

Modelling Sustainability: Simple Models and Complex Questions

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Introduction

Sustainability is often viewed as a complex issue, but to capture the basics of sustainability models require only a few parameters. The complexity of the issue lies not in the number of parts, but in the complex way that the parts interact. Simple models of sustainability which eschew detail in favour of tractability are useful as research and pedagogic tools.

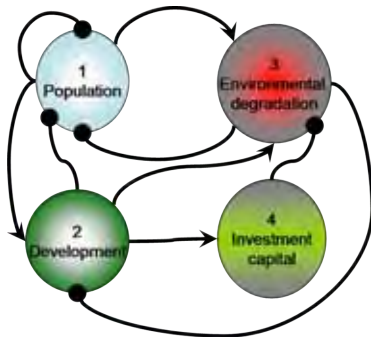


Sustainability is often described as having three components: social, environmental and economic.

The economic and social components can be seen as sub-components of a composite human component.

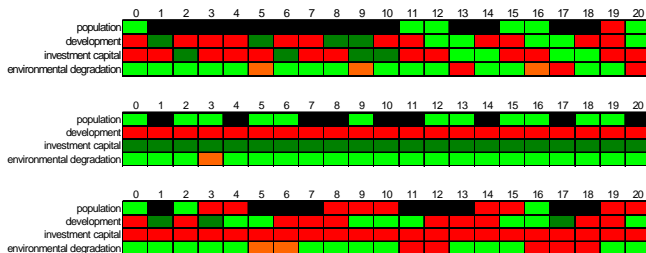
In many frameworks each of the components of sustainability is associated with a corresponding type of capital and sustainability is then assessed relative to changes in the amounts of different types of capital. Of the three, social capital is the most difficult to define.

A Simple Conceptual Model of Sustainability



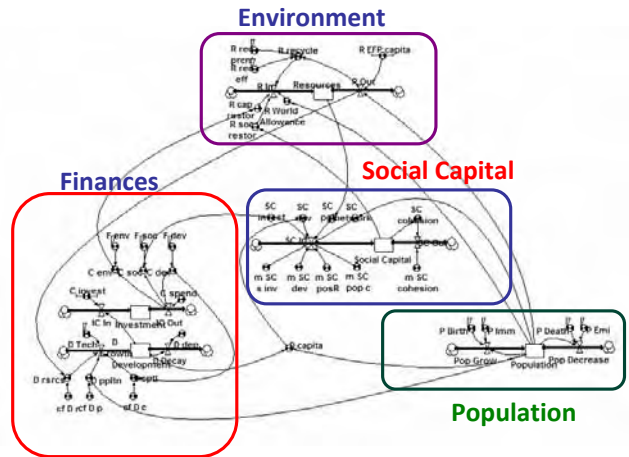
One simple model of sustainability comprises just four components: Population size, development, environmental degradation, and capital invested in environmental protection. In the system diagram above, positive effects are indicated by standard arrows, negative effects are indicated by connections with round ends.

Simple Models but Complex Dynamics



Simulation of the simple sustainability model can lead to complex predictions of the future depending on the strength of connections between the components. In the first scenario all of the concepts oscillate as positive and negative feedback loops operate. In the second scenario a constant and sufficient proportion of wealth is allocated to environmental protection; the population and development oscillate but the environment benefits. In the third scenario, no allocation of wealth is made to environmental protection, the system displays more chaotic dynamics with periods of population growth and shrinkage and periods of environmental damage and benefit. In the output 20 time steps are simulated. Red implies a dangerous level for the components, shades of green imply good values, the brighter the better. Black for the population variable implies periods of population decline.

A Simulation Model With Social Capital Included



Simple conceptual models can readily be extended to include more detail, as shown above. This model uses the global per capita ecological footprint to assess the sustainability of communities. It has been parameterised for Edinburgh.

Modelling With an Expert Knowledge Base



Is sustainability in the eye of the beholder? Work on farming system sustainability and arable ecosystem resilience brings together a diversity of natural and social scientists. The expert opinion of these scientists can be combined into simple qualitative models that reveal a great deal about perceptions of sustainability. In the above example, environmental factors were found to carry about twice as much weight as human factors in determining sustainability, but within human factors social components were found to have more importance than economic ones.

More than anything else our research and knowledge transfer efforts focus on the fact of sustainability as a property of systems in the world, not an abstraction. The sustainability of a system is, effectively, its lifespan and it can be measured.

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