Increasingly, policymakers and researchers are confronted with problems at multiple spatial and temporal scales, such as global climate change, land use/land cover change, international tourism and population migration, changes in ecosystem goods and services, and the introduction of new land use policies that have implications across socio-economic, ecological, and geographical domains. The interactions between coupled human-natural systems are played out through land development scenarios and land transformation activities that often create feedbacks and thresholds among people, place, and environment. Yet a lack of adequate tools and theoretical understanding across the social, natural, and spatial sciences has traditionally led researchers to focus on relatively coarse grains of analysis where aggregate data are available. But it is at the finer social, ecological, and spatial scales where geospatial information may be more appropriately collected, derived, and applied because of local decision-making about the use of the land with feedbacks to human behavior. Furthermore, even where adequate data have been collected at appropriate spatial and temporal scales, data analyses have tended to focus on either people or the environment, without suitable integration across the social and ecological domains.

To reduce the geographic and thematic extent of the course, we will approach the study of human-environment interactions through a focus on Island Ecosystems, Land Use/Land Cover Change, and Dynamic & Complex Systems Models. We will also read and discuss a series of papers clustered around associated topics, including, Biocomplexity, Land Use/Land Cover Change, Islands Ecosystems & Protected Areas, Agent Based Models, Dynamic Simulation Models, and Measurement & Observation Systems for assessing people and the environment. The course will entail three short papers (~7-10 pages) and class discussions that examine theories, practices, and human-environment interactions for selected case studies or more synthetically across several case study sites. In addition, a special class project will be designed that involves the study of island ecosystems and protected areas through a study of human-environment interactions, particularly, land use/land cover change and the characterization of places and contexts using dynamic and complex systems models.

Paper #1 (& presentation) is due on September 29th.
Paper #2 (& presentation) is due on November 3rd
Paper #3 (& presentation) is due on December 1st
For centuries, island ecosystems have animated the human imagination and challenged science. Probably the most famous examples of scientific interest in islands are the impact of the Galapagos Islands on Darwin’s theory of evolution, the subsequent development of island biogeography, and the development of meta-population models to improve our understanding of the flows of genetic material in a wide range of settings. However, human migration and tourism (domestic and international) have brought profound changes to the natural environment in places like the Hawaiian and Canary Islands. With the rise in global wealth, pressure on exotic island ecosystems increases as more people seek to visit and experience these “special” places. Islands are areas of considerable vulnerability to threats imposed by human and natural forces, including, climate change, sea-level rise, hydrologic processes, invasive species, tourism, and land use/land cover change caused by the direct and indirect effects of the expanding human dimension.

We will use Island Biocomplexity as the lens to synthesize human-environment relationships for island ecosystems that are distributed around the globe. Island Biocomplexity encompasses the complex interactions within and among ecological systems, the physical systems on which they depend, and the human systems with which they interact. Island Biocomplexity combines social-ecological co-evolution and adaptive resilience with a new island ecology that incorporates human impacts. Dynamic and complex systems models will be examined as our integrative and synthetic test-bed. Dynamic systems models simulate, predict, and mediate conditions given specified stocks, flows, exchange rates, and feedback loops between key parameters, whereas Agent Based Models are used to examine complex adaptive systems, critical thresholds, emergence, and feedback mechanisms linked to human-environment interactions and non-linear system dynamics.

Island ecosystems will be selected for study through a meta-analysis of island vulnerability, defined as a perceived imminence of loss, degradation, and reduction of integrity, often through a loss of site resilience imposed by threats to conservation and social-ecological sustainability. Vulnerability is related to site exposure, physical setting, social context, ecosystem sensitivity, and the ability and opportunity of island ecosystems to adapt to change. From a diversity perspective, the following group of islands will be preliminarily considered and a sample of island ecosystems will be selected for our purposes.

Hawaiian Islands (Central Pacific)  Tonga (South Pacific)
Galapagos Islands (Eastern Pacific) Martinique (Caribbean)
Puerto Rico (Caribbean) Reunion (Central Pacific)
American Samoa (South Pacific) Tahiti (South Pacific)
Samoa (South Pacific) Wallis and Futuna (South Pacific)
Guam (Western Pacific) Saint Martin (Caribbean)
Republic of Palau (Central Pacific) New Caledonia (SW Pacific)
Micronesia (Western Pacific) Mauritius (Southwest Indian)
US Virgin Islands (Caribbean) Fraser Island (Western Pacific)
Papua New Guinea (Western Pacific) Azores (East-Central Atlantic)
Solomon Islands (South Pacific) Canary Is. (East-Central Atlantic)
Fiji (South Pacific) Madagascar (Indian)
Vanuatu (South Pacific) Seychelles (Indian)

Our central goal is to create an approach to synthesize human-environment interactions for island ecosystems through an Island Biocomplexity framework that examines the
behavioral shifts seen in social-ecological interactions that are perturbed through exogenous and endogenous dynamics, complex adaptive systems, and emergent properties. Our intent is to achieve a richer and fuller understanding of island ecosystems through a multi-site synthesis using a new conceptual framework. Further, we develop dynamic and complex systems models that are tested against a set island sites that vary by location, size, and character.

We will synthesize among case studies and island sites using dynamic and complex systems models that are designed to study feedback systems through the collection of interacting elements that function together in a specified system (see Figure 1). Properties of dynamic systems include quantities that vary over time, whose variability is described causally, and whose influences are contained within a closed system feedback loop. Commonly, dynamic systems models are developed through the creation of a causal graph that is augmented with information on stocks, flows, rates of change, feedback loops, and rules of behavior that are translated into a system dynamics flow graph (i.e., a boxes and arrows diagram) and then translated into programs and/or equations. Thinking in terms of “cause and effect” is not sufficient, as feedback loops are the key to understanding system dynamics as an initial cause can ripple through a chain of causation factors ultimately to “re-affect” itself. A static systems model is the representation of a system at a particular time, whereas dynamic systems models represent a system as it evolves over time. Dynamic systems models advance the understanding of feedback loops between social-ecological factors, expressed through positive and negative relationships, endogenous and exogenous dynamics, and continuous and discrete events that lead to emergent behavior and a richer understanding of the drivers of land use/land cover change.

Figure 1. An example of a dynamic systems model in the Galapagos Islands, as a preliminary template to synthesize LCLUC of a global set of island ecosystems.
Below are a group of topics and associated readings that are linked to the focus of the course. While not all readings will be assigned, the intent is for the class to consider the breadth and diversity of readings and to add to the list of associated topics and selected readings for new (or defined) topics early in the course so that high interest topics and readings can be further identified for specific study areas, human-environment interactions, and measurement, observation, and modeling approaches.

**Biocomplexity**

**Land Use/Land Cover Change**
Islands Ecosystems & Protected Areas


Agent-Based Models & Dynamic Simulation Models for Tourism


Measurement & Observation Systems


