



INTRODUCTION

Biodiversity is distributed unevenly across the earth, and some regions hold exceptionally high levels of species richness and endemism. Mountains are an important example. The steep gradients in temperature and precipitation, the presence of many local microclimates caused by differences in slope and aspect, and the frequent isolation of mountain peaks from adjacent peaks all result in high levels of unique biodiversity. The tropics are an extreme example, where mountains located near the equator replicate in their elevational transitions a reflection of the latitudinal gradients from tropical, through temperate, to near polar latitudes. Montane systems form the backbone of subtropical and tropical regions in the western hemisphere, running from northern Mexico south through Central America, and through the Andes in South America.

Over time these tropical regions were occupied by indigenous groups that exhibited high levels of cultural diversity as the result of the same factors that led to extensive biological diversity. These groups, along with the more recent expansion of non-indigenous populations, are increasingly putting pressure on the local natural resource base through livelihood strategies that extend beyond subsistence agriculture. Most smallholder farmers in tropical regions are low income, have minimal education and lack access to resources. This means they already experience many limitations that reduce their ability to generate income and make long-ranging decisions to manage their crops and households. Additionally, large agribusinesses often favor profit maximization over the mitigation of the negative impacts of their business practices on the natural environment and the livelihood of smallholder farmers. So, an investigation into who the stakeholders are and what practices are being carried out to conserve or deplete the natural resources, is necessary in order for the development of successful conservation programs.



Coffee, forest, and local communities are a component of many tropical montane ecosystems (Sierra Nevada de Santa Marta, Colombia).

Biological data were collected using a variety of sampling techniques, including camera trapping (Huascarán National Park, Peru).

Focal group and individual farmer interviews were employed in all of these studies (Sierra Nevada de Santa Marta, Colombia).

METHODS

We conducted a five-country comparative study (Costa Rica, Guatemala, Honduras, Colombia, and Peru) to gain insights on critical issues in the development and conservation of tropical montane systems. The United Nations Sustainable Development Goals (UN SDGs) provides an international recognized framework for understanding and measuring the intersections between the social and natural environment that impact conservation and social development. Interviews and focus groups that relate to the UN SDGs were conducted to collect data related to local land uses and generate a baseline of information necessary to develop conservation programs that can lead to more sustainable land use practices.

OUR RESEARCH QUESTIONS

- 1) Who are the different stakeholders (e.g. smallholder farmers, agribusinesses, government) and what are their roles related to resource use and conservation?
- 2) What biological resources are considered important to conserve by the different stakeholders?
- 3) What current uses of biological resources are perceived to be leading to resource conservation or depletion?
- 4) How are social, economic, ethical, religious and political factors perceived to be facilitating resource conservation or depletion?



| Region/Researcher | Q1: Stakeholders | Q2: Biological Resources | Q3: Natural Resource Uses | Q4: Social, Economic, Political Factors |
|---|---|--|---|---|
| Colombia - Sierra Nevada de Santa Marta. Dr. Nicolette Roach | Small holding coffee producers, ecotourism enterprises, National Parks, NGOs. | Watersheds and water quality, forests, biodiversity (especially for ecotourism). | Coffee and cattle use modified landscapes, water for agriculture, water quality and quantity decline, agriculture chemical use, fragmentation. | Local stakeholder conflicts, between NGOs, government, and local communities. Corruption at multiple levels. Coffee producers need more financial resources to better manage landscape. Political unrest, including guerilla activities a growing concern. |
| Costa Rica - Monteverde Cloud Forest. Jordan Rogan | Private land owners (cattle, agriculture), ecotourism businesses, environmental NGOs. | Watershed quality and quantity, forest conservation, diversified agriculture, including ornamental plants and honey bees. | Cattle ranching and agriculture, resulting in water conflicts, deforestation and forest fragmentation impacting biological corridors, illegal hunting. | Local communities are tight-knit, facilitating cooperation. Region is environmentally conscious, influenced by Quaker communities. Increasing participation in Payment for Ecosystem Services programs in corridors, but no universal support. |
| Guatemala - San Pedro Yepocapa. Dr. Taya Brown | Smallholder coffee communities, intermediate coffee buyers, agricultural companies, NGOs, Agriculture Department | Minimal discussion of biodiversity in communities, mostly birds, some mammals. Some discussion of water quality. | Concern about agricultural chemical impact, erosion on slopes. Need to have more shade protection for coffee. | Lack of profitability of coffee, lack of communication between buyers and growers, need to gain information on improving cup quality. The coffee agency Anacafe has little presence. Lack of information on links between plant and soil health and coffee quality. Communities have poor health care services. |
| Honduras - Santa Rosa de Copan. Sarah Brinkley | Capucas coffee cooperative members, technicians, administrators, collaborative local universities, several coffee focused NGOs. | Soil conservation and composting valued. Use of plants to minimize soil erosion and maintain fertility. Protecting freshwater resources and pollinators. | Coffee production dominates impacts, through transportation (fossil fuels), soil impacts, combustion of coffee parchment, and litter and solid waste problems. | There is a lot of messaging about the protection of the environment but a disconnect with actual cultural practices. Conservation activities are more likely to occur if there are financial incentives. Coffee certifications were initially criticized but have received slow acceptance over time. |
| Peru - Huascarán Biosphere Reserve. Jessica Gilbert | Campeño communities, Huascarán National Park staff, other government organizations, local NGOs, mining companies, and tourism agencies. | Water resources are highest priority, conservation of grasslands, protection of forest fragments, local biodiversity in park. | Climate change is the most important threat, along with mining, agriculture intensification, and overgrazing. There is also some overharvesting of plant and animal resources, and tourism has both costs and benefits. | Fire as a cultural tool has been over utilized. Local communities mistrust NGOs and government organizations, causing conflicts with researchers. Corruption over access to mining resources is a risk. There are issues of scale regarding management perspectives and resource use, at the local versus national level. |

EMERGENT THEMES

Tropical montane systems present complex problems, but we see a number of themes emerge that can provide guidance for future research in the region. Even though we span five countries throughout Central and South America, the stakeholders are consistent, with the region dominated by small landholdings where the issues focus on local community dynamics. Coffee and cattle are dominant social, cultural and economic activities. There are conflicts with farmers and market mechanisms, where profitability limits the ability of communities to address many environmental and conservation issues that they view as important. Many of these compromise their economic well-being. Water is consistently important, both quality and quantity, with climate change exacerbating concerns over availability. There is the potential for corruption between business interests, government agencies, and even local and global NGOs, and poor communication often worsens conflict and suspicion. All of these factors are leading to deteriorating conditions for the conservation of important biodiversity and associated ecosystem services. Our current efforts are focused on the development of new interview tools to better understand the drivers of conflicts and provide recommendation to ameliorate these conflicts.



Publications

Wood, M.A., J. Gilbert and T.E. Lacher, Jr. 2020. Payments for ecosystem service's role in landscape connectivity. *Environmental Conservation* DOI: <https://doi.org/10.1017/S0376892920000016>.

Roach, N.S., N.J. Urbina-Cardona, and T.E. Lacher, Jr. 2020. Land cover drives amphibian diversity across steep elevational gradients in an isolated Neotropical mountain range: Implications for community conservation. *Global Ecology and Conservation* <https://doi.org/10.1016/j.gecco.2020.e00968>.

Gibbes, C., Hopkins, A., Inurreta, A. and J. Jimenez Osornio. (2020) Defining and measuring sustainability: A systematic review of studies in rural Latin America and the Caribbean. *Environment, Development and Sustainability* 22(1):447-468.

Publications in Progress

Roach, N.S., D. Acosta, and T.E. Lacher, Jr. Submitted. Understanding perceptions and management strategies of local land users to sustain livelihoods and biodiversity in an isolated Colombian montane region. *Ecology and Society*.

Hopkins, A.L., Gibbes, C., Clement, V., and Reyes-Can, A., Inurreta, A.F., and J. Jimenez-Osornio. (To be submitted 10-1-20) Sub-national variation in internationally recognized sustainable development goals in the Yucatan, Mexico. *Journal of Human Development and Capabilities*.

Grants

Subcontracting participants (N. Roach and T.E. Lacher, Jr.) on the Global Consortium for Sustainability Outcomes grant "Protecting the thread of life: enhancing watershed health for communities, coffee agroforestry, and conservation." To consortium members Arizona State University (B. Polidoro) and the Universidad Nacional Autónoma de México (G. Ceballos). \$94,587.00 total \$16,928.00 to Texas A&M activities in Colombia through Colombian NGO ProCAT.

Proposal

Cultural Anthropology Senior Research Proposal, National Science Foundation, Social change interventions influence on health and cultural models of wellbeing in rural Yucatan, PI: Allison Hopkins, PhD. To be submitted on January 15, 2021. 2021-2024, \$360,000

PRODUCTS

