

Task Group Summary 2

What does it take to achieve a sustainable future? The problem of the commons: achieving a sustainable quality of life.

Challenge Summary

Eight hundred million people are chronically hungry today and perhaps another 100 million will be chronically hungry within a year. Sadly, this statistic reflects no inability of the Earth and humans to produce enough food for all. We grow enough cereal to adequately feed a population of 10 billion people (current world population 6.6-6.7 billion). Issues in hunger include:

- Consumers' inability to pay for food
- Growers' inability to purchase seed, fertilizer, equipment, and other necessities for growing food, to get it to market, and to sell it at a profit
- Cultural taboos such as fear of genetically modified organisms
- Cultural limitations on what foods people are willing to eat
- Politically motivated agricultural subsidies in rich countries that undercut the ability of food producers in poor countries to compete in world markets
- Food price controls imposed by fearful governments in developing countries that limit farmers' incomes

Demographic projections suggest that nearly all of the next 2.5 to 3 billion people to be added to the planet by 2050 will live in cities in poor countries. That projection, if correct, requires building the equivalent of an additional city of 1 million people every five days for the next 40 to 50 years. Are the problems of assuring decent health, adequate sanitation housing, food supplies, amenities, and public order for such cities soluble with present scientific and technical knowledge? If not, what do we need to do to prepare for this growth?

Given these challenges ideas for a sustainable human population must be developed. Can we learn from simpler model systems, such as microbial systems in which enormous numbers of like and unlike individuals can be grown and subjected to different environmental and nutritional stresses? Perhaps such simple systems can be modeled and the outcomes experimentally verified. Particularly hospitable and particularly inhospitable situations can be examined.

In addition, we could examine evolutionary theory, particularly theories of social evolution and mechanisms of conflict and conflict resolution be used on a global human scale.

Key Questions

- How can we deal with problems of the Commons, in which the collective consequences of individual behaviors affect public goods? Can we model these interactions between units with dynamics at such different organizational and spatial scales? Can an understanding of collective phenomena and cooperation in non-human societies inform better stewardship of resources and our common environment (Levin 1999)?
- Can we meaningfully describe the complexity of any population by a few factors (for example: population, resources, environment)?
- There is evidence that desired family size is affected by cultural norms and has a contagious or imitative effect. It has also been clearly demonstrated that external phenomenon, such as the empowerment of women through education and employment, leads to smaller desired family

sizes, as the “extra hands” motivation diminishes. How could these factors be best combined to effect population control policies, while maintaining individual freedom and equity?

- Can we use tractable experimental systems to help us learn what to expect as the human population increases in a warming environment?
- Can theories derived from the field of social evolution aid us in understanding and predicting human population changes?

Required Reading

Arrow K, Bolin B, Costanza R, Dasgupta P, Folke C, Holling CS, Jansson BO, Levin S, Maler KG, Perrings C, Pimentel D. Economic growth, carrying capacity and the environment. *Ecological Applications* 2006;6(1):13-15.

Commission on Growth and Development Study 2008. [Accessed June 10, 2008: [http://www.growthcommission.org/index.php?option=com_content&task=view&id=96&Itemid=169.](http://www.growthcommission.org/index.php?option=com_content&task=view&id=96&Itemid=169)]

Suggested Reading

Cohen J. How many people can the earth support?. New York: W.W. Norton & Company, Inc. 1995.

Levin S. Fragile dominion: Complexity and the commons. New York: Perseus. 1999.

TASK GROUP MEMBERS

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TASK GROUP SUMMARY

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If the entire world consumed as much as the average United States citizen, we would need 4.5 Earths to sustain us. And, if we continue to grow and increase consumption at the same rate, by the 2030s we will need two planets to support our way of life, according to *The Living Planet Report 2008*, an annual assessment produced by the World Wildlife Fund, Zoological Society of London, and the Global Footprint Network. These figures suggest that humanity is on course for environmental collapse, and a new, more sustainable future must be implemented if we are to forestall that collapse.

Experts in biology, physics, philosophy, economics, anthropology, public health, and law, all came together at the 2008 National Academies Keck *Futures Initiative* Conference on Complex Systems to examine the problem of sustainability, describe what a sustainable future would look like, and predict whether or not it is in fact possible.

The group decided that before a sustainable solution can be drafted, we need a modeling framework that explores possible future outcomes. A new model that the group named SOS World, for scientific open source, would be a freely available model of the world that would take into account climate, economics, demographics, health, and any other input deemed necessary to simulate what the future could have in store for us. The group envisioned large groups of scientists contributing to the development of SOS World, a scientific tool that would inspire solutions and serve as a platform for developing sustainability as a research effort.

What Is Sustainability?

Many traditional economic models assumed that humanity depends on steady economic growth worldwide. Yet, as demonstrated by the current financial crisis, endless economic growth is probably not possible, nor is it necessarily desirable. Just because a country's GDP is growing, does not mean that the country is living sustainably, nor does it equate with increased quality of life for all of its citizens. The group agreed that economic growth should not be the sole measure of sustainability and that for the purposes of its analysis, sustainability would be loosely defined as quality of life not purchased at the expense of the future. Sustainability may or may not be possible, but the group said it is nevertheless necessary to work towards a future that comes as close as possible to sustainability. The primary goal of SOS World would be to identify sustainability when it arises in the model, rather than prescribing what it would look like in advance.

To move towards sustainability, seven key changes need to occur:

1. Demographic—away from unchecked population growth
2. Technological—develop and implement technology with less environmental impact
3. Social—towards social equality
4. Economic—to more economic equality
5. Institutional—to more effective means of coping with conflict
6. Informational—to greater access to information and education
7. Ideological—from ideologies that divide, to ideologies that unite

A sustainable world would be one that resulted in changes in all seven of these areas because in order to engage citizens across the world in tackling some of the greatest environmental problems, everyone would need to have the resources and opportunity to participate. Developing countries will not have an incentive to participate if doing so does not also improve their standard of living. Educating people in developing countries is also important because they could very well have something important to contribute.

A Complex Systems Model Based on Neural Networks

In thinking about how to create a model that encompasses many different variables—health, economics, climate, ecology, education, and others—it is necessary to use a model that represents a complex system; in this case a neural network. Neural networks are modeling techniques that can analyze nonlinear systems. They were originally developed to explain the neural networks in the brain, but can be applied to almost any system that cannot be explained linearly. They can be used in systems where there are multiple inputs and where there is a relationship between the inputs and the predicted outcomes, even when those relationships are complex. So for something like an ecosystem, that is affected by many different factors, a neural

network can analyze those very complex relationships and simulate the interaction among dozens if not hundreds of agents and processes.

The other main advantage of a complex systems model is that it can identify tipping points—points where small changes have huge effects on the system. These tipping points will be useful in shaping policy because they will identify crucial areas where a small change for the worse could have devastating consequences. Alternatively, it will also pinpoint small changes that will have a large positive impact, which will help create sustainability in a cost effective way. In this way, sustainability will be defined as outcomes that emerge from simulation that achieve all or many of the goals above.

An SOS World

The resulting model would be one that could be replicated and modified as necessary. The SOS World model would take into account any and all factors that are deemed important to achieving sustainability, including climate, economics, population growth and health. Sustainability can be viewed in more than one way, or as encompassing different systems, which in turn could lead to different predictive outcomes. Some scenarios or possible outcomes that SOS World might generate, depending on the parameters in the model, include:

- Growth World – Never-ending economic growth and consumption everywhere all the time. This was the world as described by some of the experts who use economics as the only measure of sustainability. The group decided this was not a realistic or desirable world.
- Death World – Everything declines. The group seemed to think this was a real possibility, particularly if the status quo is maintained.
- Wave World – Growth and prosperity move in waves across the globe.
- Chaos World – Random fluctuations of growth and prosperity. This would be similar to booms and busts, like the housing and tech booms and busts.

The purpose of creating the simulations is to identify the important variables that need to be changed to create a world that resembles sustainability. Even though the model will take into account many different variables, by using a complex systems analysis, such as a the neural networks analysis, it will be possible to identify crucial tipping points and make meaningful policy based on those tipping points, rather than piecemeal policy that often has unintended consequences. In short, the model is assembled with important parts of the global system, and the outcomes represent possible future trajectories. A key question is: Can a sustainable outcome emerge, and under what conditions (parameters) does it emerge?

Next Steps

The group intends to pursue its work at NAKFI by applying for a grant to design the model platform, recruit experts, and see what other work is being done in the area in case it is possible to combine efforts. Realizing that the project is a huge undertaking, the scientists also plan to seek out long-term funding, particularly to craft the design platform for SOS World.

The enormity of the task of first modeling and then creating a sustainable environment was not lost on the scientists, who nonetheless were driven by the urgency of the challenge. The group's adopted mantra—if not now, when?—sums up nicely the sense of responsibility and necessity the group felt towards solving the problem of sustainability. How do we live in a sustainable way, how do we ensure our children and grandchildren have a future, how do people

living in poverty grow out of it? And how do we devise a model that can meaningfully address all these questions?