Chapter 7
First Steps by the UN and Club of Rome. The Computer Model That Rocked the World

The initial symptoms or precursors to the current Global Crisis first made themselves known at the beginning of the twentieth century. Some of the greatest minds of the age, such as Nikolai Berdyayev, Oswald Spengler, Jose Ortega y Gasset, Erich Fromm and others, repeatedly tried to attract attention to various aspects of the problem. But two cruel world wars that crushed the whole first half of the twentieth century beneath them, followed by the exhausting standoff between two social systems (the so-called Cold War), squeezed all seemingly less important issues from humanity's field of vision.

The economic boom that followed the Second World War and the accompanying arms race with its mindless expenditure of resources brought about a new, even more sharply escalating extirpation of nature which now included the former colonies, the "third world" countries. Furthermore, the postwar decades were marked by a series of atomic weapons tests in the atmosphere and the feverish development of the chemical industry, including the production of polymer materials and the introduction of chemical fertilizer and pesticides into agriculture. It should then come as no surprise that, from the early 1960s, the global public began to feel troubled by the issue of environmental pollution and the preservation of nature.

In 1961, the Economic and Social Council of the UN (ECOSOC) adopted the historic resolution number 810, which brought up the need to create a worldwide chain of nature reserves and specially protected areas. That year also marked another important event in the environmental sphere with the creation of the World Wildlife Fund (WWF). The fund began by financing environmental protection works in the Galapagos Islands, that unique natural landmark, and went on to make a major contribution to preserving many endangered species. Five years later, in 1966, the International Union for the Conservation of Nature (IUCN) released the first international Red List, containing an extensive catalogue of world flora and fauna species under threat of extinction. This formed the basis for systematized work in the field, and similar books containing lists of rare and disappearing species in various world regions were thereafter published in many countries.

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During the same years, another very important measure was considered and brought into being under the aegis of UNESCO, the International Biological Program (IBP). Its realization took 10 years, from 1964 to 1974, and made an enormous contribution to studying the structure and operating principles of various ecosystems. IBP participants organized numerous land and sea expeditions enabling the creation of a kind of inventory of preserved natural resources and an overall evaluation of the state of the Earth's biosphere. UNESCO's General Conference confirmed the first results of the research in 1970 with the adoption of the international Man and the Biosphere Programme. This program was invoked to bring the problem of biospheric sustainability under human pressure to the attention of the scientific community worldwide.

And these first serious steps toward clarifying the global ecological situation and the outlook for development connected to it did not limit themselves to the UN. No less a contribution to the understanding of this problem was made by the Club of Rome. An international nongovernmental organization uniting political leaders, businessmen and scientists from different countries of about a hundred members, their concern for the fate of the world would not allow them to throw up their hands at the symptoms of the unfolding crisis, but roused them to look for new development paths. Aurelio Peccei (1908–1984), Vice-President of Olivetti, took the initiative in the club's founding. The Club of Rome took its name from the Italian capital, where its founding members held their first meeting at Accademia dei Lincei.

Once it had recruited leading specialists in the area of system prognostication, the organization's main task was to research the crisis issues in all their complexity, incorporating all its aspects and related disciplines. The research projects that Peccei initiated were funded by a number of major companies and touched on various sides of the planet's crisis state. The international team of scientists who carried out the work then put it into the form of Reports to the Club of Rome.

At the time, futurology was more actively seeking to pose itself on exact mathematical methods. By no coincidence, the club recruited MIT Professor Jay Forrester, the first to use computer modeling in the study of complex tendencies of global development, including its demographic, agricultural, industrial and resource aspects as well as environmental pollution (the World1 and World2 Models). Forrester, however, handed off the new assignment to his pupil, 26-year-old assistant at MIT's System Dynamics Group, Dennis Meadows. The small team of young enthusiasts that he put together, including his wife, Donella Meadows, managed to calculate a number of scenarios for global development for the period from 1970 to 2100 on the basis of the improved World3 computer model.

According to model dynamics, at current rates of resource expenditure, industrial and population growth, human civilization, forced to direct more and more capital toward support for the environment, should hit critical barriers in its development sometime in the mid-twenty-first century, replete with economic and demographic collapse. In 1972, this work, signed by Donella and Dennis Meadows, Jorgen Randers and William Behrens, was presented and published as the First Report to the Club of Rome under the name *The Limits to Growth* (Meadows et al. 1974).

Of course, any computer model simplifies and schematizes reality to one extent or another, particularly when global processes serve as the object of the modeling. However, the impossibility of experimenting on the real object makes it an irreplaceable tool, allowing the researcher to play out different scenarios and watch to what result one or another set of parameters in the program leads. The Meadows team turned World3 into just such a tool. It was significantly deeper and more complicated than the few models then in existence used to evaluate the longer-term prospects for global development.

Included among the key parameters in the World3 model were Earth population, food production, volume of industrial production, reserves of unrenewable resources, level of environmental pollution and anthropogenic burden (humanity's ecological footprint) as well as a set of social parameters, among them goods and services per person and average life expectancy. And these were only the most important characteristics shown on the graph. There are actually many more.

By the standards of the early 1970s, World3 was equipped with a large number of cross-connections and feedback loops which allowed it to calculate their multifaceted influence on the researched processes. For example, when consequences begin to affect their own cause, as often happens in real life. Another unique aspect of the model was non-linear connections. There would be disproportionate increases of decreases in one of the parameters in response to the change in another, which take on particular meaning in finite situations when the limits come at you unexpectedly and unmanaged problems explode like a volcano. Such non-linear thinking and feedback loops combined with a systems approach to the research subject, looking at the environment, population and economy in their dynamic unity created the conditions for a life-like model. After all, these kinds of system effects, without exaggeration, penetrate our lives at every level.

Along with this, World3 knew neither war nor corruption, not crime or terrorism, and the people in this computerized world decided global problems without a thought of political advantage, ethnic intolerance or national egotism. Thus, reality here was presented in an admittedly simplified and idealized way. However, the authors guessed these simplifications, in principle, did not change the picture so far as the aim of the research was to uncover not quantified characteristics but tendencies, trends and system behaviors. How would it respond to one or another level of environmental pollution? How would the exhaustion of unrenewable resources pan out? What possibilities were there for population growth if you calculated the finite capacity of the biosphere, etc.

The model was used to run ten basic development scenarios. Each of them represented a particular type of global system behavior depending on conditions given at the outset. For example, if reserves of unrenewable resources turn out to be significantly greater than specialists believe (which is theoretically not out of the question at all), or if society decides to reorient the economy toward resource-saving technology and concentrates its investments in that area. All scenarios were characterized by corresponding numerical value inputs, which were entered into the model for a computer run. For each of the given scenarios, World3 calculated the governing parameters (over 200) and produced values for all variables for each half year

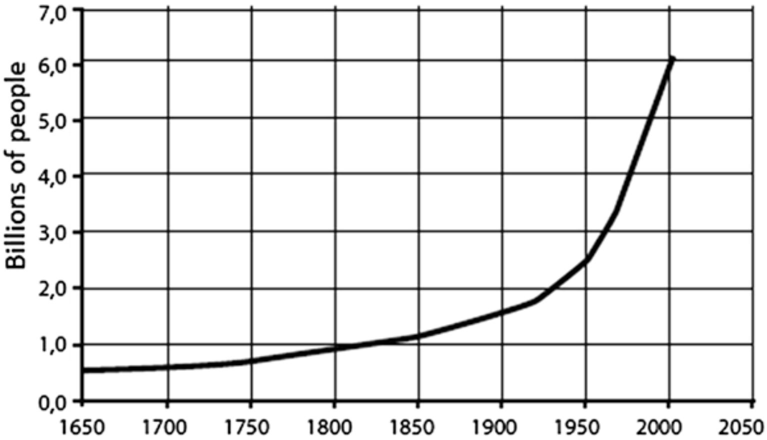

Fig. 7.1 World population from 1650. Source: UN

up to 2100. In total, for each of the scenarios, the model gave 80 thousand numerical values, which in the early 1970s was nearly the limit of computational abilities (Meadows et al. 2006).

Of course, all this would hardly shock a modern computer modelling specialist, but then, in the early 1970s, such experiments in mathematical models came as a novelty even to experienced professionals. And as we've said, the authors of *The Limits to Growth* had focused their attention primarily upon the main behavior particularities of the system relevant to the most diverse scenarios. The first of these, *exponential growth,* served as one of the chief causes of going beyond the limit. It differs from linear growth, associated with direct, uniform progression, in that the rate of growth increases simultaneously with that of each number, metric, volume, etc. As a result, at a certain moment, growth becomes explosive. The classic example is the reproduction of a yeast colony, whose cell numbers double every 10 min. Under ideal conditions, the colony would envelop the entire Earth in a relatively short period of time.

A no less illustrative example would be the colonization of Australia by a warren of rabbits, brought there by an English farmer for sport hunting in 1859. At first there was just a dozen. But on finding suitable conditions—an abundance of food, an absence of control species (predators and parasites)—the rabbits began furiously multiplying, and the population increased to 22 million in just 6 years. By 1930, the rabbits had settled the entire continent, and their numbers had reached 750 million! As a result, food supplies for flocks of sheep sharply declined, which seriously compromised the country's most important branch of agriculture. Sheep numbers were cut in half. Worse still, the rabbits were taking food from kangaroos and other herbivorous marsupials. They only managed to solve the problem in the early 1950s, when the uninvited occupants were deliberately infected with myxoma virus and their population fell by 90% (Mayr 1970).

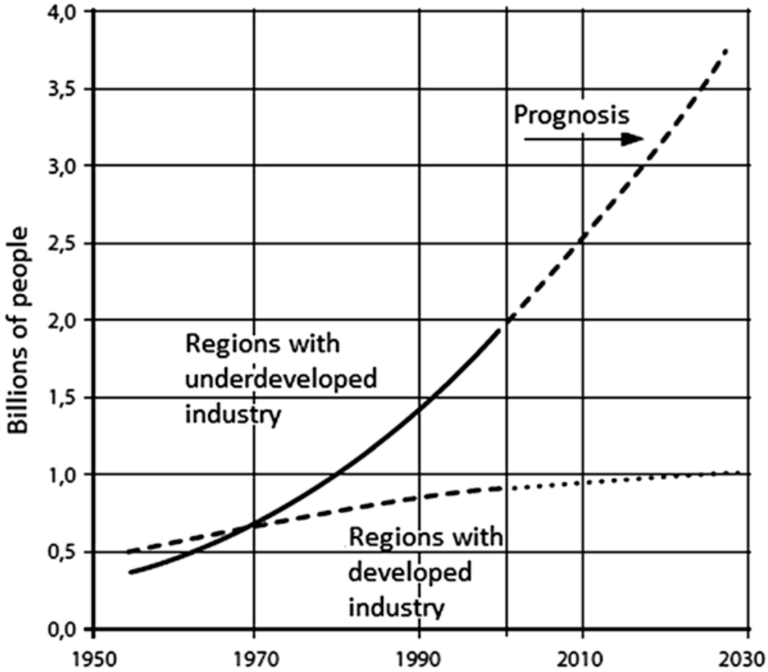

Fig. 7.2 World urban population (data from 2000). Source: UN

The growth of the human population on Earth has also been exponential for the last three and a half centuries (Fig. 7.1). In 1650, on the eve of the Industrial Revolution, there were about half a billion people, increasing yearly at a rate of 0.3%, corresponding to a doubling time of 240 years. By 1900, 1.6 billion people lived on Earth, the growth rate having increased to 0.7–0.8% a year, equivalent to a doubling time of 100 years. By 1965, the number of people on Earth already added up to 3.3 billion and growth rates had risen to 2% a year, so doubling time had decreased to 36 years. Truly, in 1999 those numbers, in total correspondence with projections, reached the six-billion mark. And while yearly growth rates started to decline in the 1980s, the increase in absolute numbers continues to this day.

Today the decisive contribution to this hyperbolic growth is made by economically backward countries. As you can see from the graph of population growth in cities in the second half of the twentieth century (Fig. 7.2), the average doubling time of urban populations in countries with underdeveloped economies is 19 years. One supposes that this trend will continue into the coming decades.

But not only populations of living beings—humans, yeast or rabbits—tend toward exponential growth. Industrial and financial capital also grows exponentially. Factories produce steel, cement, materials and equipment, machine tools and conveyor belts. A certain share of production is used to reinvest in this very capital, creating a base for future production growth. You could say we're dealing with the "birth rate" of capital, which results in the creation not only of new plant, but of new

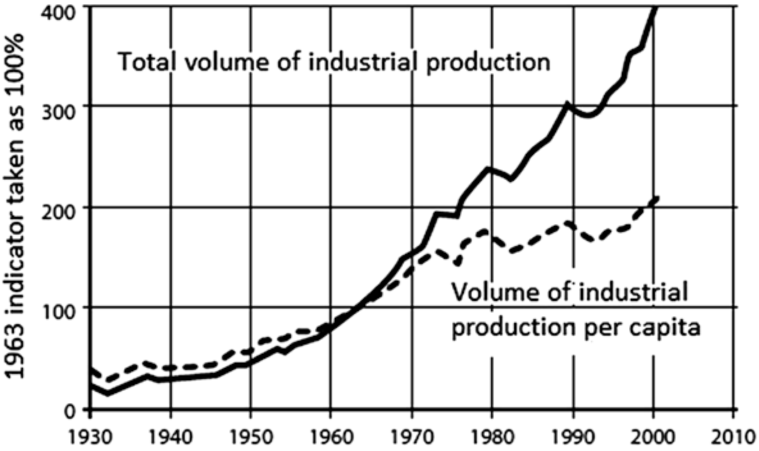

Fig. 7.3 Global industrial production. Annualized growth rates for the last quarter of the twentieth century were 2.9%, which corresponds to a 25-year doubling time. Production growth per capita was 1.3% a year, equivalent to a doubling time of 55 years. Source: UN

factories. Any commercial activity is also directed at taking in profit, which in turn will be invested in the expansion of the commercial activity and a new increase in profit (Fig. 7.3).

In cybernetics this type of phenomenon is called a positive feedback loop—when a change in some element in the system leads to a chain of results enabling still greater change in the input elements in the same direction. Increases lead to still greater increases, while decreases lead to ongoing decreases. Thus, for example, a rise in average surface temperature as the result of carbon dioxide emissions into the atmosphere speeds the melting of the permafrost zone. The melting tundra releases trapped methane, a strong greenhouse gas, which provokes further increases in the global temperature and so on. Which is to say that a process once launched will feed and stimulate itself.[1]

Of course, the realization of exponential growth requires the corresponding circumstances, and any number of factors can put a stop to it, from a lack of nutrient matter in the case of yeast to social shockwaves, war, hunger and epidemic when speaking of humans. But if one or another parameter is set to create a positive feedback loop, that means it is potentially subject to exponential growth. The input effects are strengthened by the system itself. This is the basic mechanism of the demographic explosion. Against the backdrop of a weakened stabilizing influence of negative feedback (decreasing mortality in developing countries), we as absolute

[1] In nature and technology the majority of regulatory processes are based on the principle of negative feedback, which supports the stability of the given system. In essence, any divergence of a system from equilibrium initiates such events that would slow the changing of its characteristics, increasing as the system goes further from its equilibrium state.

masters of fate have created a completely unlimited positive feedback loop, radically transforming the demographic situation on the planet.

In modern society, the main generators of exponential growth are population and industrial capital. Other factors—food production, resource use, pollution—also tend toward exponential growth, not because they reproduce themselves, but because they are stipulated by population and capital growth. Demographic and industrial growth bring ever greater quantities of energy and raw material into the economy as a secondary characteristic. The World3 Model expressed these structural peculiarities of the global system.

Another important peculiarity of large dynamic systems, including the global ecology and economy, is the *lag factor*. An ocean liner moving at the speed of 22 knots cannot suddenly change course once it sights an obstacle ahead. The more time it takes the ship to turn, the further its radar ought to see. The liner by the name of human civilization has incomparably greater force of inertia, and, therefore, the signals people receive of encroaching limits should not only be perceived in a timely manner, but properly interpreted.

In their book, *Limits to Growth: The 30-Year Update* (which we will discuss later), the Meadowses and Randers take a lesson from the "Ozone Story," a fairy tale with a happy ending. The story begins in 1974, with a publication by American chemists Frank Sherwood Rowland and Mario Molina (Nobel Laureates in Chemistry, 1995) warning that the release of chlorofluorocarbons (CFC) into the atmosphere threatened to destroy the Earth's Ozone Layer. These seemingly inoffensive chemicals were used in refrigerators, aerosol spray cans, pharmaceutical production and other things. Told in all its details, the story has all the makings of a pot-boiling novel, but for now, we turn our attention only to the lag point, particularly demonstrative when things concern the reaching of a critical limit. Here the discussion was of nothing more or less than the destruction of the ozone shield of the planet, which defends all living things from the harmful effects of harsh ultraviolet cosmic radiation.

From the above-mentioned first publication, e.g. the first proper human assessment of the distress signal, to the 1987 signing of the Montreal Protocol, which placed progressive restrictions on the wide-scale use of CFC, a whole 13 years went by. Then came nearly another 2 years until the protocol went into effect on January 1, 1989. Scientists spent a lot of energy convincing politicians and businessmen of the reality of the threat hanging over humanity. After all, there was big money at stake, and businesses would have to undergo great expense in order to find a suitable ozone-safe replacement for CFC and refit the factories that produced them. And while it would have seemed that scientists' conclusions had confirmed the broadening hole in the ozone above Antarctica, new, plausible-sounding explanations for the phenomenon were then thought up. Many companies, interest groups and entire countries took umbrage, declaring that they would defend their corporate and narrow national interests at any price. It required another 13 years to achieve total implementation of the Montreal Protocol to which, after numerous amendments and revisions, 157 governments agreed. After that, the ban on the production and use of substances harmful to the Ozone Layer took on force of law.

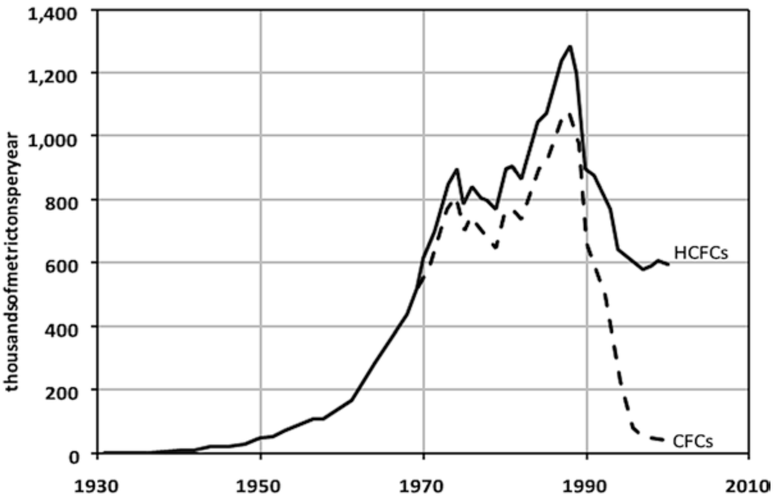

Fig. 7.4 Worldwide chlorofluorocarbon (CFC) production. Source: (Meadows et al. 2006: p. 183)

But the 26 years that passed after the harmful effects of CFC to the Ozone layer were found was just the initial lag stage, following the typical pattern of human activity according to the "discovery—implementation" Scheme. A second lag stage, already beyond the boundary of technology, arises from the reaction of nature to human action. This one is lengthier, since CFC molecules, distinguished by their persistency, leave the upper levels of the atmosphere very slowly. The thing is, it takes CFC molecules ten-twenty years to reach the Ozone Layer. At the same time, one CFC molecule can become a catalyst for several thousand reactions that destroy ozone molecules by turning them to common oxygen ($2O_3 \rightarrow 3O_2$) before it reacts with other substances (methane, for example), which can take many decades. Thus, for example, Freon-12, one of the most widely-used CFC's and whose production came to an end only in 2010, persists in the atmosphere for about one hundred years, and equipment full of it is still in service. So plenty of time will pass before ozone-destroying substances, once they have left junked refrigerators and cooling units, are carried up to the ozone layer and then begin producing their pernicious resource. To return concentrations of ozone to 1980 levels, we may have to wait until no earlier than the mid-twenty-first century.

After the Montreal Protocol went into effect, world-wide CFC production fell from one million metric tons (1.1 million standard tons) in 1988 to 100,000 (110,000) tons per year by 2000. However, ozone concentrations continued to fall and the ozone hole over Antarctica continued to expand until 1997, after which concentrations started to slowly increase. In 2007, in an amendment to the Montreal Protocol, parties adopted a decision to speed the phasing out of a group of the less harmful hydrochlorofluorocarbons (HCFCs). According to the agreed stipulations, all developed countries were obligated to reduce HCFC production and use by 90%

before 2015. (website for UNIDO/GEF-Nature Ministry of Russia http://www.ozoneprogram.ru/ozon_sloi/sohranenie_ozona/).

The trends in worldwide CFC production shown in the graph (Fig. 7.4) serve as a clear illustration of what we have said. The years from 1950 to 1974 are marked by sharp growth in CFC production, followed by a short-term fall as the result of "green" activism sounding the alarm concerning messages from scientists and the expanding ozone hole over the poles. However, the effect of social intervention, as you can see from the graph, was quite short-lived and quickly replaced by charging growth in CFC and HCFC production brought about by an expanded field of applications. Only in the late 1980s, after the Montreal Protocol went into force, did the irreversible decline in chlorofluorocarbon production begin. This was more distinct in the case of CFCs and not quite as expressed with HCFCs, which were still permitted for use in the early 2000s. The 2007 adoption of the amendment to wind down their production, however, allows us to hope for a complete end to its sale in the coming years (Meadows et al. 2006).

In this way, the lag factor is a fundamental quality of all complex systems such as the biosphere and civilization. Between the release of a pollutant into the environment and the moment when that begins to tell upon the health of a population, a certain amount of time will pass, sometimes a long one. Decades are required for the redistribution of investments compelled by food shortages and soil degradation. For people to transition to two or three children from the traditional large families as child mortality declines, one or two generations must pass. Even if a system reacts in time to the danger and distress signals it receives, it cannot change itself overnight.

Thus, in the population of countries undergoing a demographic boom, there is a very high share of young people. Therefore, however successful measures to control the birthrate may be, the population will still continue to grow for at least several decades—until the numerous youth born during demographic boom times passes its childbearing years. And while the quantity of children in the average family will contract, the overall number of families will increase. Such is demographic inertia, which will not allow us to stop population growth tomorrow or the day after. And if by some miracle we managed to reduce births to the bare replacement rate all at once, all the same, we would still have to wait several decades for the Earth's population to stabilize.

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The Limits to Growth, coming out in the early 1970s, stirred an unheard of public response. The book was translated into 35 languages and immediately became a best seller. The vast majority of readers up to then had never given thought to any "limits," naively supposing that humanity was one thing, the Earth another, and that their scales were so incommensurate that no human activity was in a position to do harm.

And while the book stirred no little disagreement among specialists, it still planted the seed and, corresponding entirely with the Club of Rome's intentions, left a shocking imprint upon the mind, not only for the casual reader, either, but also for business people and captains of industry. Management Theorist Dzherman

Gvishiani noted, "Not least of all, the dark prophesies of *The Limits to Growth* forced industry to transition to materials-saving production, to develop new technologies, re-use resources, create new synthetic materials, start economization programs, etc (Gvishiani 2002).

To the authors themselves, however, the results came as no surprise. After all, despite isolated corrective measures, the overall tendency of global development remained the same. Looking back, they wrote, "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." But such was not the case, "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" (Meadows et al. 2006: xi, xv).

Two decades later, the same team of authors (with the exception of William Behrens) returned to the topic in the book *Beyond the Limits.* While their basic theoretical impulses remained the same, they added a note of pessimism not seen at the beginning of their careers. Such feelings were well founded. The ozone holes over the poles, global climate change, more frequent natural cataclysms, a growing freshwater shortage, wide-scale cutting-down of tropical forests, declining catches of fish at sea—all of these alarm bells and wake-up calls that up to then could still be ignored testified to the fact that humanity on many fronts had already gone beyond the limits of Earth's biological carrying capacity and was living on an area outside sustainability, e.g. beyond the limits to growth. This none-too-pleasant fact the authors put into the title of their second book.

But how irreversible is this exit beyond the limits of sustainability? Is it ever observed under natural circumstances, independent of humanity? Yes, on a local scale, it has even been observed everywhere. For example, meadow and grassland eco-systems evolve together with the herds of herbivores that graze on them. These, of course, do not worry about supporting an ecological balance, and they can strip the grassy cover bare. However, nature itself does show concern about it, and if the root system is unharmed, the remaining roots and lower stems receive more water and nourishment, causing the grass to grow again. The herd temporarily makes its way to other pastures. Thus, where the possibility of migration remains, the ecosystem is not destroyed but abides in a state of dynamic balance. And with the restoration of the extirpated plant cover, the herd can once again return to its deserted feeding grounds.

Something of this kind takes place in the sphere of human activity when its steps beyond the limits do not destroy the capabilities of the environment. Here are a few examples from the book, *Limits to Growth—The 30-Year Update.*

In the history of America's New England, there have been several instances when sawmills closed down en masse due to the exhaustion of timber supplies. The mills closed, and forestry lay in a dormant state for several decades. When the forests grew again, the buzz-saws went back to work—right up until the process of forest resource overexploitation led to the next local crisis. The coastal fisheries of Norway have gone through at least one cycle of marine resource exhaustion. The government bought up fishing trawlers and had them scrapped. Fish populations had to

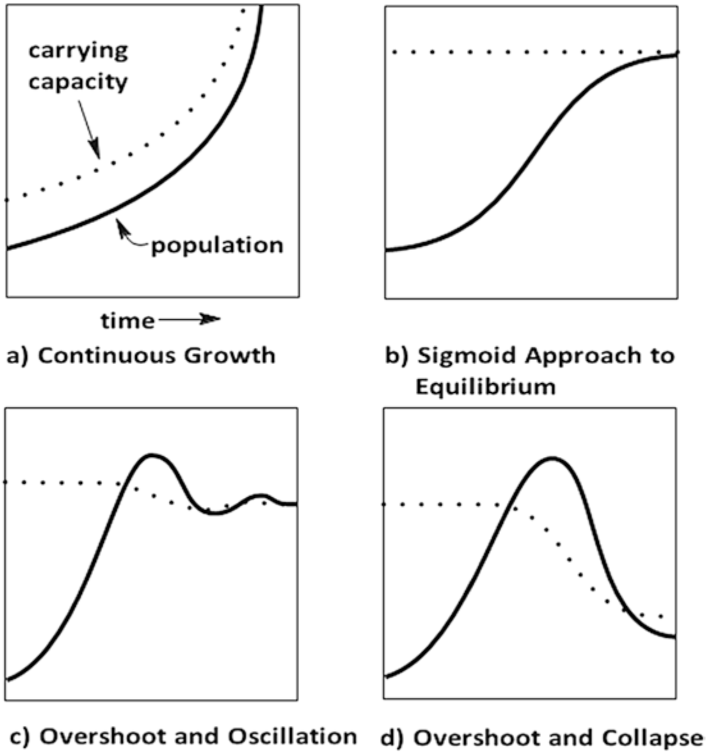

Fig. 7.5 Population growth and alternative paths of its interaction with Earth's potential carrying capacity. Source: (Meadows et al. 2006: p. 138)

recover enough to allow a return to the traditional trade (Meadows et al. 2006). The writers called this "overshoot and oscillation"—when the destruction of renewable resources is not irreversible and does not undermine the ability of life systems to restore themselves.

These examples, however, relate to instances of localized steps beyond the limits. How will human civilization as a whole behave, and what will come of exceeding the Earth's carrying capacity as the population grows? In Fig. 7.5 we have presented four graphs—the four hypothetical possibilities for the unfolding of events. The first graph (Alternative *a*) illustrates *uninterrupted (hyperbolic) growth* in the global population under circumstances when the limits are still far away, somehow do not exist or themselves grow exponentially, going off alongside the population line (which to a certain extent corresponds to the situation on Earth at the start of the previous century.)

Alternative *b*, an *S-shaped (sigmoid) curve*, illustrates growth in the population of living organisms under conditions of finite food resources and environmental resistance, when population growth slows as it approaches the limit before stopping at a state of dynamic balance. Applied to human civilization, such an alternative is possible if the system (the population and economy) consciously limits itself and reacts in a timely manner to signals of approaching limits. However, for the seven-billion-strong population of Earth, whose numbers are already beyond the limits of the Earth's potential carrying capacity, this opportunity has practically passed us by already. As Meadows and his co-authors note, "The simplest and most incontrovertible physical delays are already sufficient to eliminate smooth sigmoid as a likely behavior for the world economic system". Therefore, only the final two graphs remain relevant today—going beyond the limits with fluctuation or going beyond the limit with catastrophe.

Going beyond the limits with fluctuation ("overshoot and oscillation"). This possibility, by all appearances, is not yet lost to humanity so long as our sojourn beyond the limits remains reversible. Such was the case with the restoration of the ozone layer after CFC production was reduced. Such could it also happen with the greenhouse effect resulting from anthropogenic carbon dioxide emissions. Unfortunately, in the opinion of the Meadows team, it typically turns out differently: before taking action in the right direction, people first go beyond the limits, and only later, either on their own or facing pushback from nature, do they try to return to the zone of sustainability (Meadows et al. 2006). The kind of system behavior where going beyond the limits is not accompanied by irreversible changes to the planetary environment and can be stopped and turned back by corrective measures is shown in *Graph C.* At the same time, due to inertia and the lag in the system, the limits may be crossed repeatedly, taking on the character of waning fluctuation, as you can see.

And, finally, *going beyond the limits with catastrophe ("overshoot and collapse")*. One well-known principle of ecology is *population equilibrium*: Stability in the population of any species occurs as the result of dynamic equilibrium between its biotic potential and resistance from the environment (temperature extremes, limited food supplies, predators in the ecosystem, etc.). But, in the case of the human population, this feedback doesn't work. In creating an artificial habitat, people have provided themselves with relative independence from the planetary environment, which means that the prerequisites for totally unencumbered growth have also been provided, including a material base for the necessities of life. It's as though humans have separated themselves from the biosphere, and that has caused them to go beyond a string of limits. If anything from outside can stop it, that would be global ecological catastrophe, the likelihood of which also grows exponentially. So it should come as no surprise that most of World3's calculated scenarios ended somewhere before the end of the twenty-first century with a planet-wide crisis of renewable and unrenewable resource exhaustion, farmland erosion, shrinking food production and, consequently, a momentous collapse of the population.

In recent times, "green" internet pages have begun to fill with advice about how to minimize the harm each of us does to the environment. For example, there's "50 simple things that help save the planet": Brush your teeth with the water off, turn in used cans and bottles, buy reusable batteries instead of single-use, etc. But, as the Meadows team put it, "All these actions will help. And, of course, they are not enough…Recycling is important, but by itself will not bring about a revolution" (Meadows et al. 2006).

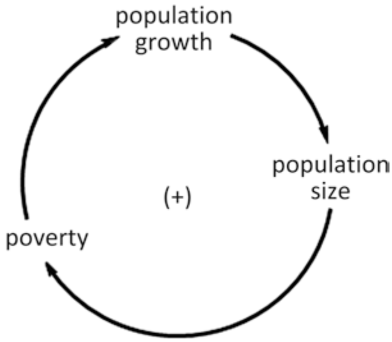

Fig. 7.6 Poverty and population. Source: (Meadows et al. 2006: p. 45)

So, what do we need to save the planet? Most of all, these are structural reforms which, in the opinion of the authors, could neutralize the very causes of this exit beyond the limits and exponential growth. For example, glaring social inequality in underdeveloped countries where, in the absence of stabilizing mechanisms to level the playing field for everyone, society's privileged classes acquire ever greater power and resources, ensuring the way is open to future riches. As a result, the rich get richer and the poor get poorer, hopelessly mired in a fen of poverty and despair which, as you know is inseparable from demographic growth.

This ends in a system trap as growth creates poverty and poverty creates growth, forcing society to remove wealth from the investment cycle for use on consumption. In short, it is eaten up. In this way, the two factors join together in a positive feedback loop, strengthening each other as illustrated in Fig. 7.6. And there is only one method to break this vicious cycle—a deliberate investment policy designed to provide access to education, health care, and family planning programs for the poorest strata of society, particularly for women. After all, in the absence of attractive alternatives to childbirth, when there is no opportunity to work or to learn, children become their lone and most important capital.

But, could you not say the same about the polarization of wealth and poverty in the world as a whole? It is easier for rich countries to save and increase their capital acquired over hundreds of years of economic development, and slow population growth enables them to invest greater means in economic expansion. Poor countries are forced to spend the lion's share of their resources on satisfying the urgent demands of a growing population, at the expense of economic and social development. Thus, only simultaneous restructuring of the consumption model in developed countries combined with the targeted use of freed-up funds in countries that badly need them would allow the untangling of the ball of problems connected to exponential population and capital growth and the fatefully growing burden on the environment.

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As we've already said, *The Limits to Growth* met with plenty of reproach among specialists, while supporters of its approach were in short supply. Criticism sounded louder than approval, but the unheard-of success among readers roused many scholars to work on improving the World3 Model as well as alternative programs. What failed to suit these detractors?

First of all, it's worth saying that among the dissatisfied were representatives of many fields of knowledge: economists, biologists, geologists, mathematicians, sociologists, political scientists, science theorists and even philosophers. And all of them, each on behalf of their discipline, chided the authors for oversimplification. The world was not as simple as the World3 Model, they said, and brought forth examples of global phenomena and processes without which World3 was incomplete and unrepresentative. The model did not properly express progress in science and technology, for example. Although it was well known that the introduction of new technology reduced resource usage rates, making them more efficient and reducing the negative effect of industry upon the environment on a per-unit basis.

Pointing to this shortcoming, the critics spoke of the necessity, without jumping to foregone conclusions, of depicting the influence of these advances on resource prices and reduced ecological consequences on a quantitative level. Naturally, this was a far from simple task, and most critics were aware of that, knowing that many scientific and technological expectations either never come true at all or arrive with great delay. Therefore, the character of scientific advancement's influence on global development, much like the hypotheses based upon it, are not distinguished by statistical certitude. In the 1960s and '70s, for example, few people doubted that by the beginning of the twenty-first century we would have developed controlled thermonuclear fusion. Today, you'd be hard pressed to find anyone willing to make a solid prediction on that account, and many doubt the practicability of its development: high water usage by controlled thermonuclear reactors could make them uncompetitive compared with renewable sources of energy. At the same time, nobody in 1970 could have guessed that in 30 years cell phones would conquer the world, or the arrival of the internet which has revolutionized our whole lives. It's worth recalling the panic that ensued in the 1950s concerning what then looked like the impending exhaustion of silver reserves widely used for black-and-white film. Once color film took over, the problem disappeared. Then on to digital technology. The list of such examples goes on and on.

Critics also made note of the self-evidence of the math conclusion in *The Limits to Growth* concerning the basic finiteness of a resource used by a growing system whose usage volume increases as it grows (as is the case under exponential population growth on Earth.) To many mathematicians themselves, Forrester's system dynamics model at the base of World3 appeared too elementary.

Another point of criticism for the first report to the Club of Rome was the concept of "zero growth" presented within. In a 2007 lecture, Dennis Meadows quoted a newspaper column of the time as saying that a non-growing economy was hard to imagine, and could lock poorer countries into poverty (Meadows 2007). President George H. W. Bush expressed it even more categorically: "Twenty years ago some spoke of limits to growth. But today we now know that growth is the engine of change. Growth is the friend of the environment." (Quoted from (Meadows et al. 2006)).

What do we see most in that turn of phrase? Populism of the worst kind, giving preference to short-term interests over that which is "hard to imagine," as it concerns not the present but future generations (in full correspondence with the famous formula “After us—the deluge?”) or the lack of desire to understand the seriousness of the threat hanging over humanity? On the other hand, one must always take into account the expansionist yearnings, native to the majority of people—to increase their possessions, their material wealth, their business, etc., —which are genuinely incompatible with the understandings “limits to growth” and “zero growth.” So it also is, by the way, with the strategy of life itself, which is based on a combination of expansion and sustainability. So we should clearly show no surprise at the opposition the Meadowses and their co-authors faced concerning zero or, what’s more, negative growth. But while, in the early 1970s, they had the power of novelty with which to drown out some of the opposition, later on, once the novelty had faded, human “nature” came back with a vengeance, returning to fight objective natural laws.

But we will not debate which is more correct: “growth is the engine of progress” or “progress is the engine of growth”. The matter is how to understand the words *growth* and *progress*. In the context of the Meadows team, growth is understood most of all in material terms, measured in physical mass and energy. That is, the growth for which limits are set. Unfortunately, for many critics of their concept, including the 41st US President, clearly no other growth presents any interest. At the same time, the human spiritual being as well demands cultural development, a deepening of scientific knowledge, improved social relations, philosophical and religious inquiry, among other things. And for growth of this kind, provided relatively insignificant material expense, obviously no limits can exist. Thus zero growth is in no way a stop to development, but primarily a stop to the negative or harmful influence on nature.

However, given the catastrophe threatening the biosphere, a different type of question is justified: Is it worth focusing on growth as the source of the problem? After all, it is not growth itself that presents the threat, but the accompanying deformation and destruction. Concentrating our attention on the latter, also inseparable from modern civilization, would be more precise. Within the bounds of this destruction, we convert the problem to a more constructive course, allowing us to use more concrete signposts, not only in ecology but in the socio-medical and humanitarian spheres. These, too, hold no shortfall of threat to human survival. This includes the undermining of population health in the species *Homo sapiens*, the increasing destructive power of social processes and much else, without which it is impossible to speak in any way of sustainable development. And beyond that, unlike limits to growth, the idea of limits to destruction harmonizes better with human nature, which is still wont to look upon the work of its hands, including the destructive consequences of its own activity.[2]

In 2004, the same team of authors (with the exception of William Behrens) again returned to the topic of limits and released another already mentioned version of their book entitled *Limits to Growth: The 30-Year Update* with a more fully developed thesis about the basic finiteness of Earth’s resource potential and a wider pan-

[2] For more on the concept of limits to destruction, see (Danilov-Danil’yan 2003).

orama of crisis phenomena in the modern world. A lot of time had passed since the first publication, which allowed not only for the integration of rich and accumulating information-science resources, but also for the comparison of global development's trajectory with the variations observed in 1972. Surprisingly, an exact correlation of indicators for real development was found with the inertia scenario from the early 1970s.

What does that tell us? Most of all, that humanity has not come to take the serious measures to ensure stability in global development. Even today, 40 years after the initial publication, worldwide assessments of the environment continue getting worse. The only hopeful sign on this horizon was the production of ozone-destroying substances and the increased concentration of ozone in the atmosphere. It was for this reason that the 1972 inertia scenario turned out so close to reality. Therefore, the nature of scientific and technological innovation also corresponded to inertial development, and the exceptions—renewable energy production and energy-saving methods—did not change the overall picture one bit, being entirely insufficient to right the ship of civilization. That, perhaps, is the main lesson that humanity can take from the retrospective evaluation of the first report to the Club of Rome. But, my-oh-my, we haven't taken it.

For the sake of fairness, it is worth recalling other, alternative models for global development designed after the pioneering research by the Meadows team (1974). In part, in the second report to the Club of Rome, *Mankind at the Turning Point*, Mihajlo Mesarovic and Eduard Pestel put forward the idea of "organic growth", according to which the various world regions coordinated harmoniously with one another would develop each in accordance with its own specifics while remaining in concert with the interests of the whole analogous to the development of a living organism (Pestel 1989). However, the modeling methodology of the second report turned out to be even more tenuous than the first. The accumulation of large volumes of information about the world's regions and the complication of the model did not lead to materially new results. More importantly, neither this nor any following report to the Club of Rome caused the type of resonance that *The Limits to Growth* brought about in the early '70s, like the striking of an alarm bell, like a warning to a humanity intoxicated with the success of civilization about where these successes would lead.

Today the World3 model and the books composed by its creators are studied at many of the world's universities. These works unquestionably influence active members of the older generation as well—politicians, business people, scientists—whose decisions in many ways determine the future of our planet. The authors, though, harbor no illusions on this account. After all, the discussion concerns restructuring the consciousness of entire nations, changing the systems of values, guide posts and stimuli for life that force people to spend natural resources more prodigally than money—indeed, changing the course of civilizational development as happened in the Neolithic and Industrial Revolutions. But while the Neolithic Revolution took more than one millennium, and the Industrial more than a century, Humanity is allowed a mere few decades to accomplish its Ecological Revolution.

"Time is in fact the ultimate limit in the World3 model—and, we believe, in the 'real world'," it says in the book *Limits to Growth: the 30-Year Update*, "Given enough time, we believe humanity possesses nearly limitless problem-solving abilities" (Meadows et al. 2006: p. 223). Experiments with the World3 model show, the longer the world puts off decisive measures to stabilize the environment, the smaller the window for transition to sustainable development. And what could have led to success yesterday, may not deliver results tomorrow.

In 2001 Donella Meadows, once the soul of that small team, passed away. And while she never got to see their final book in print, it was to her, first of all, that the authors owed the humanistic content of the work, including within its context a capacity so seemingly far from their professional sphere of understanding as a discipline capacity for foresight, responsibility, community and love, on which, perhaps, they rested their greatest hope. In the foreword to the final part of this trilogy on the occasion of *The Limits to Growth*'s thirtieth anniversary, Dennis Meadows and Jorgen Randers wrote that they had planned to write one more book, *Limits to Growth: the 40-Year Update*. But plans changed, and there will be no fourth book. As Dennis Meadows acknowledged, there is no point in once again describing a scenario for the future, seeing as by any reasonable allowance, it is a scenario of collapse…

As a final thought, we'd like to say a few words about one other scenario, not studied by the Meadows team but whose possibilities should not be forgotten, particularly in light of the impending ecological catastrophe. According to traditional literary genres, you might call it the classic dystopia. But the likelihood of this dystopian future grows with each passing year. This is the total control of human behavior which, it seems, would allow for the relatively easy resolution of most problems of overpopulation and degradation of the biosphere on Earth.

You could make a person totally controllable, for example, by inserting the corresponding microchip into their body, which in a few decades will be just as simple a procedure as a measles or smallpox vaccination. Such a controlee would acquire offspring for themselves only when considered appropriate by the system controlling them. The system would also relieve them of the charm of hyperconsumption: such desires would simply not arise. At the same time, the controlee would punctually observe all the rules of energy conservation, water economization, etc. and meekly dissolve into nothingness whenever the system required. Unlike technological regulation of the environment, such a program, in the not so distant future, will become not only feasible but not overly extravagant either, and it could be viewed as an entirely acceptable alternative to ecological catastrophe.

With regard to psychological zombification, such kinds of technology (just look at the boob-tube) could today already be considered sufficiently developed and, theoretically, capable of preparing the "human-of-the-masses" to accept this "development path." The problem here is not so much technological or economic, as much as moral and socio-political. Well, and in whose interests will such a mass- "controlling" come into being? It goes without saying: A method will be worked out, and those who wish to possess it for narrow corporate gains will always be found.

By the way, it would be completely delusional to think the described scenario could become humanity's salvation, if, of course, you consider the structure in which this even occurs "humanity." The thing is, not even from a moral standpoint, but from a theoretical one, such complexly organized and tightly synchronized systems do not last long, decaying and collapsing in the briefest periods (there will be more discussion of that in the following chapters). In the case of an artificially created super-totalitarian structure, the time of its existence could hardly go beyond a few decades. So, only a democratic social arrangement with deeply rooted democratic institutions and clearly expressed educational and cultural priorities is capable not merely of defending humanity from this looming threat, but giving us a chance to untangle the web of problems born of the global ecological crisis.

References

Danilov-Danil'yan, V. I. (2003). Sustainable development (a theoretical-methodological analysis). *Ekonomika I Matematicheskie Metody*, *39*(2), 123–135 (in Russian).

Gvishiani, D. M. (2002). The limits to growth—the first report to the clup of Rome. *Elektrony zhurnal Biosphera*, (2). Retrieved from http://www.ihst.ru/~biosphere/Mag_2/gvishiani.htm#_ednref3, (in Russian).

Mayr, E. (1970). *Populations, species, and evolution*. Cambridge: Belknap Press of Harvard University Press.

Meadows, D. (2007, Jan 16). Lecture given at the D.I. Mendeleyev Chemical and Technological University.

Meadows, D. H., Meadows, D. L., et al. (1974). *The limits to growth*. New York: Potomac.

Meadows, D., Randers, J., & Meadows, D. (2006). *The limits of growth: The 30 year update*. London: Earthscan. Retrieved from http://www.peakoilindia.org/wp-content/uploads/2013/10/Limits-to-Growth-updated.pdf

Pestel, E. (1989). *Beyond the limits to growth: a report to the Club of Rome*. New York: Universe Books.