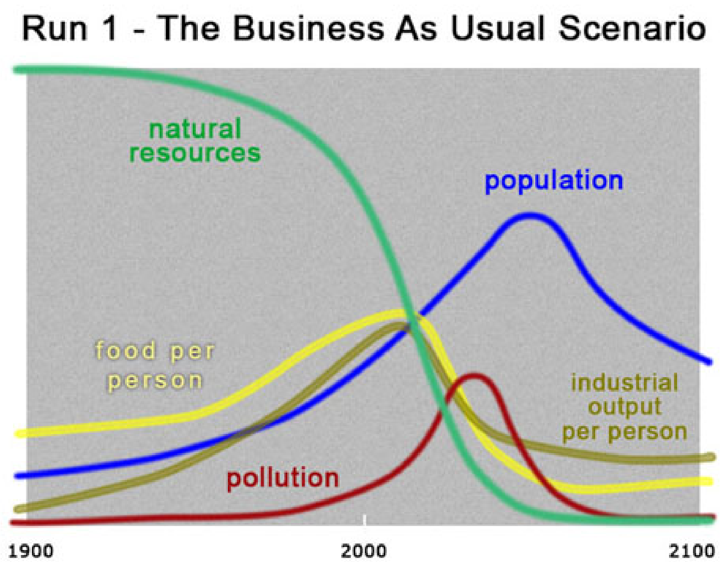
Lesson Week 11 – Systems Thinking Applied to Improving Sustainability

Leverage Which Way?

In this week's reading assignment in the course text, **Thinking in Systems,** the author, Donella Meadows makes an important observation. She says that people who operate systems often know where are the leverage points that change how a system behaves, but because they don't fully understand how the system works, they often push in the wrong direction. In 1972 Meadows co-authored a project, **The Limits to Growth World Model,** that dramatically demonstrated this phenomenon at the systemic level of the planet. The **Limits to Growth** project is perhaps the most well known example of systems thinking in action in a simulation model. As you will read in the synopsis of this project, http://www.donellameadows.org/archives/a-synopsis-limits-to-growth-the-30-year-update/, numerous simulations of the model in different policy scenarios show that it is extremely difficult to repair a system when one has pushed too hard on a leverage point in the wrong direction.



What is the character of the whole that is structured so that it reacts to our activities with the radical changes in behavior over time revealed in the Limits to Growth scenarios? Like all social systems at smaller scales, the World Model portrays the operation of a planetary human organization embedded in an ecosystem. As such, the World Model acknowledges that our species has a subordinate place in nature, that is, in the ecosystems that surround us. It follows that if we are to have any success in managing our affairs in such a complex, systemic universe, we need systemic knowledge of nature. That includes an understanding of internal cycles, and inputs and outputs (that ecologists call sources and sinks) and their management in accord with nature's laws. The tools introduced in this course allow us to study problems in their proper systemic context. The systemic knowledge gained is necessary if human activities are to survive and sustain themselves for a reasonable period of time. Hence all questions of sustainability require a systems thinking approach, a grasp of the operation of the ecological wholes, whose laws are beyond our control, in which our activities take place.

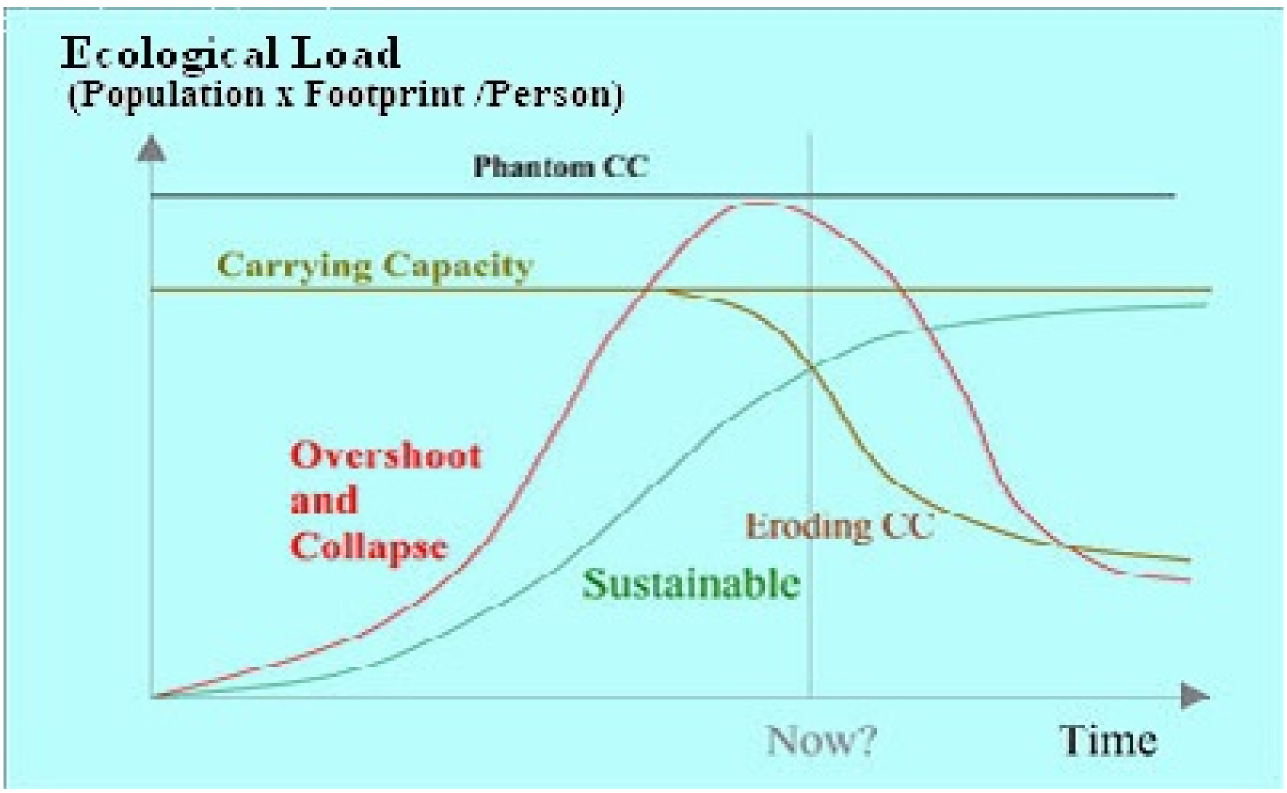
The Ecosystem Perspective and Sustainability

As the main example of system design for sustainability in this lesson will be from agriculture, actually from my own study and practice of a farming system, it will be useful to contrast some recent viewpoints on farm design. I began farming as part of the organic farming movement that emerged in recent decades. Our practices solved many of the most glaring problems of the industrial agricultural model, but few farmers in the movement had a deep knowledge of systems ecology. So a grab bag of practices emerged without a disciplined framework for design and evaluation. This was understandable because we had little guidance from agricultural scientists. Faculties in the agricultural schools still teach mostly the industrial agricultural model using reductionist rather than whole systems research methods, and even the few renegade academics who claim to be doing agroecology are not trained in systems ecology.

Under these conditions, my goal as a student of systems thinking and systems ecology was to use the framework of those disciplines in my farm design and management. There is overlap with the organic model in many ways, but with a significant difference. The organic model generally focuses on farm practices; systems ecology starts at the level of the whole farm ecosystem, or agroecosystem, and of necessity obeys the laws of ecosystem operation as a guide to improving sustainability.

In ecosystem science, the question of sustainability is about how large a population of organisms a system can sustain indefinitely. Thus one might ask how many people a farm can continue to feed over a long period of time, or what harvest of crops the soil can sustain. That population is the **carrying capacity (CC)**, defined as **the maximum indefinitely supportable ecological load**. Because the carrying capacity of an ecosystem depends on the interaction and interdependence of a complex of plants, animals and human practices, farm design and management in this approach starts at the top, at the level of the whole agroecosystem. That is, these farm system elements and their organization and interaction are chosen to maximize the health and endurance of the whole, building in attributes of sustainability like stability and resilience for the short run, and adaptive capacity for the longer term.

The focus on CC is a critical difference from both the organic and industrial agricultural models, because it forces the issue of overshoot, which can destabilize the system and threaten its survival. As you have learned in this course, it is feedback structures in the system that cause the nonlinear behavior over time that can lead to overshoot and collapse. Thus systems thinking tools are essential to this approach because they can identify feedback effects, both beneficial and threatening to farm sustainability goals.



Sources and Sinks

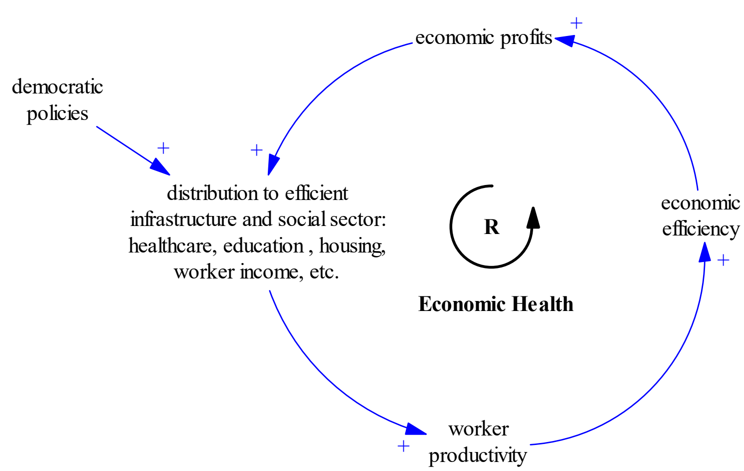
To stay within CC, within **the maximum indefinitely supportable ecological load,** farm design and management must be concerned with where farm inputs come from, and what are all the farm products, both beneficial and damaging outputs, and where they go. For example, if inputs come from outside the farm and are nonrenewable, how does that affect sustainability? Thus it involves the questions of boundaries of problems and multiple consequences ("In a complex system one can never do just one thing"), which are central issues in systems thinking.

As you will read in the paper that describes my attempt at sustainable design for Northland Sheep Dairy, to address the question of sources and sinks (inputs and outputs) I drew ideas from natural ecosystems evolved over millions of years to run on healthy mineral and water cycles internal to the system, and ideas from pre-industrial farming systems that did not rely on the crutch of fossil energy.

I also noted that in addition to the question of external inputs and outputs, a **system of influence** far beyond the boundaries of the farm agroecosystem limits how much I can improve sustainability, because every commercial farming enterprise must exist in a larger social system whose structures and constraints may not be favorable to the goal of improving sustainability. Industrial agriculture has used energy- and other input-intensive methods to improve global food production immensely in the relatively short term, but measured by the critical standard of carrying capacity, this cannot last, as the Limits to Growth Project demonstrated. This should not surprise you as a systems thinker, remembering the law of unintended consequences: due to **delays** in complex systems, immediate consequences are rarely going to be the same as later ones.

Sustainability of the Economic System

Problem solving at the level of the whole economy can benefit from the design of healthy cycles, to borrow a concept from the focus on important cycles in ecosystems. The following model demonstrates that the long term health of the economic processes depends on the level of reinvestment in efficient infrastructure and the social sector. Optimal investment in these areas maximizes economic health in the long term in a virtuous feedback cycle. Shorting such investment turns it into a vicious cycle of economic decline.



In Conclusion

Whatever else they are, problems about sustainability in any area of our lives are always ecosystemic ones. We need to discover the ecosystem of influence for a specific problem, model the problem first at that level: check the health of the water and mineral cycles and the energy source(s), how any proposed policy scenarios would affect them, and what might be the consequences later in time. That is the proper context in which to then model the problem further in regard to business productivity or other human goals. For example, as apparently simple a problem as the sustainability of household consumption is likely to reveal a far-reaching ecosystem of influence. One would need to model where the products come from, the effects of extraction of the constituent raw materials and processing into the products, energy and other resource consumption related to their household use, and what happens when they become 'garbage'.

Reading Assignments

1. ***Thinking in Systems*****,** Chapter Six
2. A Synopsis: Limits to Growth: The 30-Year Update
3. Illustrations and Challenges of Progress Toward Sustainability in the Northland Sheep Dairy Experience

Potential Discussion Assignment

Based on what you have learned in this course, comment critically or constructively on the perspective on farm sustainability described in the example of Northland Sheep Diary. Where in this example do you see systems thinking principles at work, or could be applied, but are not?