Executive Summary

The effects of human-induced climate change are an important part of environmental knowledge. Projections and scenarios allow scientists and decision-makers to understand possible ramifications on the social and ecological frameworks as well as over different spans of time. The Centro del Agua del Trópico Húmedo para América Latina y el Caribe (CATHALAC) in Panama hosts the Sistema de Monitoreo y Visualización para Mesoamérica (SERVIR), which creates, hosts, and shares vast amounts of data used in making climate change projections and in other environmental applications. Given the rapidity and intensity of anthropogenic impacts, measuring vulnerability of different ecosystem types and geographical locations is urgent, especially in Central America, which hosts so much biological diversity that is increasingly threatened by development and land use change.

While studies on ecological effects of climate change have mostly been carried out at the species level, the overall goal of our study is to assess the vulnerability at the ecosystem level. Since there is presently little done at this scale, we undertook a lengthy literature review in order to understand the dynamics of ecosystems that would guide us in how to measure their vulnerability. Thus, four domains were considered in this analysis: sea level rise, ecosystem geometry, climatic "niche," and species sensitivity. Valuing these four types of vulnerability based on their pertinence to climate change and the quality of the data, we were able to create an index of Ecosystem Vulnerability to Climate Change (EVCC) in Panama.

The purpose of this study was to create an EVCC value for each of the 1303 smaller ecosystem patches in Panama that make up larger thirty-seven different types of ecosystems, but generalizations have been made about vulnerability trends for ecosystem types and geographical regions.

The sea level rise analysis identified highly vulnerable small islands, mangroves, and tropical rainforests in lowlands, especially in Bocas del Toro. Ecosystem geometry analyses found ecosystem patches with the possibility for negative edge effects—those that are small and/or irregularly shaped. The climatic niche investigation combined historical average precipitation and temperature values and compared them with climate change scenario projections to identify those patches that are expected to experience the most change. Bocas del Toro, the Gulf of Chiriquí coastal ecosystems, central Darien, and some of the Canal Zone are highly vulnerable. Species sensitivity evaluations involved determining the average species range in a patch, given its area. Those patches with the smallest ranges were considered most vulnerable, which were various types of lowland forests, montane broadleaf rainforests, small islands, and agricultural systems. Combining these four domains to obtain the overall EVCC index highlighted patches with high vulnerability in all domains. The most vulnerable patches were almost all along coastlines (heavily concentrated in Bocas del Toro and the Gulf of Chiriquí coasts – lowland and swampy forests, occasionally flooded forests, mangroves, small islands, and agricultural systems.

Overall EVCC values were compared to four applications: degree of human intervention, protected areas, overall species richness, and endemic species richness. Higher average EVCCs were found for higher degrees of human intervention, but this comes with a degree of uncertainty. While no correlation was found between EVCC and protected areas, there seemed to be a relationship with the overall and endemic species richness.

As this was a preliminary attempt to identify ecosystem vulnerability to climate change, results are not definitive and they carry uncertainty, but an index like this has flexibility. It is important that this research be continued so that conservation objectives can be met with proficiency.