Moorea Avatar – Physical Ecosystem Modeling of a Tropical Island

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The global environment sustainability challenge

Human activities are affecting climate change and biodiversity loss on a planetary scale. The transition towards environmental sustainability, one of the defining challenge of our time, will require a far better understanding of complex social-ecological systems at local and national scales of management. To that end, a key research goal is to build functioning digital simulations, 'avatars', of model cities, islands and other objects to improve our ability to predict human and natural change especially at the scale of policy and management action.

Island Digital Ecosystem Avatars

Island systems are particularly attractive for sustainability science because they are tractable. Their geography provides a common boundary for biological and social networks, and sets clear limits on the species to inventory, ground cover to measure, organisms to count, and biosocial interactions to consider. Islands thus approximate idealized isolated ecosystems and represent rich sources of 'natural experiments'.

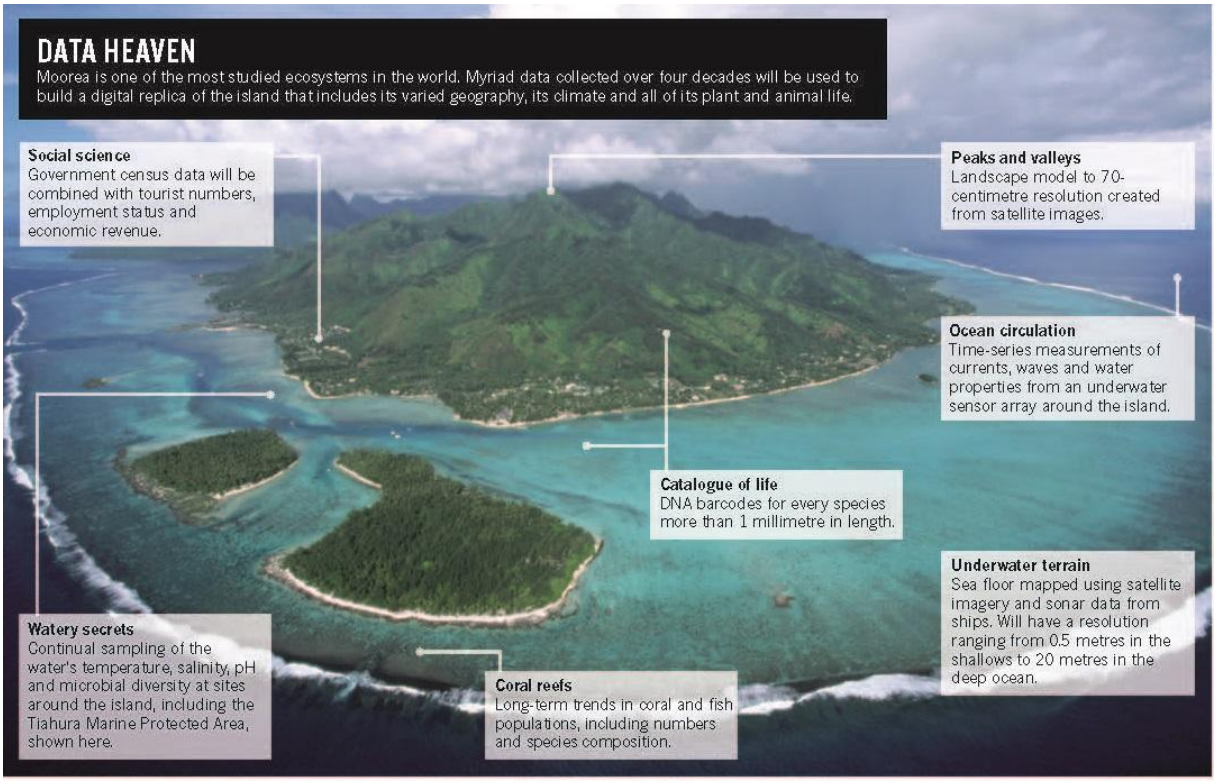
Moorea Avatar

The Moorea Island Digital Ecosystem Avatar (IDEA) project has been initiated in 2013 by a group of international researchers to build a virtual representation of Moorea Island. The main aim of the project is to model an entire ecosystem, observe the changes through it and be able to predict future changes reliably. The Moorea IDEA project incorporates observations, experiments, data, and theory across a coupled 3-D marine-terrestrial landscape to model, where physical, chemical, biological, and social processes interact to shape the island's phenotype. Moorea is a natural laboratory spanning marine and terrestrial environments that is constrained enough to be tractable, but sufficiently large (132 sq. Km) to contain all the elements of a complex socio-ecosystem, including a sizable human population (~ 17,000) (http://mooreaidea.org).

In order to generate the 3D physical model of the Island, multi-sensor data with varying accuracies, timestamps and spatial resolutions need to be processed and fused. High resolution optical satellite images (Pleiàdes), LIDAR data over land and water, existing DTMs, aerial film photography extracted and scanned from archives, underwater sonar measurements for modelling the bathymetry, underwater photogrammetry for monitoring the coral growth, UAV flights for accurate building reconstruction and recording of archaeological sites are among the data being processed in the project. This presentation describes the project in detail and addresses the processing methods and the problems encountered during the processing of multi-sensor and multi-resolution data. High resolution DSMs and orthoimages have already been generated using Pleiàdes images with 70 cm pan resolution acquired over Moorea and Tetiaroa in summer 2014. The images are tasked upon request and acquired in triplet mode, which provides three images from different angles for stereo processing with a time difference in the order of seconds. High resolution bathymetry data is available and will also been integrated into the generated DSM. The final physical 3D model,

amended by landuse data and other semantic information will provide a presentation and a geospatial analysis platform to the project participants from many other disciplines.

Building on the Moorea Island Digital Ecosystem Avatar (IDEA) platform (http://mooreaidea.ethz.ch), our overall goal is to develop data-driven models of the spatio-temporal dynamics of all processes of relevance on land and in the sea. Advanced computational simulations will be developed.



From: Daniel Cressey: Tropical paradise inspires virtual ecology lab. NATURE, Vol. 517, 15 January 2015