Human Impacts to Coastal Ecosystems in Puerto Rico (HICE-PR): The Río Loco Watershed (southwest coast PR)

A remote sensing, hydrologic, ecologic, and socio-economic assessment with management implications

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Abstract:
Since the 1960s, Puerto Rico’s coastal and marine ecosystems (CMEs), like beaches, coral reefs, mangroves and seagrasses, have suffered the effects of anthropogenic stresses associated with population growth, land use changes and direct extraction of resources. The main goal of the HICE-PR project is to evaluate the impacts of land use/land cover changes on the quality and extent of CMEs in two priority watersheds in Puerto Rico (Manatí and Guánica). Here, we present a summary of our first year of efforts within the Río Loco Watershed (Guánica). We have established collaboration with local agencies in the Guánica watershed through the Watershed Coordinator now have additional site access and data collection coordination with established projects. The first field campaign (November 2014) focused on the collection of benthic data within the La Parguera-Guánica reef platform and the establishment of sediment traps in Guánica Bay and in the watershed that augment existing sediment sampling stations. Coral cover ranged within and between reefs from 0.2-30%. Cover of additional benthic components (e.g., macroalgae and the encrusting sponge Cliona) dominate in most of the reefs sampled, which creates concern about the resilience of these degraded sites to support biodiversity and fisheries and maintain coastal protection. A preliminary assessment of runoff and sediment production from coffee farms located near the headwaters was conducted in 2014 through rainfall simulation experiments. Historic and current imagery is being collected for land cover/land use change analysis and cover change of CMEs; and a database of inputs for hydrological modeling is underway. Initial interviews with residents within the watershed were conducted. Second year field activities include: 1) characterization of additional reef sites to increase our temporal dataset, for continuity and to compare with biodiversity estimates from an earlier NASA-funded IJS project (2006-2009), 2) characterizing water optical properties and their possible correlation to the benthic data, 3) biweekly collection and analysis of sediment data, 4) development and implementation of surveys for user attribute valuation and environmental concern, 5) further empirical quantification of runoff and sediment yields at spatial scales ranging from hillslopes to the entire watershed, and 6) conduct an advanced SWAT modeling workshop and calibrate the SWAT hydrological model for the watershed.

Watershed hydrology

Main objectives:
To assess the impacts of intensive historical anthropogenic water and land management in the water and sediment fluxes to Guánica Bay, and quantify runoff, nutrient, sediment yields at scales ranging from the hillslope and headwater stream to the watershed.

Socio-economic analysis

Main objectives:
• Compute the environmental economic value of selected CMEs (e.g. mangroves, seagrass, coral reefs and beaches).
• Conduct initial fieldwork based on site visits and informal interviews with residents, visitors and key informants in the Río Loco watershed and found large differences in human interactions between the Manatí and Río Loco watersheds. We did not expect to find such a marked difference between watersheds, and as a result we had to consider various methods, not just Choice Experiments, to assess respondent attribute valuation.
• Identified and valued ecosystem services (following the Millennium Ecosystem Assessment Framework) and attributes that may be readily apparent to residents and visitors as a result of direct interaction with the watershed, for instance, recreation and cultural services.
• We found that interaction resulting from consumption or enjoyment of cultural ecosystem services, particularly recreation, was rather rare in the Río Loco watershed.
• Prioritizing services were more predominant than cultural services in the Río Loco. A significant amount of water use is dedicated to agriculture and power generation. This finding led us to a possible reassessment of the methods used in this watershed for attribute valuation.

Image analysis Land Cover/Use (LC/LU)

Main objective:
To account for changes in LC/LU within the Río Loco and Parguera watersheds during the past five decades.

Changes in LC/LU within the La Parguera watershed from a relatively unpopulated fishing village in the 1960’s to one of the most heavily developed tourist areas in the southeast coast of PR.

Image analysis Reef benthic composition

Main objective:
To identify an updated benthic characterization of selected reefs within the La Parguera-Guánica platform and produce a time series analysis by adding data collected during past NASA-funded efforts. These data will be correlated with bio-optical properties measured in the area (water quality).

This year:
• Conducted photo transects for reef benthic characterization at multiple reefs in La Parguera and Guánica.
• Generated and analyzed 9,000 random points within each reef with Coral Point Count with Excel extensions (CPCs) for presence of benthic live taxa (identified to the lowest taxonomic level possible) as well as other nonliving benthic components such as sand and dead rubble.
• Conducted reef n Gregory analysis at each transect.
• Established a series of sediment traps at each study site and inside Guánica Bay to analyze (yrs 2 and 3) reprocessed sediment composition and grain size.

Next steps:
• Characterization of additional reef zones (fore-reef) at the study sites.
• Conduct video transects with a Delta Vision HD Pro drop video camera, additional benthic characterization of selected video frames with CPCs, and produce an Ecological Niche Factor Analysis (ENFA) modeling for habitat suitability.
• Collect bio- optical data (Chl a, Kd, total suspended sediments, remote sensing reflectance), water quality and water depth at all transects to determine whether new habitats have developed in response to anthropogenic activities.

Changes in LC/LU: Impact of human activities in the La Parguera watershed. From a relatively unpopulated fishing village in the 1960’s to one of the most heavily developed tourist areas in the southeast coast of PR.

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Challenges: