

The coupled carbon-water cycle in the terrestrial biosphere

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Topic 1: Lessons from the Past: Climate, Renewable Resources, and the 'Collapse' in Easter Island.



The collapse of Easter Island is a striking example of the dependence of human societies on their immediate environment and of the consequences of irreversible damage to the goods and services provided they provide. Starting from an extremely limited resource base, the Polynesian settlers constructed one of the most advanced societies in the world -- at least when referenced to the technology available. However, resource demands placed on the environment by this development were immense and could no longer withstand the pressure - resulting in an endogenous collapse resembling a typical boom-bust cycle within 1000 years. We explore this phenomenon using a general equilibrium model of renewable resource and population dynamics that can explain the rise and fall of Easter Island's civilization. The model, based on the formulation of Brander and Taylor (1998), leads to a dynamical system similar to the Lotka-Volterra predator-prey model. Humans are represented as the predator and the resource base (i.e. forests) as the prey. The model shows how feast and famine cycles arise and explain the falling population and resource stocks. Such cycles arise when human fertility is high and the resource base grows slowly.

Reference: Brander, J.A. and S. Taylor, 1998, The simple economics of Easter Island: A Ricardo-Malthus model of Renewable Resource, *The American Economic Review*, 88, 119-138.

Group Project: The Brander-Taylor (1998) model ignores the role of climate and some elements of their boom-bust cycle are not well supported by recent reconstruction of the population and the peak of deforestation rates (at least their phase relationship). We explore climate scenarios that may 'rectify' these trends and assess their plausibility - providing an 'overture' to the second topic: Leaf Transpiration and Photosynthesis.

Extra Material: Matlab Code of the Brander-Taylor (1998) will be supplied as a starting point.