

Authors' Preface

Background

This book — *Limits to Growth: The 30-Year Update* — is the third edition in a series. The first text appeared in 1972.¹ In 1992 we published the revised edition, *Beyond the Limits (BTL)*,² where we discussed global developments over the first 20 years in the scenarios of *LTG*. This 30-year update presents the essential parts of our original analysis and summarizes some of the relevant data and the insights we have acquired over the past three decades.

The project that produced *LTG* took place in the System Dynamics Group of the Sloan School of Management within the Massachusetts Institute of Technology (MIT) from 1970 to 1972. Our project team used system dynamics theory and computer modeling to analyze the long-term causes and consequences of growth in the world's population and material economy. We addressed questions such as: *Are current policies leading to a sustainable future or to collapse? What can be done to create a human economy that provides sufficiently for all?*

We had been commissioned to examine these questions by the Club of Rome, an informal, international group of distinguished businessmen, statesmen, and scientists. The Volkswagen Foundation in Germany provided the funding for our work.

Dennis Meadows, then on the faculty at MIT, assembled and directed the following project team, which spent two years conducting the original study.

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A major foundation of our project was the "World3" computer model, which we constructed to help us integrate data and theories related to growth.³ With the model we can produce scenarios of world development that are internally consistent. In the first edition of *LTG* we published and analyzed 12 scenarios from World3 that showed different possible patterns of world development over the two centuries from 1900 to 2100. *BTL* presented 14 scenarios from a slightly updated version of World3.

LTG became a best seller in several countries, eventually being translated into about 30 languages. *BTL* appeared in many languages and is widely used as a university text.

1972: The Limits to Growth

The Limits to Growth (LTG) reported that global ecological constraints (related to resource use and emissions) would have significant influence on global developments in the twenty-first century. *LTG* warned that humanity might have to divert much capital and manpower to battle these constraints—possibly so much that the average quality of life would decline sometime during the twenty-first century. Our book did not specify exactly what resource scarcity or what emission type might end growth by requiring more capital than was available—simply because such detailed predictions can not be made on a scientific basis in the huge and complex population–economy–environment system that constitutes our world.

LTG pleaded for profound, proactive, societal innovation through technological, cultural, and institutional change in order to avoid an increase in the ecological footprint of humanity beyond the carrying capacity of planet Earth. Although the global challenge was presented as grave, the tone of *LTG* was optimistic, stressing again and again how much one could reduce the damage caused by approaching (or exceeding) global ecological limits if early action were taken.

The 12 World3 scenarios in *LTG* illustrate how growth in population and natural resource use interacts with a variety of limits. In reality limits to growth appear in many forms. In our analysis we focused principally on the planet's physical limits, in the form of depletable natural resources and the

finite capacity of the Earth to absorb emissions from industry and agriculture. In every realistic scenario we found that these limits force an end to physical growth in World3 sometime during the twenty-first century.

Our analysis did not foresee abrupt limits—absent one day, totally binding the next. In our scenarios the expansion of population and physical capital gradually forces humanity to divert more and more capital to cope with the problems arising from a combination of constraints. Eventually so much capital is diverted to solving these problems that it becomes impossible to sustain further growth in industrial output. When industry declines, society can no longer sustain greater and greater output in the other economic sectors: food, services, and other consumption. When those sectors quit growing, population growth also ceases.

The end to growth may take many forms. It can occur as a collapse: an uncontrolled decline in both population and human welfare. The scenarios of World3 portray such collapse from a variety of causes. The end to growth can also occur as a smooth adaptation of the human footprint to the carrying capacity of the globe. By specifying major changes in current policies we can cause World3 to generate scenarios with an orderly end to growth followed by a long period of relatively high human welfare.

The End of Growth

The end of growth, in whatever form, seemed to us to be a very distant prospect in 1972. All World3 scenarios in *LTG* showed growth in population and economy continuing well past the year 2000. Even in the most pessimistic *LTG* scenario the material standard of living kept increasing all the way to 2015. Thus *LTG* placed the end of growth almost 50 years after the publication of the book. That seemed to be time enough for deliberation, choice, and corrective action—even at the global level.

When we wrote *LTG* we hoped that such deliberation would lead society to take corrective actions to reduce the possibilities of collapse. Collapse is not an attractive future. The rapid decline of population and economy to levels that can be supported by the natural systems of the globe will no doubt be accompanied by failing health, conflict, ecological

devastation, and gross inequalities. Uncontrolled collapse in the human footprint will come from rapid increases in mortality and rapid declines in consumption. With appropriate choice and action such uncontrolled decline could be avoided; overshoot could instead be resolved by a conscious effort to reduce humanity's demands on the planet. In this latter case gradual downward adjustment of the footprint would result from successful efforts to reduce fertility and from more equitable distribution of the sustainable rate of material consumption.

It is worth repeating that growth does not necessarily lead to collapse. Collapse follows growth only if the growth has led to overshoot, to an expansion in demands on the planet's sources, and sinks above levels that can be sustained. In 1972 it seemed that humanity's population and economy were still comfortably below the planet's carrying capacity. We thought there was still room to grow safely while examining longer-term options. That may have been true in 1972; by 1992 it was true no longer.

1992: Beyond the Limits

In 1992 we conducted a 20-year update of our original study and published the results in *Beyond the Limits*. In *BTL* we studied global developments between 1970 and 1990 and used this information to update the *LTG* and the *World3* computer model. *BTL* repeated the original message; in 1992 we concluded that two decades of history mainly supported the conclusions we had advanced 20 years earlier. But the 1992 book did offer one major new finding. We suggested in *BTL* that humanity had already overshoot the limits of Earth's support capacity. This fact was so important that we chose to reflect it in the title of the book.

Already in the early 1990s there was growing evidence that humanity was moving further into unsustainable territory. For example, it was reported that the rain forests were being cut at unsustainable rates; there was speculation that grain production could no longer keep up with population growth; some thought that the climate was warming; and there was concern about the recent appearance of a stratospheric ozone hole. But for most people this did not add up to proof that humanity had exceeded the carrying capacity of

the global environment. We disagreed. In our view by the early 1990s overshoot could no longer be avoided through wise policy; it was already a reality. The main task had become to move the world back "down" into sustainable territory. Still, *BTL* retained an optimistic tone, demonstrating in numerous scenarios how much the damage from overshoot could be reduced through wise global policy, changes in technology and institutions, political goals, and personal aspirations.

BTL was published in 1992, the year of the global summit on environment and development in Rio de Janeiro. The advent of the summit seemed to prove that global society finally had decided to deal seriously with the important environmental problems. But we now know that humanity failed to achieve the goals of Rio. The Rio + 10 conference in Johannesburg in 2002 produced even less; it was almost paralyzed by a variety of ideological and economic disputes, by the efforts of those pursuing their narrow—national, corporate, or individual self-interests.⁴

1970 – 2000: Growth in the Human Footprint

The past 30 years have produced many positive developments. In response to an ever growing human footprint, the world has implemented new technologies, consumers have altered their buying habits, new institutions have been created, and multinational agreements have been crafted. In some regions food, energy, and industrial production have grown at rates far exceeding population growth. In those regions most people have become wealthier. Population growth rates have declined in response to increased income levels. Awareness of environmental issues is much higher today than in 1970. There are ministries of environmental affairs in most countries, and environmental education is commonplace. Most pollution has been eliminated from the smoke stacks and outflow pipes of factories in the rich world, and leading firms are pushing successfully for ever higher eco-efficiency.

These apparent successes made it difficult to talk about problems of overshoot around 1990. The difficulty was increased by the lack of basic data and even elementary vocabulary related to overshoot. It took more than two decades before the conceptual framework—for example, distinguishing

growth in the Gross Domestic Product (GDP) from growth in the ecological footprint—matured sufficiently to enable an intelligent conversation about the limits to growth issue. And world society is still trying to comprehend the concept of *sustainability*, a term that remains ambiguous and widely abused even sixteen years after the Brundtland Commission coined it.⁵

The past decade has produced much data that support our suggestion in *BTL* that the world is in overshoot mode. It now appears that the global per capita grain production peaked in the mid-1980s. The prospects for significant growth in the harvest of marine fish are gone. The costs of natural disasters are increasing, and there is growing intensity, even conflict, in efforts to allocate fresh water resources and fossil fuels among competing demands. The United States and other major nations continue to increase their greenhouse gas emissions even though scientific consensus and meteorological data both suggest that the global climate is being altered by human activity. There are already persistent economic declines in many localities and regions. Fifty-four nations, with 12 percent of the world population, experienced declines in per capita GDP for more than a decade during the period from 1990 to 2001.⁶

The past decade also provided new vocabulary and new quantitative measures for discussing overshoot. For example, Mathis Wackernagel and his colleagues measured the *ecological footprint* of humanity and compared it to the “carrying capacity” of the planet.⁷ They defined the ecological footprint as the land area that would be required to provide the resources (grain, feed, wood, fish, and urban land) and absorb the emissions (carbon dioxide) of global society. When compared with the available land, Wackernagel concluded that human resource use is currently some 20 percent above the global carrying capacity (figure P-1). Measured this way humanity was last at sustainable levels in the 1980s. Now it has overshoot by some 20 percent.

Sadly, the human ecological footprint is still increasing despite the progress made in technology and institutions. This is all the more serious because humanity is *already* in unsustainable territory. But the general awareness of this predicament is hopelessly limited. It will take a long time to obtain political support for the changes in individual values and public policy that could reverse current trends and bring the ecological footprint back below the long-term carrying capacity of the planet.

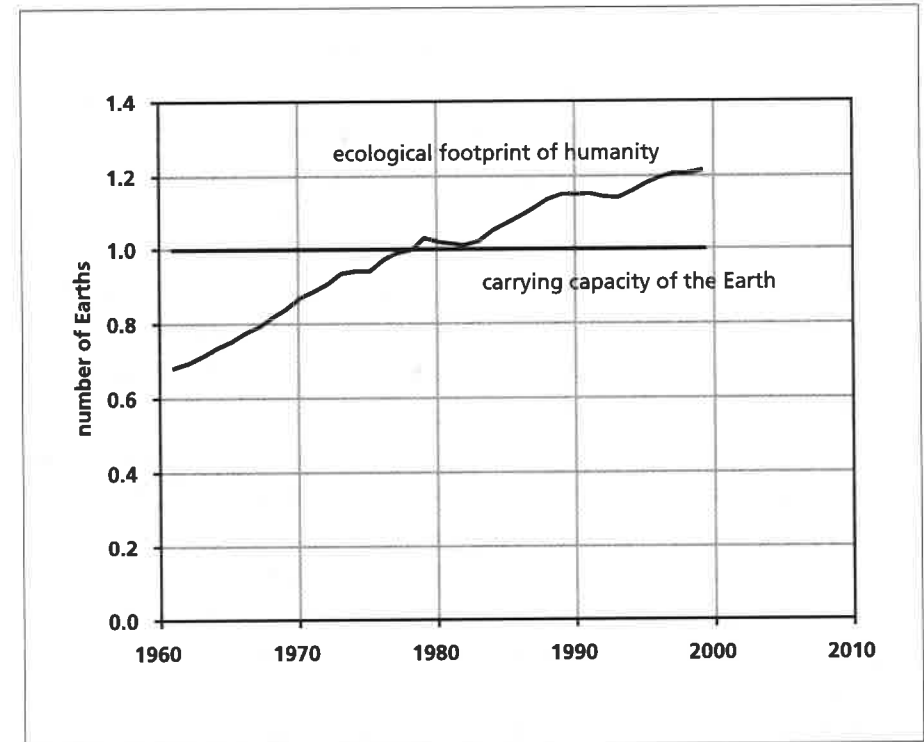


FIGURE P-1 Ecological Footprint versus Carrying Capacity

This graph shows the number of Earths required to provide the resources used by humanity and to absorb their emissions for each year since 1960. This human demand is compared with the available supply: our one planet Earth. Human demand exceeds nature's supply from the 1980s onward, overshooting it by some 20 percent in 1999. (Source: M. Wackernagel et al.)

What Will Happen?

The global challenge can be simply stated: To reach sustainability, humanity must increase the consumption levels of the world's poor, while at the same time reducing humanity's total ecological footprint. There must be technological advance, and personal change, and longer planning horizons. There must be greater respect, caring, and sharing across political boundaries. This will take decades to achieve even under the best of circumstances. No modern political party has garnered broad support for such a program, certainly not among the rich and powerful, who could make room for growth among the poor by reducing their own footprints. Meanwhile, the global footprint gets larger day by day.

Consequently, we are much more pessimistic about the global future than we were in 1972. It is a sad fact that humanity has largely squandered the past 30 years in futile debates and well-intentioned, but halfhearted, responses to the global ecological challenge. We do not have another 30 years to dither. Much will have to change if the ongoing overshoot is not to be followed by collapse during the twenty-first century.

We promised Dana Meadows before she died in early 2001 that we would complete the "30-year update" of the book she loved so much. But in the process we were once more reminded of the great differences among the hopes and expectations of the three authors.

Dana was the unceasing optimist. She was a caring, compassionate believer in humanity. She predicated her entire life's work on the assumption that if she put enough of the right information in people's hands, they would ultimately go for the wise, the farsighted, the humane solution—in this case, adopting the global policies that would avert overshoot (or, failing that, would ease the world back from the brink). Dana spent her life working for this ideal.

Jorgen is the cynic. He believes that humanity will pursue short-term goals of increased consumption, employment, and financial security to the bitter end, ignoring the increasingly clear and strong signals until it is too late. He is sad to think that society will voluntarily forsake the wonderful world that could have been.

Dennis sits in between. He believes actions will ultimately be taken to avoid the worst possibilities for global collapse. He expects that the world will eventually choose a relatively sustainable future, but only after severe global crises force belated action. And the results secured after long delay will be much less attractive than those that could have been attained through earlier action. Many of the planet's wonderful ecological treasures will be destroyed in the process; many attractive political and economic options will be lost; there will be great and persisting inequalities, increasing militarization of society, and widespread conflict.

It is impossible to combine these three outlooks into one common view of the most likely global future. But we do agree on what we hope might happen. The changes we would prefer to see are described in a slightly updated version

of Dana's hopeful, concluding chapter from *BTL*, now titled "Tools for the Transition to Sustainability." The message is that if we persist in our pedagogic effort, the world's people will increasingly choose the right way ahead, out of love and respect for their planetary companions, current and future, human and nonhuman. We fervently hope they will do so in time.

Was Limits to Growth Correct?

We are often asked, "Were the *Limits to Growth* predictions correct?" Note that this is the media's language, not ours! We still see our research as an effort to identify different possible futures. We are not trying to predict the future. We are sketching alternative scenarios for humanity as we move toward 2100. Nonetheless it is useful to reflect on the lessons of the past 30 years. So, what has happened since *LTG* appeared as a slim paperback from an unknown publisher in Washington, DC, in March 1972?

At first the voices of most economists, along with many industrialists, politicians, and Third World advocates were raised in outrage at the idea of growth limits. But eventually events demonstrated that the concept of global ecological constraints is not absurd. There truly are limits to physical growth, and they have an enormous influence on the success of policies we choose to pursue our goals. And history does suggest that society has limited capacity for responding to those limits with wise, farsighted, and altruistic measures that disadvantage important players in the short term.

Resource and emission constraints have created many crises since 1972, exciting the media, attracting public attention, and arousing politicians. The decline in oil production within important nations, the thinning of stratospheric ozone, the mounting global temperature, the widespread persistence of hunger, the escalating debate over the location of disposal sites for toxic wastes, falling groundwater levels, disappearing species, and receding forests are just a few of the problems that have engendered major studies, international meetings, and global agreements. All of them illustrate and are consistent with our basic conclusion—that physical growth constraints are an important aspect of the global policy arena in the twenty-first century.

For those who respect numbers, we can report that the highly aggregated scenarios of World3 still appear, after 30 years, to be surprisingly accurate. The world in the year 2000 had the same number of people (about 6 billion—up from 3.9 billion in 1972) that we projected in the 1972 standard run of World3.⁸ Furthermore, that scenario showed a growth in global food production (from 1.8 billion tons of grain equivalent per year in 1972 to 3 billion in 2000) that matches history quite well.⁹ Does this correspondence with history prove that our model was true? No, of course not. But it does indicate that World3 was not totally absurd; its assumptions and our conclusions still warrant consideration today.

It is important to remember that one does not need to put World3 on a computer to understand its basic conclusions. Our most important statements about the likelihood of collapse do not come from blind faith in the curves generated by World3. They result simply from understanding the dynamic patterns of behavior that are produced by three obvious, persistent, and common features of the global system: erodable limits, incessant pursuit of growth, and delays in society's responses to approaching limits. Any system dominated by these features is prone to overshoot and collapse. The central assumptions of World3 consist of cause and effect mechanisms that produce limits, growth, and delays. Given that these mechanisms indisputably exist in the real world also, it should be no surprise that the world is evolving along a path that is consistent with the main features of the scenarios in *LTG*.

Why Another Book?

Why do we bother with publishing this updated version of *BTL*, if it is still making basically the same points as the two previous books? Our main goal is to restate our 1972 argument in a way that is more understandable and better supported by all the data and examples that have emerged during the past decades. In addition, we wish to give the many teachers who use our earlier texts updated materials for use with their students. *BTL* still gives useful views of the future, but it is a questionable practice for any teacher in the twenty-first century to assign a text with data tables ending in 1990.

And we have other reasons to write this text. We wish, once again, to

- stress that humanity is in overshoot and that the resulting damage and suffering can be greatly reduced through wise policy;
- offer data and analysis that contradict prevailing political pronouncements that humanity is on the correct path for its twenty-first century;
- inspire the world's citizens to think about the long-term consequences of their actions and choices—and muster their political support for actions that would reduce the damage from overshoot;
- bring the World3 computer model to the attention of a new generation of readers, students, and researchers;
- show what progress has been made since 1972 in understanding the long-term causes and consequences of growth.

Scenarios and Forecasting

We do *not* write this book in order to publish a forecast about what will actually happen in the twenty-first century. We are *not* predicting that a particular future will take place. We are simply presenting a range of alternative scenarios: literally, 10 different pictures of how the twenty-first century may evolve. We do this to encourage your learning, reflection, and personal choice.

We do not believe that available data and theories will ever permit accurate predictions of what will happen to the world over the coming century. But we do believe that current knowledge permits us to rule out a range of futures as unrealistic. Available facts already invalidate many people's implicit expectations of sustained growth in the future—they are just wishful thinking, attractive but erroneous, expedient but ineffective. Our analysis will be useful, if it forces citizens in the global society to reconsider and become more informed and respectful of the global physical limits that will play an important role in their future lives.

Books and the Transition to Sustainability

A book might seem like a weak tool in the struggle to attain sustainable development. But the history of our work gives a different view. Millions of copies of *LTG* and *BTL* were sold. The first book triggered a widespread debate, and the second one rekindled it. We did increase awareness and concern about environmental issues in the early days of the environmental movement. Many students who read *LTG* were led to adopt new career goals and to focus their studies on issues related to environment and sustainable development. That was all useful.

But our work fell short in many ways. The main ambition in *LTG* and *BTL* was to draw attention to the phenomenon of global ecological overshoot and to encourage society to question the pursuit of growth as a panacea for most problems. We did bring the phrase “limits to growth” into widespread use. The term, however, is often misunderstood, and it is typically used today in a very simplistic way. Most critics believe that our concerns about limits result from a belief that fossil fuels or some other resource will soon be exhausted. In fact our apprehension is more subtle; we worry that current policies will produce global overshoot and collapse through ineffective efforts to anticipate and cope with ecological limits. We believe that the human economy is exceeding important limits now and that this overshoot will intensify greatly over the coming decades. We failed in our earlier books to convey this concern in a lucid manner. We failed totally to get the concept of “overshoot” accepted as a legitimate concern for public debate.

It is useful to compare our results with those groups (largely comprised of economists) who have spent the past 30 years pushing the concept of free trade. Unlike us, they have been able to make their concept a household word. Unlike us, they have convinced numerous politicians to fight for free trade. But they, too, are faced with a widespread and fairly fundamental lack of conviction and fidelity that emerges whenever free trade policies also entail immediate personal or local costs, such as job losses. There are also many misconceptions about the total package of costs and benefits that result from adopting the goal of free trade. Ecological overshoot seems to us to be a much more important concept in the twenty-first century than free trade. But it is far behind in the fight for public attention and respect. This book is a new attempt to close that gap.

Overshoot and Collapse in Practice

Overshoot—and subsequent decline—in societal welfare will result when society does not prepare sufficiently well for the future. Welfare loss will occur, for example, when there is no ready replacement for dwindling reserves of oil, for scarcer wild fish, and for more expensive tropical woods, once these resources start to deplete. The problem is worse when the resource base is erodible and gets destroyed during overshoot. Then society might experience collapse.

One vivid example of global overshoot and collapse did actually take place around the turn of the millennium: the “dot.com bubble” in the global stock market. The bubble illustrates the dynamics of interest in this book, although in the world of finance and not in the world of physical resources. The erodible resource was investor confidence.

What happened, briefly, was that share prices rose spectacularly from 1992 to March 2000, to what was in retrospect a totally unsustainable peak. From this peak share values fell for a full three years before reaching a bottom in March 2003. Then prices gradually recovered (at least up to January 2004, when this is written).

Just as will be the case when humanity exceeds a resource or emission limit, there was little hardship associated with the long upturn in share prices. To the contrary, there was broad enthusiasm whenever share indices reached new heights. Most noteworthy, enthusiasm continued even after share prices had reached unsustainable territory—which in retrospect seems to have happened already in 1998. It was only long after the peak and some years into the collapse, that investors started to accept there had been a “bubble”—their word for overshoot. Once the collapse was well under way, no one could stop the fall. When it had lasted for three years, many doubted it would ever end. Investor confidence was completely eroded.

Sadly, we believe the world will experience overshoot and collapse in global resource use and emissions much the same was as the dot.com bubble—though on a much longer time scale. The growth phase will be welcomed and celebrated, even long after it has moved into unsustainable territory (this we know, because it has already happened). The collapse will arrive very suddenly, much to everyone’s surprise. And once it has lasted for some years, it will become increasingly obvious that the situation before the

collapse was totally unsustainable. After more years of decline, few will believe it will ever end. Few will believe that there once more will be abundant energy and sufficient wild fish. Hopefully they will be proved wrong.

Plans for the Future

Once the limits to growth were far in the future. Now they are widely in evidence. Once the concept of collapse was unthinkable. Now it has begun to enter into the public discourse—though still as a remote, hypothetical, and academic concept. We think it will take another decade before the consequences of overshoot are clearly observable and two decades before the fact of overshoot is generally acknowledged. The scenarios in this current volume show that the first decade of the twenty-first century will still be a period of growth—as did the scenarios in *LTG* 30 years ago. Our expectations for the 1970–2010 period therefore do not yet diverge much from those of our critics. We must all wait another decade for conclusive evidence about who has the better understanding.

We plan to update this report in 2012, on the fortieth anniversary of our first book. By then we expect there will be abundant data to test the reality of overshoot. We will be able to cite proof that we were right, or we will have to acknowledge data indicating that technology and the market have indeed boosted global limits far above the demands of human society. Population and economic declines will be imminent, or the world will be preparing for many more decades of growth. Until we can prepare that report, you will have to form your own opinion about causes and consequences of growth in the human ecological footprint. We hope you will find this compilation of information a useful basis for that effort.

January 2004

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LIMITS TO GROWTH