

# **New model shows moderate resource use, reduced economic inequality keys to sustainability**

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A new analytical tool adds human factors to a widely-used biological model of how animal populations interact, suggesting that human societies can reach a steady state that is sustainable when they do not over-deplete natural resources and avoid extreme economic inequality.

The paper, titled "Human and nature dynamics (HANDY): modeling inequality and use of resources in the collapse or sustainability of societies," was published in the May 2014 issue of the journal *Ecological Economics*. Its authors are Safa Motesharrei, a Ph.D. candidate in applied mathematics at UMD; Jorge Rivas of the Institute of Global Environment and Society; and Eugenia Kalnay, Distinguished University Professor in the Department of Atmospheric and Oceanic Science and the Institute for Physical Science and Technology at UMD.

Kalnay, an internationally recognized weather and climate scientist, worked in leadership positions at NASA and the National Oceanic and Atmospheric Administration (NOAA) for two decades and currently serves on the UN Secretary General's Scientific Advisory Board on Sustainability. She is renowned, in part, for leading the National Weather Service's advances in weather modeling in the 1990s. Her recent work has focused on advancing understanding of climate change and environmental sustainability through improved modeling of the coupled interaction of earth and human systems.

HANDY's starting point is a well-known model in biology and population ecology, commonly known as the "predator-prey model," which is used to understand the dynamics of [animal populations](#). The researchers applied that model's concepts to [human societies](#), and incorporated two new variables that are not included in existing models: accumulation of wealth and economic stratification between rich and poor. These changes are necessary, the researchers say, to reflect that some segments of human society use more resources than others, and accumulated wealth can delay, but not prevent, the decline that occurs when a population exceeds the carrying capacity of its environment. With HANDY, the researchers say, they have developed a practical method for using the relevant natural, social and economic conditions to estimate a human society's carrying capacity.

While some HANDY scenarios are suggestive of past civilizations that flourished and then collapsed, such as the ancient Romans and Mayans, the model was not created to explain specific societies' collapse, team members said.

The model is "not intended to describe actual individual cases" – such as modern Western society – "but rather to provide a general framework that allows carrying out 'thought experiments' for the phenomenon of collapse and to test changes that would avoid it," the authors wrote in the research paper.

"The model does not say that society's collapse is imminent," said Rivas, "nor does it predict a collapse for 'Western' or 'industrial' civilization despite some pre-publication reports to the contrary."

"HANDY is not a forecasting model," Motesharrei said. "It cannot be used to predict the future of any society. It can, however, help us understand the possible underlying mechanisms in the evolution of a society."

This minimal modeling approach focuses on the long-term behavioral properties of dynamical systems, the authors explain. The goal is not to find precise solutions for the variables of the real system, but instead to address questions such as:

- In the long run, will the system settle at a steady state?
- What are these possible steady states?
- What factors determine which long-term behavior is followed?

"The results of our model are optimistic, because they show that by making certain decisions, we can bring about a sustainable future," said Rivas. Unlike physical and natural systems, such as the solar system or an ecosystem, "we can, as humans, make critical choices that can change the long-term path that our social system will take, and we can optimize such choices using scientific models. This is a key takeaway lesson of this paper."

However, the [model](#) shows that "if we continue to over-deplete nature, and if inequality continues such that the rich consume far more than the poor, the system eventually collapses," Kalnay said.

**More information:** [www.sciencedirect.com/science/.../S0921800914000615](http://www.sciencedirect.com/science/.../S0921800914000615)

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