

## ONGOING PROJECTS

**Ecosystem services and disservices by urban green infrastructure in residential yards of a tropical city** (*Sofia Olivero-Lora (PhD candidate), E. Meléndez-Ackerman (co-advisor), and collaborators*). This study integrates information on social drivers, green infrastructure management and ecosystem assessment tools to evaluate factors that may influence the use of trees in residential yards of the Río Piedras Watershed. At these sites ornamental non-native shrubs dominate yards vegetation, so a question that arises is the extent by which preferences and perceived services and disservices from trees or non-native species are a factor leading to this pattern. This project will incorporate the use of the i-Tree Eco tool to evaluate ecosystem services and disservices of trees and shrubs.

**Governance and knowledge-action networks for urban sustainability** (*Tischa A. Muñoz-Erickson*)

We are studying the governance characteristics that shape urban social-ecological systems and ways that we can improve linkages between research and decision-making. We develop a tool, the knowledge-action systems analysis (KASA), to examine the visions, knowledge systems, and social networks of actors influencing decision-making on urban planning, sustainability, and resilience. The KASA has been implemented in San Juan in 2009 and in 2015, and will be conducted every 5 years to assess changes in governance and social networks across time.

**Green infrastructure strategies for urban flood control in San Juan** (*Pablo Méndez-Lázaro, Elvia Meléndez-Ackerman, Ariel Lugo, Tischa A. Muñoz-Erickson, Jorge Hernández, David Carrasquillo, Dalimar Martínez, Rubén Pomales, María Matos*)

We are working with planners of the Municipality of San Juan in developing a capacity building program for exploring green alternatives to flood control in San Juan. In 2013-2014 we co-designed workshops that explored and deliberated successful approaches using green infrastructure used in other cities. Four different workshops have been held so far that included nine presentations from scientists and professionals from backgrounds in climate change, hydrology, green infrastructure, landscape architecture, and program development. More details on the workshops and presenters can be found on the projects website (<http://www.lacuencadelriopiedras.com>). A key outcome of this effort is the formation of a civic alliance to bring the various participants and stakeholders that participated in these workshops and are interested in further working for the improvement of flood control measures in the city's Río Piedras River Watershed.

**High-resolution mapping of land cover and green infrastructure in San Juan** (*Sebastián Martunizzi and Olga Ramos*)

We developed a high-resolution (0.3 m) imagery to quantify the vegetation of San Juan and surrounding municipalities using novel geospatial techniques. We found that 61% of San Juan is green, and that some neighborhoods are greener than previously thought. Further, our study showed that very small pixels (< 1-2 m) are ideally needed for quantifying and mapping urban vegetation in places such as San Juan. We are in the process of developing similar maps for Santo Domingo, Dominican Republic, and other cities in the urban tropics to improve knowledge of urban vegetation patterns in tropical systems.

**iTree Urban Forest Assessment of Santo Domingo, Dominican Republic.** (*Jerry Bauer, Elvia Meléndez-Ackerman, Mervin Pérez (PhD Students), Sofia Olivero-Lora (PhD students)*). The goal is to train Dominican CLIMA project counterparts from the municipalities of Santo Domingo, San Pedro

Macorís and Las Terrenas in iTree survey techniques, data analysis, and use of iTree program to evaluate ecosystem services of urban forests. We have trained 30 Dominican conservationists, municipal planners, economists, biologist, and students in iTree Canopy and iTree Eco. We have completed two surveys which include INTEC Instituto Nacional Tecnológico, (a college campus) and the Colonial Zone of the National District. Collaborators in Santo Domingo include: Pronatura (conservation NGO), INTEC, USAID, Ayuntamiento Distrito Nacional, Santo Domingo, Federación Dominicana de Municipios (FEDOMU), Ministerio de Medio Ambiente, Sur Futuro (conservation, community development NGO), Fundación Propagas (conservation NGO).

**Linking science-based ecosystem service approaches, public health and innovative community engagement strategies to encourage greening visions in urban planning and design in small communities.** *Investigators: (Pablo Méndez-Lázaro, Elvia Meléndez-Ackerman (Advisor), Ana Trujillo (PhD student), USF, Foundation for Puerto Rico, ENLACE).* This seeks to integrate social, economic and ecological data to help create a shared understanding effects of multiples stressors (climate change, flooding, vectorborne diseases), support decision-making, share knowledge on the links between green spaces-ecosystem services-human health, promote action and stewardship in different stakeholder groups of low-income communities. A goal is to provide an assessment of the processes that can lead to vector-borne diseases outbreaks and that can also aggravate several chronic diseases such as cardiovascular and respiratory disease resulting in both increased illness and death in Santurce. Community engagement in the use of iTree tools to generate ecosystem services data for this project is also a goal.

**Mangroves of the city: Urban mangrove biology and ecology along an urbanization gradient of the San Juan Bay Estuary.** *(Benjamin Branoff (PhD student), Ariel Lugo (Advisor) and collaborators).* This research is exploring relationships between urban land use and mangrove eco-physiology and ecology, and testing hypotheses concerning these systems that have been hinted at in previous studies throughout the world. Measurements revolve around mangrove questions of: 1) forest structure and floral composition, 2) leaf isotopic signatures and nutrient content, 3) leaf heavy metal concentrations, 4) community assemblages of birds, amphibians, and fish, and 4) the resulting effects on the provisioning of mangrove ecosystem services. These measurements are being conducted at 14 sites along a well defined and quantified urban gradient throughout the San Juan Bay Estuary. Results are revealing evidence for systematic influences of various components of urbanization on mangroves in the estuary, such as changes in leaf stomatal density and nutrient isotopic signatures. It is my hope that this research will contribute to the formation of an urban mangrove paradigm that will be critical to mangrove conservation in a future of rapidly urbanizing tropical coastlines.

**Potential use of native species (shrubby and herbaceous) in urban residential areas as a viable and effective strategy to increase the biodiversity of native pollinators (Lepidoptera)** *(Digna Rivera (PhD student), Elvia Melendez-Ackerman (co-advisor), Mia Sued and collaborators).* This work seeks to characterize the pollinators (butterflies) of shrub and herbaceous plants in urban yards via field observations and then introduce native shrub and herbaceous species with landscaping potential to find their functional differences in terms of attraction of native butterflies. A long-term goal is to evaluate if there is an added value in the use of native vs available non-native species to the social-and ecological functions of urban residential yards.

**Quantifying the spatial relationships among landscape morphology, hydro-meteorological events, and stormwater discharge in urban watersheds** *(Christopher Nytch (PhD Candidate), E.*

*Meléndez-Ackerman (Advisor), USFS, Baltimore Ecosystem Study, Arizona State University*). This research is focused on investigating the linkages among heterogeneous land cover patches and stormwater runoff in urban watersheds. The study is a comparative analysis between the Gwynns Falls Watershed in Baltimore, Maryland and the Río Piedras Watershed in San Juan, Puerto Rico. Objectives are to 1) assess the variability of urban land cover morphology and stream network structure within and across urban subwatersheds; 2) determine if consistent scaling properties exist across stream orders between spatially-explicit properties of urban land cover, such as the proportion of impervious surface cover, and surface drainage pathways; and 3) quantify the relationships between urban land cover and stormwater discharge generated by precipitation events of variable magnitude and intensity. A goal is to advance urban hydrologic theory and inform resilient strategies for managing flood hazards across the urban landscape.

**Residential Knowledge of Urban Flood Events in Two San Juan Communities.** ([Molly Ramsey](#), Chris Nytech Benjamin Branoff, SJM, IITF, UPR). Community residents have first-hand knowledge of the different types of flooding that can occur in these communities, but it is not well-known what kinds of information this knowledge or experience can provide planners and municipal managers. In this study, we used household interviews and mapping to collect information from residents of two San Juan communities, University Gardens and Jardines Metropolitanos, about 1) the location, timing, and impacts of the most recent flood event that caused major damage in their home or neighborhood; 2) the frequency with which they have experienced problematic flooding in their urbanization due to river overflows and failures of the stormwater drainage system; and 3) their perceptions about why flooding occurs, and potential solutions. We used this information to evaluate the utility of resident knowledge about flooding for management, by comparing reported perceptions with existing hydro-meteorological data sources and maps of flood risk.

**[Stewardship Mapping and Assessment Project \(STEW-MAP\)](#)** (*Tischa A. Muñoz-Erickson, Tania del Mar López, and Hedy Nieves*)

STEW-MAP is a Forest Service research and decision-making tool that examines the social and spatial interactions of civic groups who conserve, manage, monitor, advocate for, and educate the public about their local urban environment. STEW-MAP has been implemented in New York City, Baltimore, Philadelphia, and Chicago. San Juan ULTRA is implementing STEW-MAP in San Juan, with results expected to be out in late 2016. For more information visit [www.stewmap.net](http://www.stewmap.net).

**Underwater City: Knowledge Systems and Flooding in San Juan, Puerto Rico.** ([Molly Ramsey](#), *Tischa Muñoz-Erickson (co-advisor), Elvia Melendez-Ackerman (co-advisor) and collaborators*). This study will address the problem of flooding in cities and the need to transition to more adaptive and resilient modes of flood risk governance with an in-depth examination of the multi-scale framing of flooding (individual to community to macro-scale of policy), and how social-hydrological feedbacks influence those frames in an urban, tropical system. The overarching question of this study is how is the social-hydrological framing of flooding co-produced in the urban, tropical system of San Juan, PR. Using a frame and knowledge systems analysis approach, I will investigate these three research questions: 1) who are the actors and what are the frames around the issue of flooding, 2) how have knowledge systems shaped these frames, and 3) what are the feedbacks between biophysical flows of urban water (or flooding) with knowledge systems of flooding.

**Urban Resilience to Extreme Events Sustainability Research Network (UREx SRN)** (*Pablo Méndez-Lázaro, Jenniffer Santos Hernández, Tischa Muñoz-Erickson*)

With researchers and practitioners from 10 other cities in the US and Latin America through the Urban Resilience to Extremes Sustainability Research Network (UREx SRN) we are developing models that integrate social, ecological, and technological aspects of urban infrastructure and that are resilient to climate change extreme events, including flooding (coastal and urban), drought, and heat. We have created a Practitioner Team of San Juan practitioners and stakeholders to develop future urban scenarios and strategies for their implementation. Results of models are expected in late 2017-early 2018.