

The Limits to Growth: Background and Exercise Suggestions

The Limits to Growth (Figure 1) describes the prospects for growth in human population and industrial production in a global system over the next century. The book is quite likely to be the most widely read application of system dynamics modeling. The model and the book provide opportunities for student exercises to improve your command of modeling and your understanding of the challenges of dealing with population and industrial growth in a finite world.

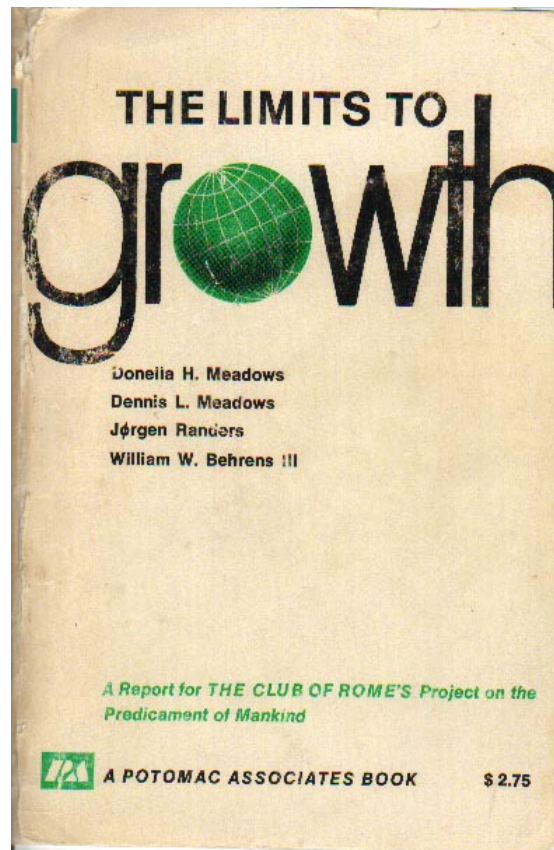


Figure 1. Cover from *The Limits to Growth*.

The Limits to Growth describes a system dynamics model used to simulate investments in food supply and resource production needed to keep pace with the needs of a growing world. The model also simulated the generation of persistent pollutants and the ability of the environment to absorb and degrade the pollutants to harmless form. The model was used to study futures with widely different estimates of the total food supply, the total resource base, and the role of technology to improve production and efficiency. The researchers used the model to study the most likely pattern of accommodation with the limits in our global system.¹ One possible pattern is s-shaped growth. With this scenario, the global population and industrial output would gradually slow down over several decades and reach a level that could be sustained indefinitely. Another possibility is the overshoot. With this scenario, the limiting effects of food and resources would not be felt immediately (or would be ignored), and population would grow past a sustainable level. A downward correction could then be required due to inadequate food production, declining resources or a worsening environment.

The fundamental finding from *The Limits to Growth* was that the overshoot scenario is the more likely outcome given current attitudes and policies about growth, technology and the environment. The researchers argued, however, that the world system is not locked into the overshoot pattern. They concluded that it is possible to alter the growth trends and to establish a condition of ecological and economic stability that could be sustained far into the future. The earth's resources could allow for a state of global equilibrium in which the basic material needs of each person could be satisfied on a sustainable basis.

The Reaction to *The Limits to Growth*

The Limits to Growth was an international best seller. The newspapers and news magazines were filled with commentary. Indeed, some news coverage included full reproduction of the standard simulation of the world model (see Figure 2).

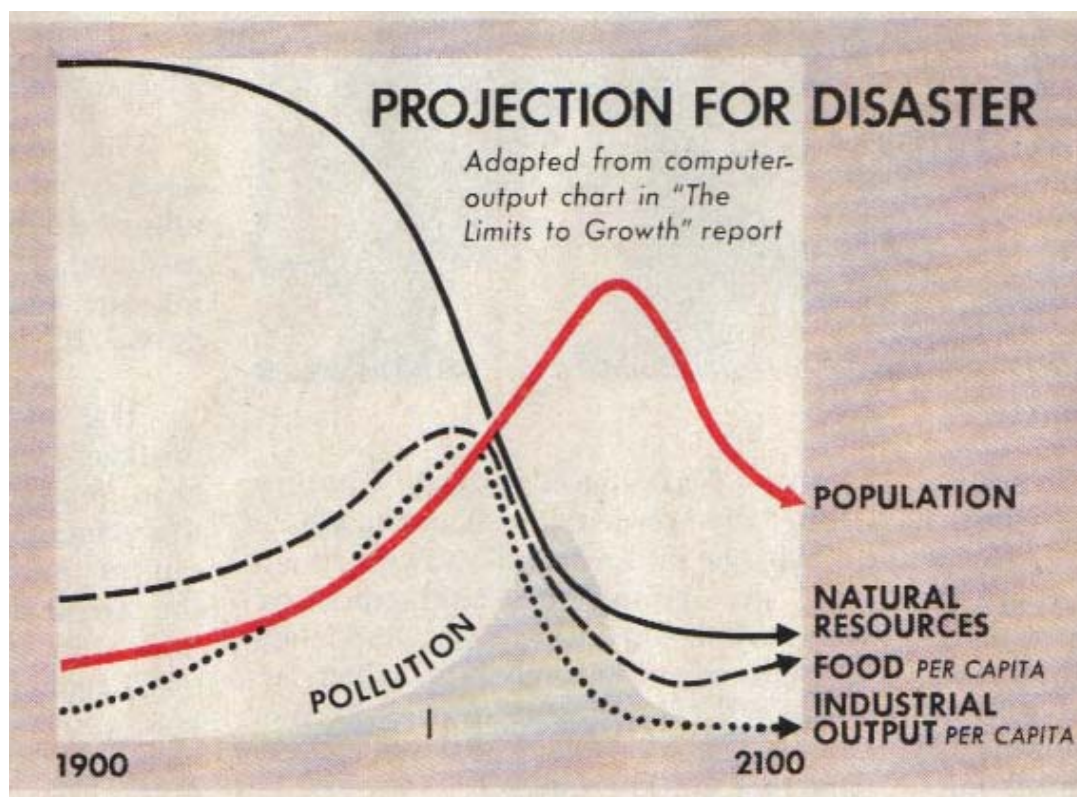


Figure 2. Standard simulation from *Limits* shown in *Time* magazine, Jan 24, 1972.

The book's publication generated a storm of debate and controversy. Anthony Lewis, a columnist for the *New York Times*, found it to be the *most fascinating and the most disturbing book* that he had read in a long time. Robert Townsend, an author and chief executive commented that *if this doesn't blow everybody's mind who can read without moving his lips, then the earth is kaput*. Henry Wallich, an economist, called the book a *piece of irresponsible nonsense*. Another critic called the book *an empty and misleading work*. As the debate spread, its supporters and critics found fault with each other's commentary. Robert Socolow, an economist from MIT, remarked that *the amount of commentary -- pro, con and orthogonal -- has exceeded the original text by a factor of several hundred*.

Learning About Limits

Limits provides an opportunity for learning and reflection about the nature of our global system and about the use of computer simulation modeling to influence our thinking. To learn more about this topic, you might begin with three books from the 1970s:

- Start with *The Limits to Growth* (Meadows 1972). It is written in a clear and compelling fashion for a general audience.
- Then turn to *The Dynamics of Growth in a Finite World* (Meadows 1974), the technical report on the world modeling project. You'll discover that the world model is comprised of separate sectors to keep track of population, pollution, resources, agriculture and capital. All five sectors are carefully documented and tested before they are combined to create a systems perspective on the world.
- The best description of the debate is Greenberger's (1976) *Models in the Policy Process*. His account is interesting, detailed and insightful. And to his credit, Greenberger describes the many conflicting viewpoints in a respectful manner.

To bring yourself up to date with the authors' views twenty years after the publication of *Limits* you should turn to *Beyond the Limits* (Meadows 1992). The title is both a play on words and a serious statement about the current world system. *Beyond* reminds us that the 1992 book is a sequel, and it conveys the author's views of the sustainability of the world in the 1990s (Meadows 1992, xiv):

we realized that in spite of the world's improved technologies, the greater awareness, the stronger environment policies, many resource and pollution flows had grown beyond their sustainable limits ... we discovered as we began to talk to colleagues about the world being "beyond the limits," that they did not question that conclusion. We found many places in the literature of the past twenty years where authors had suggested that resource and pollution flows had grown too far ...
The human world is beyond its limits. The present way of doing things is unsustainable. The future, to be viable at all, must be one of drawing back, easing down, healing.

Beyond the Limits, published in 1992, was a 20-year update on global trends and the relevance of the findings from 1972. A 30-year update was published in 2002: *Limits to Growth: The 30-Year Update*. This update reinforced the conclusion that population and industrial growth has pushed the global system past sustainable limits. The authors argued that we should aim for a deliberate correction of this unsustainable situation. They argue for a “careful easing down” which could lead to “a desirable, sustainable, sufficient future for all the world’s peoples.” And they concluded that “if a profound correction is not made soon, a crash of some sort is certain. And it will occur in the lifetimes of many who are alive today.” A short summary of *Limits* and related readings is provided by Wikipedia, the on-line encyclopedia: http://en.wikipedia.org/wiki/The_Limits_to_Growth

These books and articles will raise many questions about the nature of our global system, and you will certainly have many questions about the usefulness of the computer model. Some of you will be skeptical of the model; others will be supportive. Regardless of your initial reaction, you will probably agree with the position taken on the back cover of *Limits* by Paul Ehrlich, Professor of Biology at

Stanford University. Ehrlich believes that the limits team has

done a great service in constructing a preliminary model of the world in which all the assumptions and parameters are explicit and thus open to criticism and modification.

Those who object to the characteristics of the model are challenged to help improve it; those who dislike the characteristics of the system it simulates might consider working for changes in the real world.

Exercises with World3

World3 is the computer model used in Limits. The Dynamo version is thoroughly explained by Meadows (1974). You may also obtain a Stella version of World3 from the University of New Hampshire, as explained in *Beyond the Limits* (Meadows 1992, p. 252). And if you prefer to use Vensim or Powersim, you will find that World3 is provided as one of the demonstration models that accompany the software.

Your first step should be to simulate the model to verify the tendency for the population to overshoot. Then you should verify some of the key sensitivity tests that deal with parameters in your area of interest. The model touches on so many different aspects of the world system that you will surely think of ways to improve the realism in one of the five sectors.

An instructive class project is to expand and improve one of the sectors to provide a more realistic picture of the world system. You may then use your version of the model to learn whether you agree or disagree with the recommendations from *The Limits to Growth*.

¹ The model in *The Limits to Growth* is a global model with profound implications for the challenges of dealing with resource and environmental problems. Most readers will reflect on the global implications and translate what they learned into strategies at the local level (*Think Globally, Act Locally*.) The *Limits* research team did not reach its conclusions with the global model alone. Rather, the global simulations were supplemented with a collection of case studies published in *Toward Global Equilibrium* (Meadows and Meadows, editors, 1973). The models used in these case studies provide useful opportunities for student exercises, several of which are included elsewhere on the BWeb:

Anthropology – the case of the Tsembaga in New Guinea

Limnology – cultural eutrophication of a carbon limited lake

Resource Economics – the discovery and production of natural gas