Developing Participatory Water Monitoring Systems in Southeast of Peru

This project developed a participatory freshwater monitoring model through an agreement between the Peruvian State (National Water Authority-ANA and National Service of Natural Protected Areas - SERNANP), civil society (Amazon Conservation-ACCA) and indigenous communities (Executor of the Administration Contract of the Amarakaeri Communal Reserve) in the Alto Madre de Dios watershed within the Amarakaeri Communal Reserve (ACR) and Manu National Park (MNP), protected areas of high biodiverse values in Southeast Peru. This pioneering initiative aimed to generate a baseline for water quality and biological conditions in this aquatic ecosystem, as well as evaluate patterns of water flow during rainy and dry seasons. This information is critical to evaluate the impact of future development projects planned for the region and guide decision-making on the management of these protected areas and water bodies. Our strategy also aimed to engage local communities in the practice of water monitoring through training and participation in the collection of samples, as well as improve the local understanding of water data and its role in guiding aquatic resources management. In addition, we sought to empower local communities to closely monitor decision-making processes and future development projects that can potentially impact the Alto Madre de Dios watershed, their main source of water.

We employed biological indexes to measure environmental and conservation indicators, including plankton, periphyton, aquatic macroinvertebrates and fish communities at 20 sampling stations within a range from 900 to 1,700 feet above sea level in the past three years (2015-2018). Our results indicate that this area is highly conserved and diverse. For example, local diversity of plankton comprises 158 species; fish include 174 species, represented by 27 families and seven orders. The perifiton consists of 147 species, while Bentos included 127 species. The Ephemeroptera + Plecoptera + Trichoptera (% EPT) index rated the conservation status of these aquatic resources as between regular and good through analyses of macroinvertebrates. The Biological Integrity Index (IBI), which evaluates the conservation status through fish analyses, displayed higher values for water bodies in the Amarakaeri Communal Reserve than in the Manu National Park. The level of biodiversity identified within the aquatic communities we studied is associated with significant habitat-heterogeneity in this area. This information has contributed to strengthen and inform the management and conservation of water and biological resources in the Alto Madre de Dios basin and thus increase the protection of the ACR and MNP and local indigenous populations. We have extensively promoted this pilot within Peru for its future replication in other protected areas so as to improve management of water resources countrywide.
Nickie Cammisa  
PhD student, Institute of the Environment and Sustainability, UCLA

Blue Prosperity: Designing a Toolkit to Support Sustainable Small Island Economies

As part of a large, interdisciplinary collaboration called the Blue Prosperity Coalition, we are developing resources that promote sustainable development of the Blue Economy in small island developing nations. Balancing the needs of multiple stakeholders while making decisions that benefit both marine conservation and economic development is challenging. We aim to provide decision-making support to natural resource managers and policymakers through a toolkit that is specific to the challenges small islands face—economically, socially, and environmentally.

The toolkit will distill findings from research teams focused on: developing human capital, public finance strategies from sustainable tourism, sustainable waste management, identifying industries with growth opportunities, financial administration, known and emerging risks, ports, and the public-private intersection. The design of the toolkit is informed by lessons learned from existing conservation and policy toolkits as well as interviews with toolkit developers and natural resource managers. As a result, the toolkit will be comprised of an interactive web component (providing the option to include a reference library, an online community support network, and video training materials) as well as a print version to increase dispersal in internet- and computer-limited nations. The toolkit, like InVEST, will be built modularly over time, so it can be tailored to the needs of various island nations in the future.
Modeling the Impact of Urbanization on Water-related Ecosystem Services and Productivity Response of a Major Urban Lake

Freshwater ecosystems play an important role in the quality of life in urban areas by providing a variety of ecosystem services including recreation, water supply, flood damage reduction and wildlife habitats. Most of these ecosystem goods and services are water-quality related and are negatively impacted by many anthropogenic actions. The overall focus of this study is to assess how land use changes can impact water quality and ecosystem services of a major urban freshwater system in a rapidly urbanizing basin. Understanding the consequences of future watershed development on water quality and habitats can inform management and restoration efforts. Central Puget Sound and Lake Sammamish were selected as study systems. Central Puget Sound is one of the fastest growing regions of the United States. Lake Sammamish is a major recreational destinations and a valuable natural resource as urban wildlife refuge and habitat for the native kokanee salmon.

Land use scenarios developed in previous studies will be used to illustrate increasing gradient of urbanization for the 2005-2060 time-period and alternative land development under both permissive and more constraint environmental policies. The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) freshwater models will be applied to these stakeholder-defined scenarios to model nutrient and sediment retention across the landscape and how land use changes may impact the cost of water quality maintenance for this major urban lake. Values of phosphorus export (Kg/ha) generated by the InVEST models will serve as inputs to a dynamic, deterministic total phosphorus simulation model developed and applied to Lake Sammamish. The aim of this study is to provide an effective tool to incorporate multiple freshwater ecosystem services provided by urban lakes into a watershed land-use planning.
Margaret A Daly  
*PhD candidate, Department of Civil & Environmental Engineering, Stanford University*

**Local Oceanographic Variability around Isla Natividad to Inform Fisheries Management**

As hypoxic and warm events become more common, it is increasingly important to understand how to manage coastal fisheries and locate areas that are more susceptible to these harmful regional trends or more protected. Coastal geometry and kelp forest canopy cover can create high variability in temperature, dissolved oxygen, and velocities. Additionally, complex interactions between hydrodynamic processes and the kelp forests themselves govern transport of food, nutrients, and larvae.

High temporal and spatial resolution field experiments were conducted around Isla Natividad, Baja Mexico at 14 locations with 4 transects through the major kelp forests. Instrumentation includes an Acoustic Doppler Current Profiler, CTD (including DO), pressure sensors, and a thermistor chain. The West (unprotected) and East (protected) side show significantly different patterns in temperature, dissolved oxygen, and velocity profiles. The Micheli Ecology Lab is assessing the *in situ* survival and growth rates of green abalone. Combining their ecological findings, such as abalone growth rates and survival, with the physical oceanography, the most significant environmental factors that promote species sustainability can be resolved.

Submerged vegetation also reduces wave heights and attenuates wave-induced currents which can lesson inundation and shoreline erosion. Future work will quantify wave dissipation from kelp forests. Multiple accelerometers will be placed vertically along kelp plants to determine near-plant hydrodynamics and wave-current interactions.
Marisa Escobar  
*Water Program Director, Stockholm Environment Institute*

**System-wide Tools for Managing Water and Ecosystems**

The Stockholm Environment Institute (SEI) has developed the Aquatic Habitat Assessment (AHA) modeling platform to integrate hydro-ecological processes within a water operations model. AHA forms part of SEI’s existing WEAP (Water Evaluation and Planning) system. AHA has been applied to a water utility district in California to calculate the effect of different reservoir operation rules on the habitat availability index (HAI) for Chinook salmon and Steelhead in the watershed. The HAI measures suitable habitat area and is calculated for each migratory fish species life stage, including immigration, spawning, incubation, rearing, and emigration. The HAI is calculated by comparing the modeled velocity, depth, and temperature against the tolerances defined by biological suitability curves of each life stage. Temperature is modeled using a 1D heat balance equation in streams and reservoirs. Vertical stratification modeling in reservoirs allows for release options from different layers, such as “cold water release” from the bottom of the reservoir. Streambed cross-sectional data were used to relate streamflow to velocity and depth at points of interest. The HAI results were linked to visualization tools, including Tableau, to allow water managers to effectively evaluate the trade-offs of potential modifications to reservoir operations. AHA has the potential to being applied to other areas where system-wide tools for managing water and ecosystems are needed.
Barbara Gemmill-Herren  
*Agroecologist, World Agroforestry Centre*

**A Holistic Lens on Rice Value Chain Pathways in Senegal: Application of “The Economics of Ecosystems and Biodiversity for Agriculture and Food” Framework**

Recognising the multiple failings of our current global food system, there is an intense call for developing viable and more sustainable systems. Agriculture and food systems are tremendously complex, and their evaluation requires a willingness to understand the linkages between ecosystems, agricultural lands, pastures, inland fisheries, labour, infrastructure, technology, policies, culture, traditions, and institutions (including markets) that are variously involved in growing, processing, distributing and consuming food. Moreover, food systems interact with other key systems or sectors such as health and energy, and identifying these interactions is central to understanding the role and function of food systems. A response to evaluating current agriculture and food systems, and possible alternative pathways has been developed by the TEEB (‘The Economics of Ecosystems and Biodiversity’) initiative, hosted by the United Nations Environment Programme. This initiative has sought to demonstrate how to capture the complex reality of today’s diverse and intertwined “eco-agrifood” systems in order to evaluate their performance in a holistic manner to support decision-making. A major challenge in such a holistic evaluation is identifying and utilizing an expanded range of metrics conveying the complexity of the “eco-agrifood” system, well beyond the simple metrics largely used in the past, such as per-hectare productivity. If food systems are to be developed and managed to reduce their negative impacts while generating multiple benefits, including but going beyond calories of food, a systems approach is needed that considers the entire food value chain, tracing the significant but often economically invisible (i.e., non-market) forms of stocks (natural, human, social as well as the better documented produced capital) and flows between these. The TEEB initiative has developed an evaluation framework to facilitate such an assessment (TEEB 2018). An important next step is the application of this framework on national levels; this poster describes the application to rice food value chains in Senegal, and the contribution of holistic planning in the agriculture sector to building capital and attaining the Sustainable Development Goals.
Pedro Gerhard

*Researcher, Brazilian Agricultural Research Corporation (EMBRAPA)*

**Construction and systematization of knowledge on ecosystem services in the context of Brazilian Amazon smallholder farms**

The Brazilian Amazon covers approximately half of the Brazilian territory. Experiences in the quantification and valuation of ecosystem services already exist in some restricted locations. In other states, however, nothing has been advanced in the experiences and public policies involving this concept. This poster presents the general lines of a project conducted by the Brazilian Agricultural Research Corporation in six territories of the biome. The main objective is to promote the exchange of knowledge about ecosystem services between and for different audiences related to family agriculture, such as technicians, environmental managers, rural producers, rural youth, rural women and rural community leaders. In addition to training on the theme based on identified experiences, case studies will be carried out on the quantification and valuation of ecosystem services. Case studies will employ InVEST software to assess flows and stocks of water, carbon and soil services. It is expected that, at the end of the project, with the qualified public, new proposals for the quantification and valuation of ecosystem services may move towards the creation of remuneration policies geared to smallholder farmers.
Proposal of a Vulnerability Analysis of Ecosystem Provision Services and Livestock Production in Watersheds

Mexico is the seventh producer of beef worldwide and devotes 54% of its territory to livestock. It takes place on landscapes with high biodiversity generating high impacts on biodiversity, landscape connectivity and ecosystem provision services, negatively affecting human populations and ecosystems, a situation that can potentially worsen in a context of climate uncertainty. This proposal seeks to strengthen territorial planning instruments by incorporating recommendations for actions to adapt the livestock sector in the integrated watershed management action plans (PAMICS) of eight coastal watersheds in the Gulf of Mexico and the Gulf of California in Mexico. These watersheds are situated in the states of Veracruz and Jalisco, where most of the production is concentrated. According to the National Atlas of Vulnerability to Climate Change, which evaluates at municipality level, all the municipalities within these watersheds present a vulnerability related to livestock production, where 74% have from medium to very high vulnerability (vulnerability of livestock production to floods, vulnerability of livestock production to water stress, and vulnerability of forages production to water stress). The analysis contemplates four phases; i) analysis of vulnerability at the local level, ii) identification of priority zones of supply and demand of ecosystem services in livestock areas, iii) evaluation of potential impacts on ecosystem provision services considering climate change, and iv) proposal of actions to reduce impacts and adaptation to climate change.
Coastal Resilience from Multiple Angles: Interactions between communities, physical processes, and city resilience planning

Current city-level coastal resilience efforts and planning varies by location and level of threat, among other factors. Effective and adaptive coastal planning involves not only the physical, scientific effects of climatic changes and shocks such as sea level rise or storms, but also addresses the range of effects on different communities, community involvement in resilience planning, and community-based action plans and projects. By evaluating plans using a pre-set criteria this study aims to analyze coastal resilience plans at the city level to assess how all-encompassing current coastal resilience plans are.
Power-to-Gas Plants as Object of Project Finance – Insights from Germany

Due to the high demand of electricity storage systems, Power-to-Gas (PtG) plants have been researched regarding technology and readiness for market in more than 30 pilot projects in Germany. In doing so, PtG storage systems are of high relevance in the near future as they do not only contribute to a long-term energy solution storage by transforming electricity into hydrogen or methane but also target sector coupling. As a second macroeconomic factor, renewable energy plants have been largely realized through project finance. With the continuing low-interest period in Europe, banks are actively looking for new profitable projects to finance. Regarding this context, the underlying research sheds light on the question “Under what conditions can PtG plants be realized by the use of project financing in Germany?“.

Approaching this research question, desk research as well as in-depth semi-structured interviews with industry partners from banks, PtG-manufacturer and PtG-operator have been conducted. PtG plants can be realized through project finance under certain prerequisites. The implemented technology should be proven, which is fulfilled by the alkaline- or proton-exchange-electrolyzer. By looking at the market prices of renewable hydrogen and synthetic methane, only the mobility sector is economically promising with a nationwide price of 9.50 €/kg. Regarding stakeholder management, the core-participants have to prove appropriate experiences and credit ratings. Additionally, substitutability has to be considered in case of the event of default. Furthermore, regulatory authority and regional acceptance management should be incorporated in the planning phase in order to mitigate temporal approval risks. Identification of endogenous and exogenous risks are key to appropriately transfer the risks to the respective stakeholders in the context of risk-sharing. Besides required guarantees and sureties from the main stakeholders, all long-term contracts regarding supply- and demand-side must include a fixed price, a fixed quantity and a defined period, as the structure of all contracts represents the value of the PtG plant over the project duration. Purchase- or sales-side merchant cases should be avoided or reduced by means of financial hedging. Remaining risks are considered within the scenario technique and sensitivity analyses in the banking-case. Consequently, the debt and mezzanine capital is determined in an iterative process with a distinction of equity requirement in the construction phase, with at least 40 % equity, and in the operating-phase, with at least 30 % equity. In case of a successful operating phase, the equity can be gradually replaced by long-term debt, which may be also structured as mini-term-structures followed by refinancing rounds.
Wanyi Li
PhD student, Department of Management Science & Engineering, Stanford University

Contract Design for Payment for Ecosystem Services (PES) in an Uncertain Environment

In our work, we create a theoretical mathematical model that aims to design an optimal PES contract. The goal of this work is to inform a contract designer (an NGO or a local government) rules of thumbs on how to design the conservation payments in an uncertain environment. There are several novel elements about our model: 1. We consider a developing region where the agents (e.g. private forest owners) are cash-constrained and have a much higher discount value comparing that of the principal (contract designer); 2. We use a dynamic model where the conservation costs faced by the agents are not only private information but also stochastic over time; 3. We consider a very practical setting where the contract designer is budget-constrained and can decide how to allocate the budget over time. The incentive mechanisms in this practical setting can be very complex. However, we are able to show that stable and simple forms of contracts yet can still be desirable. By applying a mechanism design framework from economics and operations research, we hope to provide useful insights and recommendations for PES contract designers in the field.
Monica Moritsch  
*Geospatial Research Assistant, Stanford Center for Ocean Solutions*

**Blue Carbon Mapping: Integrating coastal habitats into nature-based carbon sequestration solutions**

Coastal habitats sequester significant amounts of carbon, despite their small global footprint. However, climate impacts and coastal development threaten these habitats and their ability to store carbon. To support decision makers in effectively allocating limited resources for managing coastal ecosystems, the Stanford Center for Ocean Solutions used the InVEST Coastal Blue Carbon Model to quantify future carbon sequestration capacities of California’s salt marshes, using Elkhorn Slough, Humboldt Bay, and Tijuana River Estuary as case study locations. We modeled the social benefits of this sequestration using the Social Cost of Carbon, which estimates the damages caused by increased carbon in the atmosphere. If marsh area in 2016 remained the same until 2100, these habitats would increase their carbon storage to between 1.1 and 16.9 times their current levels. This would produce between $4,000 and $28,000 per hectare in avoided climate-related damages. To avoid losing these benefits, coastal planners will need to maintain current marsh area and invest in protecting areas where marsh will move in the future. Including the value of this carbon storage from coastal habitats in carbon budgeting and climate mitigation strategies can provide an important pathway for protecting these coastal habitats.
Joanne Moyer  
*PhD student, University of Texas at El Paso*

**Habitat Quality Analysis Using InVEST to Understand Urbanization Impacts on the Ecosystem in El Paso, TX**

El Paso is located in the south westernmost point of the second largest state in the United States, i.e. Texas. Its’ unique location borders the state of New Mexico and the country of Mexico. It lies within the largest desert region in North America, the Chihuahuan Desert. The region exhibits a variety of environmental features in which the city is comprised. Features include the Rio Grande River, riparian wetlands, Franklin Mountains State Park, arid climate, shrublands, and a predominantly Hispanic population of over 840,000 within El Paso County. This unique, yet fragile environment, will be examined by analyzing the Natural Capital the region possesses to assist decision makers in pursuing sustainable development for the growing city of El Paso. An InVEST model will be utilized extensively to examine the threats and their impact within El Paso County. The Habitat Quality model consisting of habitat degradation, habitat quality, and habitat scarcity will be evaluated through InVEST. These results will assist decision makers in making informative decisions on infrastructure investment that will provide an optimal livable city for El Paso residents in future.
A study on Geotourism of Andaman Isles, India: Implications for Sustainable Development

The rocks, landforms and soils of Andaman Isles are linked closely with most other aspects of the natural capital. They form the basis of our distinctive geotourism destinations that provide the optimum environment for the habitats for coastal biosphere. At a time when interest is growing in sustainable use of natural capital, landscape interpretation, geotourism and integrated management based on a knowledge of physical processes, it is timely to address more explicitly the broader links of the earth sciences to ecosystems and landscapes in the back drop of sustainable development. In addition, the earth sciences have practical value in resource management, land management, local authority planning, environmental education and geotourism. The enchanting Andaman Isles, are the ultimate destination for the tourists across the world. Situated between 90° - 94° E and 6° - 14 N°, the isles are a pure blend of rare geodiversity and biodiversity as well. Until 1950s, the isles were synonym for punishment (guilty were exiled here) but now for pleasure. Floated in splendid isolation in the Bay of Bengal is the archipelago of over 570 islands with an area of 8,249sq.kms known as Andaman Isles is now at the top of the league for visitor destinations in India. These, along with silvery-sandy beaches on the edge of meandering coastline of carefree relaxation and makes the Islands a unique geotourism destination. Because of the shallowness of the Sea around the Isles, the gentle slope from the coast line and lack of strong currents the Sea supports a rich and wide variety of coral reefs. This paper outlines aspects of Geotourism in the larger interest of sustainable development on the socio-economic scenario of the Isles and approaches to the interpretation of geology for general audiences.
Bitter Pill: Medicine’s unrecognized reliance on biodiversity for drug discovery

The Anthropocene -- the current geological age, shaped largely by human actions on the climate and the rest of Earth -- has been called the “sixth mass extinction.” One reason that’s a problem is that over half the new drugs approved in the United States over the past quarter-century have come from nature. Consider endangered polar bears, which are insulin-resistant and so may hold clues to curing Type 2 diabetes. Biodiversity is crucial to medical research, and it’s threatened. Highlighting this relationship could drive R&D funding from the 300 billion dollar pharmaceutical industry towards species discovery and biodiversity conservation.
Roy Remme
Post-doctoral researcher, Natural Capital Project, Stanford University

Changes in ecosystem services resulting from the implementation of green-blue infrastructure strategies in the city of Amsterdam

Green and blue infrastructure elements, such as parks, green roofs and canals, provide significant contributions to people living within urban areas. Natural capital provides urban dwellers with services such as air quality regulation, carbon sequestration, temperature regulation, noise reduction and rainwater storage. In turn, these ecosystem services lead to socio-cultural and economic benefits, such as improvements in health and the associated reductions in medical and labor costs.

Recognizing the challenges posed by a rapidly growing population, the Municipality of Amsterdam developed a spatial plan that lays out the road map for the city’s green-blue infrastructure development. This poster examines how different proposed green-blue infrastructure strategies affect ecosystem service delivery in the city of Amsterdam. It does so by quantifying a suite of ecosystem services across different strategy scenarios for the year 2025. The results shed light on the complexity of ways in which different green-blue infrastructure strategies affect human well-being within cities, and the trade-offs that may result from their implementation.
Urban Expansion and Intensity Across the US

Urban growth and expansion are well studied in the United States. Existing national urban land studies provide useful insight into the physical expansion of urban development and the subsequent impacts on natural resource production and ecological habitat. Other studies target evolving regional social and demographic patterns, such as the growing prevalence of exurban settlement. However, these studies fail to address how the spatial expression of urban growth manifests in different urban ecologies. This study leverages the imperviousness and tree canopy products from the National Land Cover Database to implement metropolitan scale metrics on urban ecological intensity. These metrics, calculated for all metro regions in the contiguous US, begin to capture how urban ecosystem service production both varies across the US and has been changing over time. Augmenting the traditional “expansion”-based studies with “intensification” measures substantially improves our understanding of how urban growth threatens both natural and human systems, providing a new and important social-ecological perspective on US cities.
Claire Shellem

Master’s candidate, King Abdullah University of Science and Technology

Assessing Changes in Fisheries Benefits Across a Gradient of Healthy to Degraded Coral Reefs in the Southern Red Sea

Marine ecosystem services are the benefits that people derive from nature including provisioning (such as fisheries), maintenance and regulation services (carbon sequestration and coastal protection) and cultural services (recreational opportunities). Based on global case studies of 16 biomes, coral reefs were estimated as having the highest value of ecosystem service delivery in monetary units ($352,915/ha/yr). Much of that value comes from the benefits of fisheries, reef associated tourism, and coastal protection. Red Sea coral reefs are recognized as having high levels of biodiversity yet there is a significant lack of ecosystem service (ES) assessments for the region. The Saudi Arabian region of the Red Sea is unique because currently there is limited international tourism, with a primary ES benefit generated from small-scale artisanal fisheries which accounts for 99.4% of local catches. However, Saudi Arabian fisheries are experiencing increasing pressures from overfishing and habitat degradation with associated economic and social consequences. Notably a mass bleaching event occurred in the Farasan Banks in the Southern Red Sea in 2015, causing up to 90% coral mortality in some areas. Based on reef surveys conducted before and after the bleaching event, the level of coral mortality and recovery varies greatly throughout the region. Our study therefore aims to assess fisheries revenue generated by healthy reefs compared to degraded reefs. Focal species were selected based on those that are most abundant in local fish markets. We couple in-situ fish community data from reef surveys with species specific prices from local fish markets and reports from the Kingdom’s Ministry of Agriculture, Marine Fisheries Department. This study assesses how fish communities have changed across gradients of reef degradation providing initial fisheries valuation information which can inform the implementation of effective fishing regulations and coral reef protection plans in the region.
Anais Vermonden Thibodeau  
*Subdirección de Análisis de la Oferta de Servicios Ambientales Hidrológicos y Adaptación al Cambio Climático, Mexican National Institute of Ecology and Climate Change*

**Action Plans for Integrated Watershed Management: a tool for Focusing Climate Change Adaptation Process in México**

One of the main challenges in territorial planning is the design and implementation of action plans that include the hydrographical watershed dynamics within a context of climate uncertainty. The Action Plans for Integrated Watershed Management (PAMIC by its acronym in Spanish) promote the integrated management of coastal watersheds to preserve their biodiversity, trigger adaptation processes and contribute to climate change mitigation. Their objective is to increase the functional connectivity, by identifying the territorial relationship between supply and demand zones of the Hydrologic Environmental Services (HES), to provide information for adaptation actions. The PAMICs have promoted the collaboration between three public institutions (CONANP, CONAFOR, and INECC) and one private (FMCN) through the innovative component of building a common vision seeking the implementation of integrated action in the context of watershed management pursued by the interinstitutional cooperation, collaboration and aligning financial resources. The project operates in two regions, through two regional funds; Gulf of Mexico Fund (FOGOMEX by its acronym in Spanish) and Northwest Fund (FONNOR by its acronym in Spanish), led by a technical committee project (CTP by its acronym in Spanish) composed by representatives of the three federal institutions and the private organization. The tool has three components; one analytical, one relational and the participatory. The first one corresponds to the geographic modeling and identification of high potential areas for the supply of superficial water and preservation of soils, that is, supply priority areas of HES. The relational component identifies water uses and volumes and determines the hydrographic relation between supply and demand areas of HES to identify the areas for priority intervention. The participatory component covers the local traditional knowledge, community and institutional capacities for implementation of adaptive actions focused on the conservation of natural capital and the adequacy of productive practices in priority supply areas of HES. Currently, the tool is used to identify the best areas for the payment of environmental services by the National Commission of Forestry (CONAFOR), in the implementation of conservation actions by the National Commission of Protected Natural Areas (CONANP) and others projects for climate change adaptation operated by regional funds.
Connecting with Nature for Better Health: Examining the Impacts of Nature Relatedness on the Psychological Benefits of Nature Walks

The connection between nature and psychological benefits is well documented (Ulrich, 1983; Kaplan & Kaplan, 1989; Grahn & Stigdotter, 2003; van den Berg & Staats, 2018). Multiple studies reveal individuals who experience strong relatedness to nature perceive natural environments as more restorative than their counterparts (Tang et al., 2015; Berto et al., 2018). Restorative landscapes provide an opportunity to engage in involuntary attention, which in turn reduces levels of stress and anxiety (Kaplan & Kaplan, 1989), and improves mood, memory, and the capacity to engage in directed attention. Among the measures of connections to nature is nature relatedness (NR) which assesses an individual’s physical and psychological connection to the natural world (Nisbet, Zelenski & Murray, 2009). An abbreviated NR6 scale (Nisbet & Zelenski, 2013) captures three primary dimensions of human connectivity to nature: 1) identification with nature, 2) contact with nature, and 3) pro-conservation attitudes. Understanding the degree to which NR predicts psychological health outcomes provides an opportunity to improve individuals’ restorative experiences in nature.

The purpose of this pilot study was to examine the relationship between NR scores and perceived psychological benefits of nature walks. A repeated measures cross-over design with 38 participants assessed effects in two treatment conditions: walking in a 1) suburban area and a 2) forested area. Select psychological measures were assessed before and after a series of three, 50-minute walks, separated by a weeklong washout period. Repeated measures ANOVA revealed significant and improved changes in three of the four measures assessed: 1) positive affect, 2) negative affect and 3) anxiety. In contrast with expectations, these changes were greater for people with lower NR6 score. Impacts increased with the number of walks taken. In contrast to hypotheses, perceived stress scale scores did not significantly change and actually worsened, likely due to a design issue. Further research using longer walks, a more complex nature-relatedness measure, and a more diverse sample could reveal nuances in these results.
Mei Hua Yuan  
*Post-doctoral researcher, Graduate Institute of Environmental Engineering, National Taiwan University*

**Estimates of coastal wetland value for damage prevention in Taiwan**

Wetlands are the most biologically diverse ecosystems on Earth. They provide various valuable services for humans and the environment. Recently, the increasing damage events of hurricanes, cyclones, and tsunamis have spurred global interest in the function of wetlands in flood control and shoreline protection. This study collected 37 typhoon cases since 1986. On the basis of total damages by typhoons and wind speed, as well as estimated wetland area and GDP in the average typhoon swath, and annual storm probabilities by category, the value of Taiwan’s coastal wetlands has been estimated. Our results revealed that wetlands provide substantial typhoon damage prevention value. These wetland areas generated an annual expected marginal value for each swath of $3,065 to $7,510 per wetland hectare per year. These values were calculated in an effort to sensitize the general public to the possible magnitude of wetland functions.