage to their river basin was permanent. Later research done by CATIE however suggests that there is little underground water in the Hojancha area and therefore it is important to determine how to conserve what is there (Mendez, 2012).

Community-adaptation

The disruption of natural systems and subsequent crisis led to the creation of the Fundación Pro Reserva Monte Alto in 1992. The Fundación strategy was to purchase lands within the river basin to allow the natural regeneration of the forest which would prevent sedimentation of the river and conserve biodiversity in the area. This area bounded by the river basin became the Monte Alto Reserve. The Fundación began by purchasing parcels of land along the steepest slopes within the river basin where springs originated. Partners of the Fundación purchased one hectare or more through installments depending on their economic means. At the start of the initiative, land in the river basin was valued at approximately US$700 per hectare. The majority of supporters are made up of resident families who have purchased one or two hectares of land, though partners also include organizations which have the means to purchase larger parcels. These partners include the Sub-regional branch of the Ministry of Environment (MINAE), corporate entities and a German NGO (Mendez, 2012). In time, left to its own devices, the forest began to regenerate which allowed for decreased runoff and sedimentation, an increase in infiltration and the eventual restoration of the river.

Alongside their conservation efforts, members of the Fundación sought ways to use the restored river basin for economic development projects which would preserve local ecosystems while providing employment and revenue opportunities to local residents (Fundación Pro Reserva Natural Monte Alto, 2012). Though operating with the support of MINAE, which regulates activities in the area, the community-based conservation project owns the land giving them some measure of control. The Monte Alto Reserve began accepting both local and international visitors and researchers in 1999 and since then has developed a number of community-based ecotourism initiatives. These include the construction of an orchid garden, lookout point, eco-cultural information centre, hiking trails through the forest and supporting amenities such as on-site lodging, food services and a meeting hall.

To date the Fundación has purchased a total of 274 hectares of the river basin with the oldest parts having been protected for 20 years. This however is only a fraction of the total reserve envisioned by the Fundación, whose borders were intended to define the entire river basin. It has become more difficult over the years for the community to continue to purchase land though not for lack of willing sellers. The low return for small holder farmers in the area combined with the global collapse in beef prices has led to farmers and ranchers eager to sell. The issue now is the rising land prices stemming from increased tourism development moving in from the coast. Prices have now risen to a point beyond the reach of the average resident family to purchase. The main activities of the Fundación currently center on encouraging further research in the area and educational initiatives in

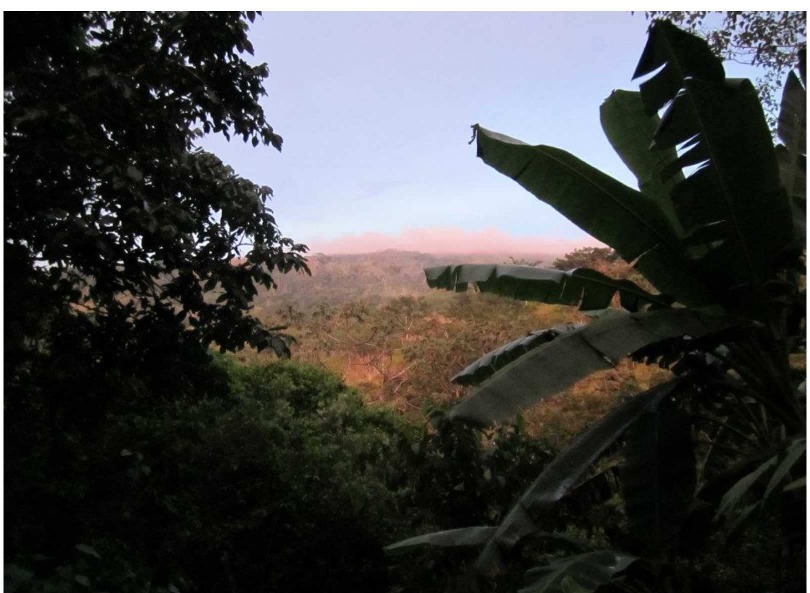

Figure 3. View from information centre, Monte Alto Reserve, 2012.

the local communities. Outreach activities take place in schools where youth are educated mainly on water conservation issues though other community concerns such as poaching and forest fire risk are also addressed. A new initiative working with local famers to adopt sustainable agricultural practices has seen some success.

Results and future challenges

The benefits of this initiative can been seen in the restoration of water supplies to Hojancha, the development of tourism projects to support the community and increased biodiversity in the area. Local organization around this project has built administrative capacity with the creation of a management plan for the reserve. Currently in its second iteration, the Monte Alto Reserve Management Plan is revised every ten years and provides strategic direction to the activities of the Fundación. Sound management systems have been necessary in order for the administration to consider a changing climate that has created hotter and drier forests, destroying habitat and increasing the risk of forest fire. The successes of this project have been attributed to the formation of solid partnerships, good organization on the part of the Fundación and the project's status of being a locally-owned and community-based initiative controlled by local interests. That the project was so well received and supported by the community speaks to the fact that the scarcity of such a key resource was something which all residents had in common and could serve as a rallying point. Individuals were readily able to recognize the urgency in conservation efforts thus helping to move the project forward (Mendez, 2012).

Despite the success of restoring water flow and creating economic opportunities for residents, Monte Alto continues to face a number of challenges. These challenges include changing government priorities to promote tourism development, lack of funds for purchasing land for the reserve, scarce data on water resources and the absence of analysis of the cumulative effects of water use across multiple sectors.

In Guanacaste in general, reforestation has been largely a result of the global crash in meat prices and intentional government policies offering incentives for conservation. The question remains what happens to projects such as the Monte Alto Reserve when the funding for conservation initiatives runs out. The success of this project has been two sided, as the regeneration of the forest has created an attractive landscape for tourism development. Rising land prices due to increased tourism prospecting are a significant barrier to the growth and continuation of the reserve. Fundación members worry that these changes pave the way for a reversal of their work. Despite law in Costa Rica which prevents the conversion of currently forested lands into another use, it remains relatively easy to circumvent this, especially with the promise of increased economic development (Mendez, 2012).

Little is known of the water supplies contained within Costa Rica's aquifers or what the current demand on both surface and ground water are. Municipalities are able to monitor consumption within their boundaries, however in rural areas there is little to no data as residents continue to rely on traditional wells or access water directly from streams. Currently Costa Rica manages groundwater through a concession system which does not correspond to overall supplies (Ballestero, 2007). Coupled with the limited data on water resources, policies such as these do not consider monitoring cumulative effects on the overall resource supply. With climate impacts in the next decade predicted to further constrict supplies, this situation is worrying for conservation efforts such as the Monte Alto Reserve.

An unintended and somewhat counter intuitive result of the Monte Alto conservation project was the impact which the restoration of the Nosara River had on water consumption in Hojancha. It was found that following the crisis, overall water use by Hojancha residents increased to the point where they have the highest consumption rates in the country (Mendez, 2012). In comparison, the much larger community of Nicoya, 14km north of Hojancha, has an average monthly individual consumption which is almost half what a resident of Hojancha now consumes.

	City of Nicoya	**City of Hojancha**
Population	15,315	7,197
Individual water consumption per month (m^3)	4.62	8.34

Table 1. Relative population and water consumption of Nicoya and Hojancha; adapted from a presentation by Xenia Campos (MINAET), Nicoya, Costa Rica, May 2012.

This increase in water use forces the consideration of how to integrate behavioral and cultural factors into adaptation measures. Miguel Mendez, a staff member at the Monte Alto Reserve, observed that residents do not perceive a condition of scarcity despite the recent crisis due to the improved water pressure following the successful reforestation of the river basin. This sentiment is echoed by MINAET employee, Xinia Campos, who points out that Hojancha's pipes are the same diameter as those for the much larger community of Nicoya which results in excellent water pressure to the fewer residences in Hojancha, contributing to a sense of abundance. This sentiment has led to numerous wasteful practices including washing cars and watering lawns during the dry season. Campos believes that there are cultural factors at play which prevents serious water conservation and that the lack of a culture of conservation will be detrimental in the long term for local supplies.

These explanations of the dramatic increase in water use by residents of Hojancha illustrate the importance of incorporating human behavioural factors when designing adaptation measures. When assessing the vulnerability of various regions to climate change, much attention is paid to the adaptive capacity or ability of the system to weather damages, deal with the consequences and take advantage of opportunities (Perez, 2010). A major factor of a municipalities' adaptive capacity revolves around human behavior and perception of the natural world which in turn influences how individuals use and conserve resources.

Discussion of factors influencing the increase in water use

The increase in consumption of water resources in Hojancha following the success of the Monte Alto Reserve raises concerns over how to ensure future sustainable use of water in the area. Gains in quality of life for residents and restoration of the river basin will stand for little if the increased consumption levels cause the river to dry up once more. Understanding the cause of this increase in water use is a necessary step towards tackling this issue of sustainable development in the river basin.

When looking for explanations, comparisons can be made to the debate over the Jevons Paradox or rebound effect. The paradox describes a situation where an increase in technological efficiency causes the price of a resource to drop thus encouraging an overall increase in consumption, mitigating any conservation gained by the initial efficiency measure. This phenomenon was first described by Stanley Jevons in 1865 to refute the belief that increased technological efficiency would necessarily result in a reduction in overall resource use. Jevons used the example of a more efficient steam engine which caused the price of coal to drop, in turn encouraging even greater consumption in the long term as the resource became economically available to a greater number of people and for new commercial purposes (Gottron, 2001). Normally expressed as a ratio, the Jevons Paradox/rebound effect is the lost environmental benefit compared to the expected environmental benefit when holding consumption constant.

A closer examination of the real effects efficiency has on resource use is important when making policy whose goal is to encourage sustainable development. There is concern that promoting technological efficiency as the means to solve the problem of resource overuse encourages a belief that there is no need to reduce overall consumption as continued technological innovation will be able to eliminate the problem. This is a dangerous assumption when it is unclear as to the actual environmental benefits of increased efficiency. If the Jevons Paradox is in fact true, then the amount of resource conservation due to an increase in efficiency could be much less than expected. A worst case scenario could be a situation of “backfire” where the increase in efficiency causes an overall increase in consumption above and beyond what was used prior to the adoption of the efficiency measure. This renders that measure not only ineffective in conservation goals but damaging to those goals.

The Jevons Paradox/rebound effect has most often been referred to in studies of energy efficiency and use (Gottron, 2001, Herring, Horace & Roy, 2007, Irrek, 2001, Sorrell, 2012, Van den Bergh, 2011). In this field, the size of rebound effects is hotly contested and difficult to assess as they depend greatly on choices made by those doing the measuring (Sorrell, 2007). In general however it is accepted as a real phenomenon which should be considered when creating energy policy. For this reason recommendations for sustainable resource development often centre on the role played by increased technological efficiency coupled with appropriate policy measures to mitigate the rebound effect. Accompanying policies could include a system of taxation which would take any cost savings from efficiency gains out of further economic circulation and put it to use investing in natural capital rehabilitation (Rees & Wackernagel, 1997). Approaches such as these seek to prevent resource prices from dropping from efficiency gains, thus taking away an incentive for increased consumption.

How applicable the Jevons Paradox is to a resource like water is a subject of debate. Jevons’ argument focuses on the effect of efficiency on profitability, price and demand (Alcott, 2012) however these phenomena apply in a different way to water compared to energy at a system scale (Rodriguez, 2012). Water differs from energy in a significant way; water that is unused is not lost in a river basin but rather the return flows have the potential to be used downstream. Energy if not used productively is effectively lost. The behavioural incentives and changes around water use are varied and there is some evidence that consumption choices are not tied solely to the price of water. Llop conducted a study of the impact of alternative water policies implemented on the Spanish production system (Llop, 2012). The findings demonstrated that increased efficiency for water use and production decreased water prices and lead to an increase in industrial water consumption. This increase in consumption was lowered with the introduction of a tax on water alongside efficiency measures. This appears to be consistent with the Jevons Paradox. However the author does note that water demand is very similar in the two scenarios which could mean that price is not necessarily the only factor which determines total water use.

Lecina et al in their study of irrigation modernization in Spain expand on this idea by demonstrating that there are many other factors which influence water use beyond price (Lecina et al., 2010). The study found that accounting for resource use using efficiency measures alone misses key factors such as water reuse, influence of the location of use within the basin, water quality and the distinction between total water use and water consumption. The study showed that hydrological factors and a desire for increased productivity on the part of commercial farmers were the main causes of the rise in water use and not price. The authors conclude that in order to avoid unrealistic expectations about water savings due to efficiency, accounting measures need to look at a wider range of factors than price. Rodriguez et al. echo this sentiment by stating that the Jevons Paradox assumes a linear argument to explain how efficiency gains impact resource use whereas in reality water as a resource is a part of a larger complex system where many factors influence conservation attempts (Rodriguez et al., 2012). Expanding our view to include these other factors will avoid misleading claims of conservation for policy makers interested in sustainable development.

UNEP and the European Environment Agency (EEA) cite the Jevons Paradox as reason for caution when relying on technological efficiency to conserve resources (UNEP, 2012, EEA, 2012). However both state the need to move beyond efficiency when considering how to make a shift to a future green economy. Analysis should instead focus on impact decoupling; the impacts of resource use and the status of natural systems when determining appropriate levels of human use. This impact decoupling would focus on the conditions required for aquatic ecosystems to function properly and support human wellbeing. In this line of thought resource use has to be grounded in an awareness of not just the impact of increased efficiency on the quantity of the resource used by humans but the wider impacts that use has on the environment and its resilience.

The case of Hojancha presents an interesting case study to consider how best to measure the impact of human water use to ensure sustainable levels are maintained. After the restoration of the river basin, there was no resultant drop in price as the cost of water remained constant in the area. Residents continued to pay the amount determined by meter readings, therefore those using more water would find themselves paying more than they were previously. This could reflect the fact that those households were previously under serviced and are now consuming at a level in line with their basic needs. It could also indicate that the current price for water is set too low to encourage conservation.

It would be difficult to determine in the future whether the Jevons Paradox will factor in the development of water resources in Hojancha as the city is now sourcing its water from another area that is pumped via pipeline from the lowlands and not from the Nicoya system (Mendez, 2012). However focusing on whether the Jevons Paradox is at play in this case study could be beside the point anyway for policy makers interested in water conservation in Hojancha. If the objective is to create policy which encourages water conservation, it could be more productive for decision makers to instead focus on determining what conditions are required to maintain a healthy ecosystem in the river basin as recommended by UNEP and the EEA. This knowledge could better inform conservation policies by determining a baseline condition to be met in order for the river basin to function properly.

Figure 4. Furrowed agriculture in the Central Valley, an example of practices intended to minimize erosion from hillside agriculture.

Conclusion

Adaptation planning is of particular importance where communities depend on climate-vulnerable sectors such as agriculture and tourism. Costa Rica's Guanacaste province faces uncertainty in future water supplies due to a changing climate and increasing demand. Though the establishment of the Monte Alto Reserve has been a success for community-based adaptation and ecosystem restoration in Guanacaste, there remain challenges to the realization of benefits in the future. The challenges facing decision makers include increasing urban development in water stressed areas, increasing demand, limited data on actual water supplies and the cumulative effects which current connections are having on overall supplies. The dramatic increase in water consumption in Hojancha following the successful restoration of its water supply highlights the need to take human behavior and culture into consideration when designing adaptation projects. When designing future policy to encourage conservation, decision makers need to look at a wide range of factors which influence water use, including both human motivation and ecological systems. This case study has demonstrated that humans are an integral part of ecosystems and adaptation measures should include actions to change socio cultural patterns which affect natural systems in order to avoid repeating the past mistakes.

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