Chapter 4
Who's Afraid of Thomas Malthus?

Jörg Friedrichs

4.1 Introduction

The main impediment to science integration in the study of resource management, not only between various social scientific disciplines but also between the social and the physical sciences more generally, is a refusal of social scientists to appreciate how deeply the societal sphere is embedded in wider biophysical and social-ecological systems. Recently, however, researchers working at the intersection between human and natural systems have come to acknowledge that society is inextricably embedded in, and constrained by, wider ecological systems including the earth system as a whole. This research program is commonly called the social-ecological, socio-metabolic, or earth-systems perspective (Berkes et al. 2003; Walker et al. 2004; Haberl et al. 2011; Bierman et al. 2012), and it undeniably holds significant promise for the study of resource management.

It is important to note, however, that integrating a social with a biophysical perspective is not new if we take the long view of the history of science. This is not a problem in and of itself, as science is always a kind of palimpsest. But since amnesia can also hamper the development of new ideas, it is worthwhile for those interested in a social-ecological systems perspective and other related research programs to scrutinize earlier traditions for potentially useful contributions.

Indeed, the linkages between natural resources and social change were studied long before the separation between physical and human sciences, and the subsequent specialization of social science into various academic disciplines. Take for example the *physiocrats* of the eighteenth century, who emphasized that all economic

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wealth is ultimately derived from a land base. In the present chapter, I focus on another early integrated framework, namely the tradition founded by the enlightenment polymath Thomas Malthus (1766–1834). Malthus was versed in an impressive array of areas, from theology to philosophy and from population analysis to the emerging field of political economy. He integrated all of these disparate fields of knowledge in order to study the interaction between population dynamics and food production, including the social consequences of that interaction.

Today, Malthus' determination to integrate whatever field of knowledge had something to contribute to the issues under study is a source of inspiration to all those who want to take a genuinely integrated look at resource management. As we will see, modified Malthusian theories constitute a uniquely promising bid for grounding the study of resource management on science integration, not only between various social scientific disciplines but also between the social and the lages between population dynamics, food production, and social change, modified Malthusian theories go beyond his original framework. The most sophisticated models are equipped to consider *any* kind of resource constraint and incorporate *any* challenge to the ecosphere, from biodiversity loss to climate change.

Despite the considerable potential of modified Malthusian theories, most social scientists have a hard time accepting that social change can be anything but endogenous. Physical scientists are more open to Malthusian hypotheses, but their social theorizing often lacks sophistication and is therefore duly criticized.

To overcome this unproductive state of affairs, I start from the classical Malthusian framework and gradually add complexity to it. After an introduction and discussion of classical Malthusianism I show how, despite the failing of Malthusian predictions, its logical structure is reproduced by simple neo-Malthusian theories that have been developed to account for contemporary global challenges. Subsequently, I show the potential of more sophisticated neo-Malthusian models and theories, from the iconic *Limits to Growth* study in the 1970s to the eco-scarcity theory of the 1990s and from climate-based eco-scarcity to Tainter's theory of diminishing returns on civilizational complexity. I conclude by pondering the prospects of modified Malthusian theories contributing to better science integration.

4.2 Classical Malthusianism

The original theory of Thomas Malthus is neatly summarized by an oft-quoted statement from the *Essay on the Principle of Population*: "Population, when unchecked, increases in a geometrical ratio. Subsistence increases only in an arithmetical ratio" (1798, 14). Population is assumed to grow exponentially, but the growth of a society's means of subsistence is assumed to be only linear. If this is so, exponential growth of population unavoidably outpaces the linear increase of subsistence. Alas, population levels are constrained by food supply as people need enough food. Tragically, food intake per capita shrinks as population grows faster

than subsistence. Linear growth in food supply cannot make up for the skyrocketing needs of the exponentially growing population. At some point, population growth runs against the limit imposed by minimum food intake per capita.

In a society characterized by social inequality, the poorest of the poor will be the first to feel the looming food scarcity. As population levels rise and food per capita decreases, the food available to the poor will fall below the minimum intake that is necessary for their subsistence. Redistribution can keep the poor fed for a while, but this will not prevent more and more people from becoming destitute due to the inexorable fall of food per capita. In the end, the system is likely to be readjusted by brutal mechanisms such as famine, war, and pandemics.

Logically speaking, another solution would be to limit population growth to "arithmetical ratio" in line with the linear growth of food production. In practical terms, this would mean birth control. To Malthus, who was an Anglican country curate and a moralist, family planning and any kind of sex without the aim of reproduction came under the category of sinful behavior. He therefore advocated voluntary forms of "moral restraint", but at the same time believed that curtailing the reproductive instinct of the masses was simply not realistic.

During his lifetime, Malthus modified his theory several times: first in the two-volume version of the *Essay* (1803) and then in various further editions (Winch 1987). These modifications need not detain us here, as they left the basic theory in place. Nor is there any need to dwell on the finer points of the theory or its policy implications, which were important during the nineteenth-century debate about the poor laws. For our present purposes, we are only interested in the logical structure of the theory and its applicability to issues of resource management.

The enduring appeal of the theory is mostly due to its plausible assumptions and axiomatic elegance. It is indeed plausible to assume that population grows by an annual rate multiplied by current numbers—much like the stock on a bank account grows by the iterative application of an interest rate. The result of compound interest, or of children and children's children following the reproductive behavior of their forefathers, is exponential growth. Similarly, it appears plausible to assume linear growth for a population's means of subsistence because agricultural innovation and other improvements in food production tend to happen in an incremental fashion, suggesting linear progress rather than a self-reinforcing mechanism. This appears much more plausible than to assume that improvements in food production are like a compound interest rate applied over a stock.

There is an important element missing from the account, or rather implicit in it: namely the notion of *overshoot*. Overshoot means that a system can temporarily exceed its long-term limits. Malthus assumed that this was indeed possible. Otherwise, why did he assume that population levels would be readjusted through "vice and misery"—shorthand for famine, war, pandemics, and sinful behavior—rather than simply being limited by minimum food intake per capita? In fact, "vice and misery" are unavoidable only insofar as population can temporarily exceed subsistence. Plain commonsense has it that this can easily happen. Population levels may exceed agricultural yields during years of good harvest, but the famine bound to occur in a later year of bad harvest will then be even more catastrophic. Malthus

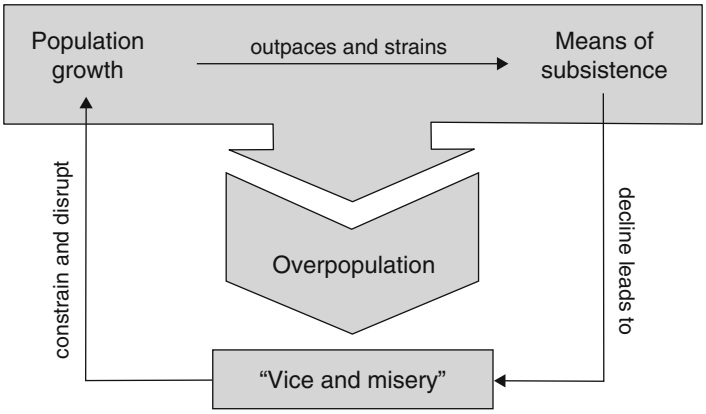

Fig. 4.1 Classical Malthusianism

assumed that such misery was likely to be accompanied by war and pandemics, as well as objectionable forms of non-reproductive sex, or "vice".

To illustrate the axiomatic elegance of the theory, consider Fig. 4.1.

4.2.1 The Logical Structure of Malthusianism

Malthusianism is more than simply a theory about the social interaction effects of population dynamics and food production. Logically speaking, it is the study of how different functions, which are all essential to social production and reproduction, enable and constrain each other. In abstract formal terms, this logical structure can be visually expressed by the following general scheme (Fig. 4.2).

At the heart of the model, there are two functions which are both vital to social production and reproduction. The first function (f_1) outpaces and strains the second one (f_2). For a while, this is obfuscated by the fact that time lags built into the system enable a temporary overshoot. In the long run, however, there is an inexorable mechanism by which the second function (f_2) constrains the first one (f_1). The way the mechanism operates is that the decline of f_2 leads to significant problems, which at the end of the day disrupt the unsustainable growth of f_1.

As we have seen, in classical Malthusianism population growth (f_1) outpaces and strains food supply (f_2) because the former function is exponential while the latter is only linear. Overshoot is possible for a while, for example due to a series of good harvests. In the long run, however, food supply (f_2) inexorably constrains population growth (f_1) because caloric intake per capita cannot fall below subsistence level. Famine and other calamities are then unavoidable. According to Malthus, "vice and misery" will ultimately bring population levels down.

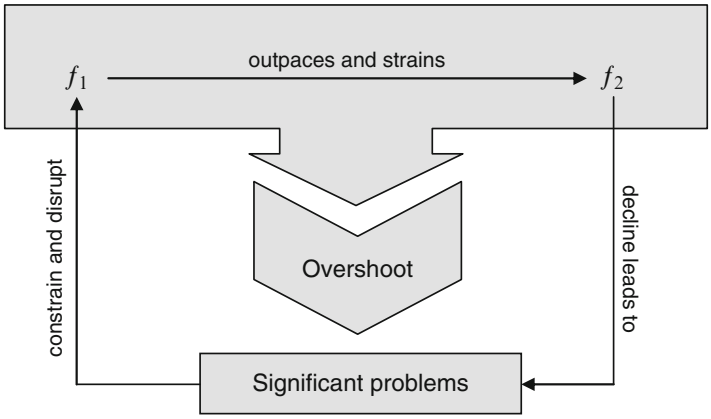

Fig. 4.2 The logical structure of Malthusianism

4.2.2 Why Malthus Was Wrong

The theory is axiomatically true if one assumes, with Malthus, that the growth of food production is at best linear while population growth is inherently exponential. Or, more mildly, if one assumes that population growth outpaces but is ultimately constrained by the means of subsistence. Quite obviously, this is not how modern history has unfolded. So far, overpopulation has neither led to mass starvation nor to planetary pandemics or other forms of catastrophic rebalancing.

With hindsight, there are four reasons why Malthus has not been vindicated. First, his assumption of exponential population growth was largely correct at the time but is less so today. As a result of the so-called demographic transition, world population is moving away from familiar patterns of exponential growth. It is still projected to grow by another two billion people, from around seven billion in 2011 to about nine billion in 2050. But, at the same time, population growth has started to level off in most parts of the world (Lutz and Samir 2010; UN 2011).

Second, growth in food production has been far more than linear. Since the nineteenth century, industrial inputs such as chemical fertilizer and motorized machinery have dramatically intensified agricultural productivity. Thanks to an abundant supply of such inputs, food production has been largely able to keep pace with population growth. For the last couple of centuries, agricultural innovation has eluded Malthusian predictions over and over again (Trewavas 2002).

Third, globalization has enabled an unprecedented growth of both world population and food production. In line with circumstances in the early modern period, Malthus saw population levels as constrained by food production at the local level. Over the last two centuries, however, mobility and trade have shifted the territorial frame of reference first from the local to the national level, then to

the international, and finally to the global level. To begin with, Europeans were able to move to "underpopulated" landmasses such as America and Siberia and to import raw materials and foodstuffs from the colonies. Subsequently the globalization of trade, and more recently of aid, has had similar effects, although in the reverse direction, buttressing indigenous population levels in developing countries.

Fourth, vulgar forms of Malthusianism tend to assume that any given resource base can sustain only a fixed number of individuals of some species, commonly called *carrying capacity*. For example, wild deer can for some time overgraze the available herbs on an island, but their population level will inevitably be adjusted downward to carrying capacity after a period of overshoot. While this notion of carrying capacity is suitable for simple cases of population biology, for example algal growth constrained by the surface of a lake, it is far too static for the study of more complex constellations.[1] When applied to human populations, carrying capacity can only be understood as a dynamic cultural concept, depending *inter alia* on technological innovation and social choice (Cohen 1995; Seidl and Tisdell 1999). The carrying capacity for irrigation agriculture is higher than for rain-fed agriculture, and the carrying capacity for a population of vegans riding on bicycles is higher than for a population of meat lovers driving about in SUVs.

4.2.3 Why Malthus May Still Turn Out to Be Right

Today, industrial civilization is buttressing a globalized system that injects trade and aid to some of the most vulnerable parts of the world, which would otherwise suffer serious problems of overpopulation. In our globalized world, even the poorest countries are embedded in industrial civilization, both by virtue of transnational interdependence and through governmental links such as development aid and military intervention. This does not always apply to the extent desirable from a humanitarian viewpoint, but in most places and most of the time Malthusian scenarios are successfully prevented by world industrial civilization.

Alas, this applies only as long as world industrial civilization is in a position to bail out places afflicted by overpopulation. In a way, the industrial era with its enormous energy inputs and technological inventiveness may have created a "fool's paradise" which temporarily abrogates the worst effects of overpopulation. Once industrial civilization enters a terminal decline, Malthusian fears may still be vindicated after all (for the "worst case", see Duncan 1993, 2001, 2005, 2007).

[1] Even in the case of wild deer, overshoot may lead to a lowering of overall carrying capacity due to various forms of ecological damage. For example, after a cycle of overgrazing an island may be able to sustain fewer deer than previously.

4.2.4 Science Integration

For our present purposes, classical Malthusianism is interesting not only as an intuitively plausible and axiomatically elegant theoretical model to study important phenomena, but also as a paradigm case of science integration. At its core, classical Malthusianism deals with a wide array of vexing ethical and empirical questions pertaining to multiple areas of knowledge, connecting the physical and human sciences and spanning various social scientific disciplines.

Let me simply list a selection of the questions broached and scientific disciplines involved. What are the empirical patterns driving population growth, and how do they operate at the level of individual reproductive choices (population biology, human demography)? How is subsistence affected by various regimes of technological innovation and social distribution, and how is it impacted by a population's level of affluence and food habits such as meat consumption versus vegetarianism (agronomy; food studies)? At what point must a specific territory be considered overpopulated, taking account of the fact that trade and aid can support very high levels of population density in urban areas and countries receiving an inflow of food and other means of subsistence (economics; development studies)? Which social and political mechanisms are triggered by overpopulation, and under what circumstances (comparative sociology; political science)? When is there a serious risk of population pressure leading to a pandemic (epidemiology)?

4.3 Simple Neo-Malthusian Theories

Simple neo-Malthusian theories apply the logical structure of classical Malthusianism to other important issues of resource management. Like classical Malthusianism, they have a certain commonsensical appeal due to their plausible assumptions and axiomatic elegance. Simple neo-Malthusian theories therefore often play a powerful role in the popular imagination, although more often than not without any direct reference to classical Malthusianism as the source of the tradition.

4.3.1 Environmental Neo-Malthusianism

Environmental neo-Malthusianism is a typical case in point. According to this school, environmental impact (f_1) such as land degradation and biodiversity loss outpaces and strains nature's ability to provide ecosystem services (f_2) such as biomass production and carbon sequestration. The reason is that environmental impact constantly increases, while ecosystem services are either stagnant or declining. After a period of overshoot, the decline of ecosystem services inexorably leads to

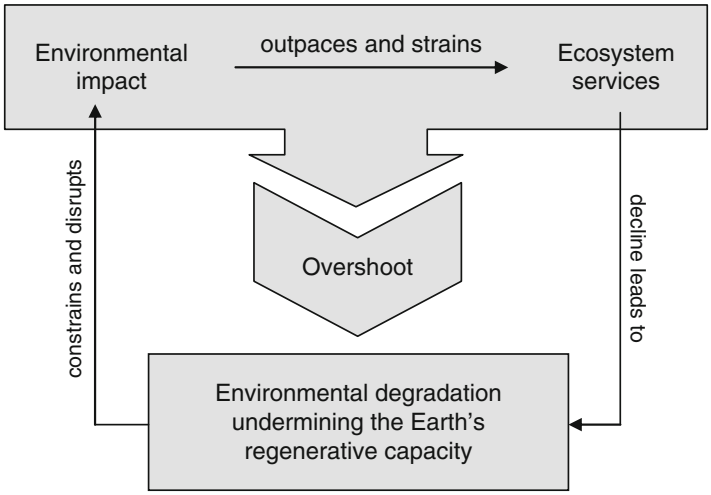

Fig. 4.3 Environmental neo-Malthusianism

environmental degradation, undermining the Earth's regenerative capacity. This must lead to catastrophic consequences, constraining humanity's ability to make further demands on ecosystems and ultimately rebalancing environmental impact with nature's ability to provide ecosystem services (Fig. 4.3).

Environmental neo-Malthusianism is neatly illustrated by ecological footprint analysis, as in the World Wildlife Fund's *Living Planet Report* (WWF 2012).[2] The report closely follows the neo-Malthusian template, with ecological footprint outpacing and straining biocapacity but ultimately constrained by it.

Ecological footprint (f_1) is a measure of environmental impact. It is understood as the land base that would be required to compensate for a given level of environmental impact, most notably greenhouse gas emissions. It is based on the so-called IPAT equation, which specifies environmental impact in terms of population, affluence, and technology (Ehrlich and Holdren 1971). The equation has seen many specifications over the years (Chertow 2000).[3] To cite just one prominent example, Ehrlich et al. (1999, 270) define environmental impact (I) as:

> a product of population size (P), per capita affluence (A) measured as per capita consumption, and the environmental impact of the technologies, cultural practices, and institutions through which that consumption is serviced (T), measured as damage per unit of consumption.

[2] Ecological footprint analysis goes back to Wackernagel and Rees (1996) and is also applied by the Global Footprint Network (Ewing et al. 2010).

[3] Most authors interpret IPAT as an equation [$I=P\times A\times T$] or even as an identity [$I = P \cdot \frac{GDP}{P} \cdot \frac{I}{GDP}$], although it is better understood as a complex function allowing for interaction effects between its variables [$I=F(P;A;T)$].

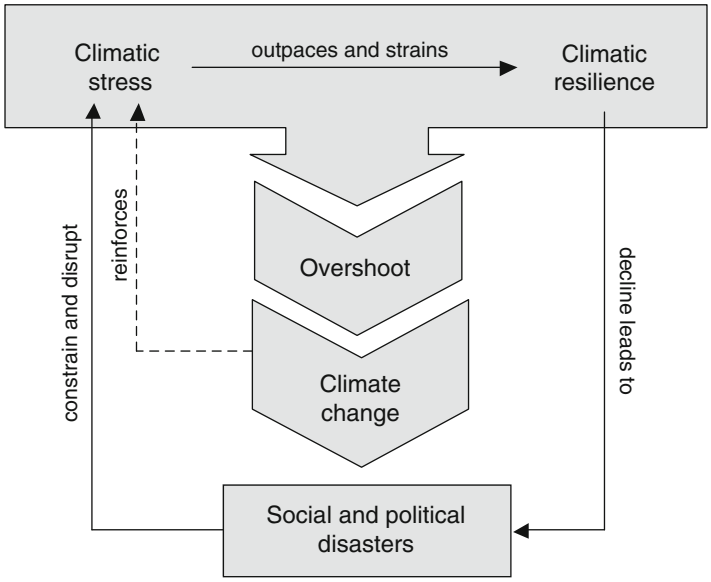

Fig. 4.4 Climate-based neo-Malthusianism

Biocapacity (f_2) is a measure of ecosystem services. It is defined as "[t]he capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans" (WWF 2012, 146).[4] Ecological footprint constrains biocapacity insofar as, after a period of overshoot, the overburdening of biocapacity by ecological footprint must lead to dismal consequences such as land degradation and climate change, which in turn must lead to significant social calamities: environmental migration, resource wars, pandemics, and so on. Short of a sustainability transformation, such calamities may be the only way for ecological footprint and biocapacity to return to a long-term global equilibrium.

4.3.2 Climate-Based Neo-Malthusianism

In climate-based neo-Malthusianism (Fig. 4.4), climatic stress (f_1) is understood in terms of atmospheric concentrations of greenhouse gases, most notably CO_2. Climatic resilience (f_2) is almost impossible to measure, but it is usually understood as the ability of the climate system to absorb stresses without exceeding an envelope of change deemed acceptable to human society, such as a maximum global warming

[4] Biocapacity is understood here as a specific ecosystem service, namely the bioproductivity of the earth. It is operationalized as the average bioproductivity of a "global hectare", multiplied by the surface of the earth in hectares.

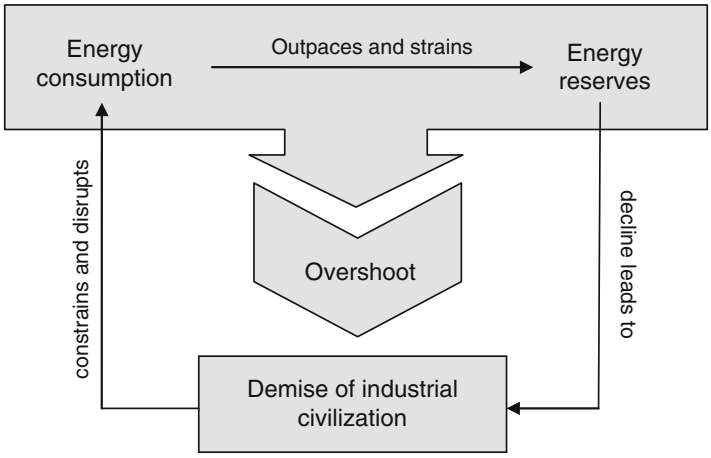

Fig. 4.5 Energy-based neo-Malthusianism

of 2 °C. To the extent that, at the global level, greenhouse gas emissions are an unavoidable collateral of economic growth (Peters et al. 2012), climatic stresses are destined to outpace climatic resilience. Despite considerable time lags in the climate system, climate-based neo-Malthusians warn that the erosion of climatic resilience is destined to operate as a constraint on tolerable levels of climatic stress. When unchecked, climate change is expected to lead to a variety of social and political disasters that may eventually force a concomitant reduction of climatic stress (Dyer 2010; Welzer 2011).[5]

4.3.3 Energy-Based Neo-Malthusianism

Energy-based neo-Malthusians (Fig. 4.5) emphasize, first, that energy consumption (f_1) is a fundamental precondition for economic growth. Second, they point out that energy consumption is constrained by the availability of energy reserves (f_2). They further claim that energy reserves are unavoidably depleted due to their finite nature. Therefore, energy consumption has an inherent tendency to outpace the ability to extract declining energy reserves, with the latter ultimately constraining the former. Insofar as economic growth and human subsistence are tightly linked with energy consumption, energy scarcity will ultimately reverse the growth trajectory and lead to the demise of industrial civilization. This in turn will lead to all sorts of social and political calamities while at the same time constraining future energy consumption (Hubbert 1993; Heinberg 2003; Kunstler 2005).

[5] As indicated by the dashed arrow, however, climate change itself may tragically reinforce climatic stress due to feedback mechanisms (Lenton et al. 2008).

4.3.4 *Critique of Simple Neo-Malthusianism*

Simple neo-Malthusian theories are problematic precisely because they are so simple. For example, it is only a half-truth that economic growth and CO_2 emissions, as well as economic growth and energy consumption, are inextricably linked, as technological innovation can weaken that link by reducing the carbon and energy intensity of GDP. Similarly, it is only a half-truth that energy production is inextricably linked to CO_2 emissions and resource depletion: this appears to be true in the case of non-renewable but not renewable sources of energy. Expanding the share of renewable energy such as solar and wind can weaken the link between economic growth, resource depletion, and climate change.

4.4 Complex Neo-Malthusian Theories

While simple Malthusian theories are limited to the examination of only a couple of functions and the way they outpace and constrain one another, more complex forms of neo-Malthusianism explore how a variety of different trajectories mutually enable and/or constrain each other. This is not to deny that Thomas Malthus has been so much discredited by his detractors that only few modified Malthusian theories openly claim a Malthusian lineage. Based on the logical structure of Malthusianism, however, it is easily possible to identify Malthusian theories even where their complexity goes beyond the original framework.

4.4.1 *Limits to Growth*

In 1972, a group of MIT researchers around Dennis Meadows applied a complex neo-Malthusian framework to the planetary level and used the emerging method of computer-driven system dynamics, developed by Jay Forrester, to examine the earth system as a whole. In their iconic study *The Limits to Growth* and its two sequels, they compellingly demonstrated that exponential growth on a finite planet is impossible in the long run (Meadows et al. 1972, 1992, 2004).[6]

Meadows and colleagues found that, for a while, the growth of various parameters such as world population, resource consumption, and environmental pollution may appear to defy physical limits, but only until the systemic feedbacks kick in. In the long run, as resource depletion and/or pollution exceed physical limits, an abrupt decline or indeed collapse of industrial society is the only way for the world system to return to equilibrium. The delay between temporary overshoot and ultimate collapse is due to the fact that there are various time lags between anthropogenic

[6] For a related warning, see Ehrlich and Ehrlich (2004); see also Bardi (2011).

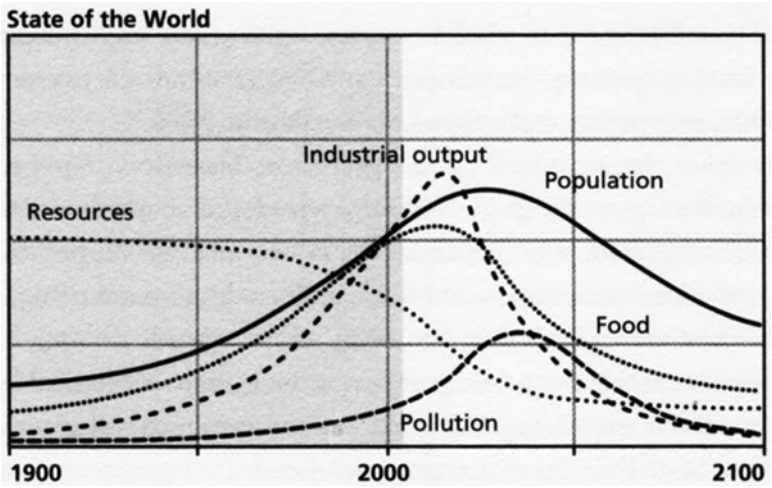

Fig. 4.6 World model standard run (Source: Meadows et al. (2004, 169). Despite some updating, Fig. 4.6 is remarkably similar to its precursor in Meadows et al. (1972, 124))

causes such as resource depletion and greenhouse gas emissions, and systemic outcomes such as energy scarcity and climate change.

The diagnosis of *The Limits to Growth* is a systemic pattern of exponential growth, overshoot, and collapse. Contrary to what their detractors sometimes surmise, Meadows and colleagues did not envision imminent doom. On the contrary, their baseline model, called "standard run", displays a continued pattern of exponential growth and overshoot until about 2010 or 2020, followed by the onset of systemic collapse between 2020 and 2050 (Fig. 4.6).[7]

The end result of the standard run scenario is a contraction of world population to the level of about 1960 by 2100.[8] Shockingly, this implies a dramatic decline by more than two billion people from current levels. However this decline would not happen by starvation alone, as it would occur over several generations and other demographic factors would also play a role: lower birth rates, pandemics, declining life expectancy driven by failing healthcare systems, and so on.

As the model suggests, it is perfectly possible for industrial civilization to "overshoot" and exceed planetary limits for a limited period of time. In the long run, however, no society, and much less the human race as a whole, can live beyond their means. No matter how recklessly we tap into the resources of the earth crust to sustain our unsustainable lifestyles, the improvement of our economic welfare and the increment on global carrying capacity are only temporary.

[7] The model is on track with historical data (Turner 2008; Hall and Day 2009).

[8] In the original version (1972, 124), the projected contraction of world population by 2010 was "only" to the level of about 1980.

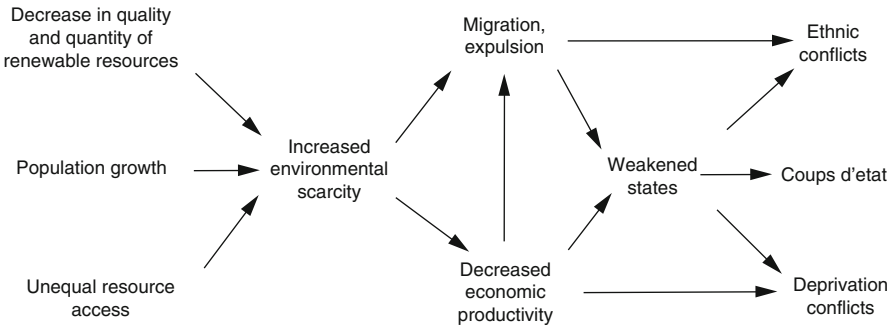

Fig. 4.7 Causal pathways from environmental scarcity to violent conflict

4.4.2 Eco-scarcity Theory

Another complex version of neo-Malthusianism is "eco-scarcity theory", whereby land degradation and other environmental strains combine with population pressure to unleash Malthusian scenarios of social conflict and political disorder.

Eco-scarcity began in the 1990s with conflict theorists suggesting complex causal links between environmental pressure, defined as scarcities of renewable resources, and the outbreak of violent conflict.[9] Their strategy was to collect case studies substantiating the claim that, particularly in overpopulated developing countries, environmental pressure can lead to the outbreak of violence. Two ample collections of case studies were produced roughly at the same time, one by a Canadian team (Homer-Dixon 1994, 1999) and the other by a team based in Switzerland (Bächler et al. 1996). Both of these teams focused on developing countries, and both had the aim of tracing the social processes leading from environmental scarcity, eventually combined with population pressure, to the outbreak of violent conflict. Thomas Homer-Dixon (1994, 31), the leader of the Canadian team, presented these "mechanisms" in a neat causal model (Fig. 4.7).[10]

According to the model, environmental scarcity is triggered by a combination of population growth and excessive strain on some dwindling renewable resource, typically exacerbated by unequal access to that resource. Together with the direct effects of the scarcity itself, the ensuing economic crisis engenders the forcible displacement of people and/or their voluntary emigration. The result is social segregation and a weakening of state structures, both in the country affected by the scarcity and in neighboring countries targeted by a massive inflow of migrants. In some cases this may lead to a coup d'état or even state collapse.

[9] For a recent survey, see Bernauer et al. (2012); see also Mildner et al. (2011).

[10] For a slightly modified version of the model, see Homer-Dixon (1999, 134); see also Kahl (2006, 59).

All of this increases the risk of conflict in two different ways. First, scarcity-driven migration may provoke violent clashes between the migrant population displaced by environmental pressure and the recipient population (ethnic conflicts). Second, the economic crisis in the area immediately affected by the scarcity, combined with a declining ability of the state to manage the crisis, can lead to an insurgency of citizens who feel deprived of the standard of living they either feel entitled to, or need in order to survive (deprivation conflicts).

4.4.3 Critique of Eco-scarcity Theory

Eco-scarcity theory is a logically sound extension of the original Malthusian framework which, at least sometimes and in some places, applied before the advent of industrial civilization (LeBlanc 2003); would apply in the absence of industrial civilization; and will again apply after its terminal demise. In the presence of industrial civilization, however, it is an easy target for empirical criticism. The reason for this is that, just as classical Malthusianism, eco-scarcity theory fails to account for the beneficial systemic effects of industrial civilization (see Sect. 4.2.2). Due to this failure, it is easy for critics to come up with countervailing case studies to "falsify" eco-scarcity theory (e.g. Peluso and Watts 2001).

For the same reason, eco-scarcity theory can also be undermined by the application of conventional statistical techniques. Here, the procedure is to collapse eco-scarcity models into bundles of causal factors, with violent conflict as the dependent variable and environmental pressure as the independent variable of interest. Factors intervening in eco-scarcity models, such as the strength of state institutions, are added to the list of independent variables as "controls". This reductive procedure makes it then possible to "test" via correlation analysis whether or not there is a connection between environmental pressure and violent conflict.

While early quantitative scholarship seemed to confirm the claim of a strong and significant causal relationship between environmental pressure and violent conflict, subsequent studies have undermined this belief.[11] Consider the fate of an early quantitative study that found a clear causal link between environmental pressures, such as land degradation and fresh water scarcity, and the risk of domestic armed conflict (Hauge and Ellingsen 1998). Ten years after its publication, the study was replicated by another scholar—and most of its findings turned out to be spurious (Theisen 2008). Overall, the balance of recent quantitative studies do not support the claim that environmental pressure has any statistically significant causal effect on violent conflict (Bernauer et al. 2012).

To be sure, the quantitative literature debunking eco-scarcity theory can itself be criticized. It is problematic to reduce complex social-ecological processes, with their multiple discontinuities and feedback mechanisms, to independent and dependent variables. Insofar as environmental strains and population pressure are remote

[11] See for example Urdal (2005); Binningsbø et al. (2007).

causes in complex social-ecological processes, it is unfair to place them alongside more proximate causes such as unequal distribution, ethnic hatred, or inadequate institutions. The danger of reductivism is occasionally recognized even by quantitative scholars: "Conventional statistical techniques run into problems when the relationships to be investigated are of a complex and interactive kind, which is exactly the case for eco-scarcity theory" (Theisen 2008, 814).

And yet, when measured against its own validity claims, eco-scarcity theory is in trouble. The absence of a strong and demonstrable statistical nexus linking environmental pressure with violent conflict questions the applicability of this complex neo-Malthusian school of thought to the analysis of conflict patterns.

That said, however, it is important to recall that the criticism applies only to the recent past. It does not alter the fact that eco-scarcity scenarios may yet be borne out in the near future if industrial civilization enters a terminal decline. Just as the neo-Malthusian proponents of eco-scarcity theory fail to acknowledge that we are still living in the industrial age, their critics fail to appreciate that the durability of industrial civilization cannot be taken for granted in a world entering various forms of geophysical turbulence. Climate change and energy scarcity, either to prevent catastrophic global warming or due to a terminal decline of global oil production, are dramatic game changers that may drive the world towards a post-industrial and post-global age where we may see precisely the complex neo-Malthusian scenarios that have so often been discarded (Friedrichs 2013).

4.4.4 Climate-Based Eco-scarcity

If eco-scarcity theory is a logical extension of classical Malthusianism, then climate-based eco-scarcity is in turn a logical extension of eco-scarcity theory. In essence, it explores the multiple ways by which climate change may lead to environmental scarcity and, thereby, affect the likelihood of violent conflict and other social problems through a variety of social mechanisms such as migration.

The academic debate about climate-based eco-scarcity is a kind of déjà vu in that it tracks the same trajectory as the previous debate about eco-scarcity theory. It started with some authors postulating a causal link between climate change and violent conflict. As is typical for eco-scarcity theory, environmental migration was considered as an important intervening factor (Barnett and Adger 2007; Reuveny 2007). The specific causal mechanisms under scrutiny are also similar to those previously considered by eco-scarcity theorists. Let us take as an example the model outlined in Fig. 4.8 (source: Buhaug et al. 2010, 82).

Like eco-scarcity more generally, climate-based eco-scarcity was countered by arguments based on the statistical analysis of recent events and highlighting the absence of a strong and significant causal link connecting climate change with violent conflict (Raleigh and Urdal 2007; Theisen et al. 2012). Also like in the case of eco-scarcity, even authors representing the variable-based approach sometimes acknowledge that statistical models based on recent historical events are unable to

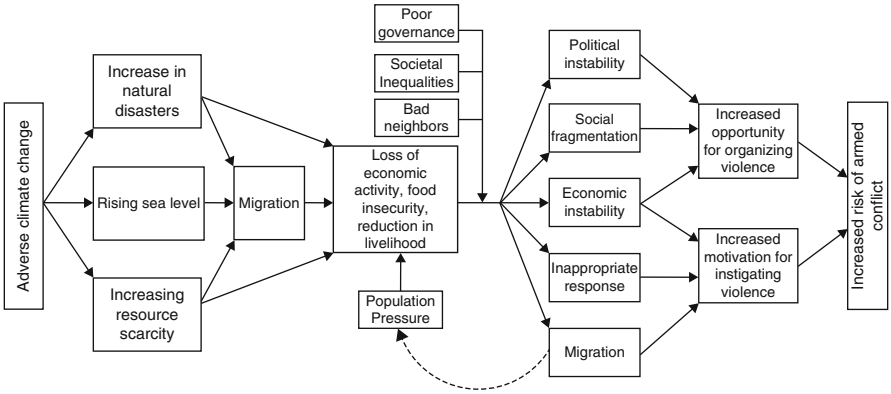

Fig. 4.8 Causal pathways from climate change to violent conflict

predict the conflict dynamics to be expected under abrupt climate change: "We are only beginning to experience the physical changes imposed by global warming […], so a lack of systematic association between the environment and armed conflict today need not imply that such a connection cannot materialize tomorrow" (Buhaug et al. 2010, 93–94).

In fact, climate change of a magnitude similar to what is currently underway has not happened for at least a couple of centuries. Therefore, the statistical analysis of recent events is not empirically adequate to understand the effects of future climate change. Instead, we need to hark back to earlier historical episodes when societies were actually confronted with comparable climatic stresses.

4.4.5 The Future in the Past

Climate-based eco-scarcity has been successfully applied in historical research. Most notably, Zhang and colleagues (2007, 2011) have looked at the period between 1500 and 1800 to understand the social and political effects of climate change. Based on time series from the Northern Hemisphere, especially from Europe but also from China, Zhang et al. (2011, 17298) have come up with a sophisticated causal model that is thoroughly grounded in empirical data (Fig. 4.9).

The model is neatly illustrated by Europe's "general crisis" of the seventeenth century. A drop in average temperature around 1560 was immediately followed by a reduction of bio-productivity, which negatively affected agricultural yields and thus food supply per capita. Over the next 30 years or so, this was followed by cascading escalations of social unrest, migration, famine, war, epidemics, and widespread malnutrition. From 1618, the crisis culminated in the Thirty Years War. Subsequent warfare, together with famines and epidemics, led to a considerable shrinkage of the European population (Zhang et al. 2011).

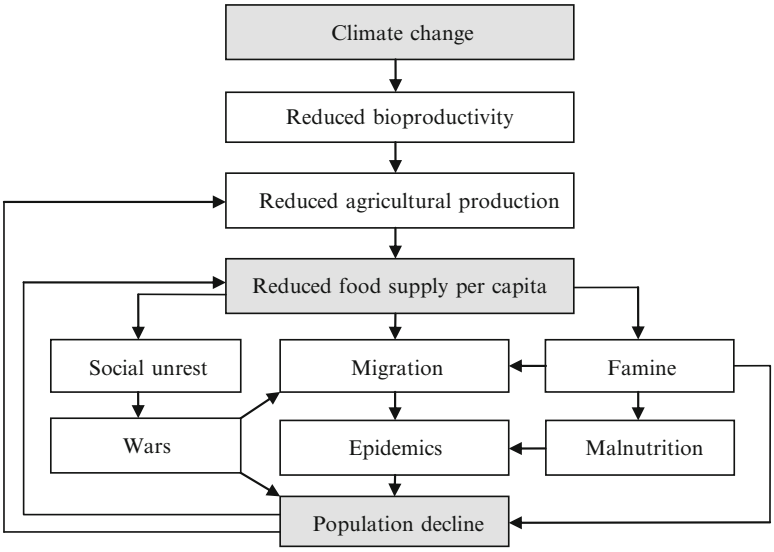

Fig. 4.9 Causal pathways from climate change to large-scale human crisis

When tested against data from the Northern Hemisphere more generally between 1200 and 1800, the expectations derived from the model are largely confirmed. The authors observe strikingly similar macro-patterns for regions as disparate as Europe and China, at a time when Europe and China were largely detached from one another both economically and politically. Zhang et al. (2007) suggest that this synchronicity can hardly be explained unless one assumes that similar social mechanisms were triggered by similar climatic stresses.[12]

4.4.6 Science Integration

While the insights of Zhang and colleagues are of a heuristic nature, the interdisciplinary nature of a research program such as that suggested by Fig. 4.9 is obvious. It takes climatologists, ecologists, and agricultural experts to trace the links between climate change, reduced bioproductivity, and agricultural shortfalls. The link between agricultural production and food supply per capita must be unpacked by social scientists sensitive to political inequality. One level further down, when it comes to the study of social unrest, migration, and famine, we are entering the

[12] While Zhang et al. have shown that social and political dislocations in the temperate regions of the Northern Hemisphere are mostly associated with climatic warming, others have demonstrated that the opposite holds for the tropics where warmer El Niño years have always been, and are still, associated with serious social and political trouble (Fagan 2009; Hsiang et al. 2011).

bailiwick of political scientists, economists, and sociologists. The study of war is the turf of international relations scholars, while epidemics and malnutrition are at the intersection of medical and social scientific disciplines. Demographers are competent to study the dynamic of population decline.

Systems scientists and people trained in advanced computer technology would be needed to further refine the operationalization of the model. Because the model is supposed to work across time and space, historians and area specialists would obviously have to actively contribute at every stage of the research cycle. Ironically, however, empirically oriented multidisciplinary papers such as those by Zhang et al. are hardly ever discussed by disciplinary social scientists.

Why do "hard" scientists such as Zhang et al. come up with deductive models, rather than social scientists developing them inductively? It is too comfortable and surely not helpful for social scientists to accuse those who develop complex models of "environmental determinism" while digging in behind disciplinary walls. Social scientists would not have to agree with every detail of such models, but they could make important contributions to improving and refining them.

4.4.7 Civilizational Neo-Malthusianism

Civilizational neo-Malthusianism is perhaps the most original modified Malthusian theory. It states that a civilization's problem solving capacity is depleted as social and technological complexity rises to unsustainable levels.

The classical statement is Joseph Tainter's theory of the emergence, survival, and collapse of complex societies (1988). According to this theory, the fate of societies depends on their ability to adapt to emerging challenges either by an upgrade or by a voluntary downgrade of their systemic complexity. In general, upgrades are obviously the preferred option. They are particularly rewarding at the early stages of civilizational development, when the marginal cost of higher complexity is still low. Later on, the growing marginal cost of complexification makes comparable upgrades gradually more expensive. The strategy of problem solving through complexification becomes entirely punitive at the final stages, when the return on investment in further complexity is negative. Tragically, however, the alternative option of voluntary simplification is hardly available because advanced civilizations are not "downward compatible". They are incapable of a planned reduction of their level of complexity because the existing complexity represents indispensable solutions to real problems. Consequently, involuntary collapse is often the only way for the fragments of the system to reach a new equilibrium.

The fundamental underlying point is that societies are always driven to respond to emerging problems (Wilkinson 1973). These problems can be either exogenous to the society in question, or they can be externalities produced by it. Either way, the logical answer is additional layers of complexity. Tragically, however, complexification has diminishing returns because the easy fixes are implemented first. Moreover, increasing complexity implies increasing costs for the maintenance of

Climatic stress	Dominant response	
10800–9500 BC Younger Dryas	More complexity	Agricultural revolution
3300–3000 BC	More complexity	Rise of urban culture
2500–1950 BC	Temporary increase in complexity, followed by systemic collapse	Northern Mesopotamia: rise and fall of the Akkadian empire Southern Mesopotamia: rise and fall of the Third Dynasty of Ur
1200–850 BC	Collapse	"Dark ages" all across the Old World

Fig. 4.10 The ancient Near East, 11000–1000 BC

that complexity (Homer-Dixon 2006). When the capacity for problem solving has been depleted due to the declining returns on complexification and the escalating cost for the maintenance of the existing level of complexity, only collapse remains because voluntary simplification is not a feasible option.

The framework has sometimes been applied to the rise and fall of civilizations in history. For example, archaeologists such as Weiss (2000) and Ur (2010) have explained the rise and fall of ancient civilizations in Mesopotamia by the initial ability of these civilizations to respond to climatic stresses with more complexity, followed by a later inability to avoid collapse in the face of otherwise similar stresses (Fig. 4.10, from Friedrichs 2013, 62).[13] The theory can be adapted for the diagnosis of current predicaments such as anthropogenic climate change, energy scarcity, or financial instability (Friedrichs 2013, Ch. 3; Korowicz 2010, 2012).

4.5 The Role of Social Science

While natural science is a main driver of unsustainable patterns of industrial development, it also acts as a catalyst for public awareness and political action to address the concomitant sustainability crisis (e.g. climate science). Social science, by contrast, more often than not plays a sedative role. For example, this is seen in energy studies where mainstream economists have largely defined away the problem of scarcity. Mainstream economists staunchly believe that the price mechanism invariably translates demand into supply. If a resource becomes more expensive, more of it

[13] See the interesting edited volumes by McIntosh et al. (2000) and Costanza et al. (2007). See also the work by climate historians (Lamb 1977; Fagan 2004, 2008, 2009), as well as Chew (2007, 2008) on the "recurring dark ages" and Greer (2009) on the "ecotechnic future".

will be produced—period. This axiomatic assumption is incompatible with the idea that there are physical limits to industrial growth.[14]

Even social scientific fields explicitly dedicated to environmental issues have a poor record when it comes to preparing the world for the possible demise of industrial civilization. For example, environmental sociology develops policy suggestions for mainstream environmental policy rather than addressing the fundamental unsustainability of industrial society. Similarly, the literature on ecological modernization and green growth pretends that industrial society can be made environmentally viable by technological innovation and incremental social and political reforms, while playing down the dreadful fact that the "treadmill of production" is going round and round while the planet is hopelessly in overshoot.[15]

Even worse, social scientists have been complicit in subverting the notion of sustainability. Originally, sustainability was about socio-political and socioeconomic regimes that are viable in the long run because they do not overstrain the environment. This is a vague regulative ideal that leaves many questions open, but it does imply that political and economic considerations ought to be subordinated to ecological concerns. But then the *Brundtland Report* introduced the notion of sustainable development, based on the optimistic assumption that sustainability and development go together rather than contradicting each other (World Commission on Environment and Development 1987). This has led some social scientists to claim that sustainability has three pillars: environmental, economic, and social (Littig and Grießler 2005).[16] The implication is that, insofar as any economic or social retrenchment is anathema to markets and citizens, suggestions for environmental sustainability that are not palatable to markets and societies must be seen as incompatible with the imperative of economic and social sustainability. This is exactly what the public and political decision makers like to hear, but as a result the original idea of environmental sustainability was turned on its head.

In principle, critical social scientists unsatisfied with the system-stabilizing role of mainstream social science can help us gain a better understanding of the current sustainability crisis and elucidate the moral dilemmas that make it so hard to address it. This does not automatically imply that the crisis can be overcome, but a better understanding of the predicament would be valuable in and of itself. Unfortunately, however, this is not how most critical social scientists are (re)acting. Instead, many have gone post-positivist. Rather than providing any guidance about the precise nature of the crisis and how it might be addressed, they develop sophisticated accounts of how industrial society engages in collective self-delusion (for a survey,

[14] Following pioneers such as Karl William Kapp, Nicholas Georgescu-Roegen and E. F. Schumacher, proponents of ecological economics such as Herman Daly, Kenneth Boulding, Robert Costanza, H.T. Odum, and David Pimentel have not been able to pose a significant challenge to mainstream economics. But note the important textbook by Ayres and Warr (2009).

[15] On ecological modernization, see Mol and Jänicke (2009); for a critical survey, see Warner (2010); on green growth, see Ekins (2000); on the treadmill of production, see Gould et al. (2004); see also Mol (2002).

[16] For an ambitious (and upbeat) attempt by a physicist-turned-development-economist to translate this into practice, see Munasinghe (2009).

see Blühdorn 2010). There is nothing fundamentally wrong with this, but it cannot replace a direct focus on the problems themselves.

4.6 Conclusion

Despite the considerable potential for science integration inherent in modified Malthusian theories, mainstream social scientists are generally reluctant to engage in, or even consider, such research programs. To put it in the words of the anthropologist Possehl: "We should stop thinking about the physical world and start looking at the fabric of society" (quoted in Lawler 2008).

Looking at the fabric of society is what social scientists have been doing all along, so what is the actual worry underlying Possehl's statement? Quite obviously, it is fear of transdisciplinary hybridization or bastardization. Indeed, integration with other disciplines may be less desirable to most social scientists than suggested by solemn calls for inter- or multi-disciplinary collaboration.

The main impediment is a refusal on the part of social scientists to accept that societal change can be anything but endogenous to the social sphere (for a critique, see Sørensen 2008). Mainstream social science follows an increasingly counterproductive division of labor whereby physical scientists study the physical world and social scientists study the social world—as if the two were separate and not interconnected. Natural scientists mirror this by a concentration on physical processes, although some are open to neo-Malthusian theories and models.

The self-encapsulation of the social sciences works reasonably well in times of resource abundance and material affluence. It is epitomized by economists reducing scarcity to a problem related to the allocation but not the physical availability of resources, and constructivists cordoning off their scholarship from the analysis of material factors and thus making social change endogenous to self-(re)producing patterns of human interaction. However, the separation between social and physical sciences rests on the cornucopian assumption that industrial society always expands and never contracts. Under conditions of abrupt climate change and looming energy scarcity, social scientists do themselves a disservice by dismissing "materialistic" theories as reactionary or deterministic.

Just like the intersubjective norms that are at the core of social constructivism, resources constrain and enable human action. Precisely for this reason, it is self-defeating for social scientific research to dismiss Malthusian hypotheses. Social scientists should seriously (re-)engage with modified Malthusian theories. As we have, seen some pioneering work has already been done at the fringes of social science, leading to remarkably sophisticated causal models belying knee-jerk allegations of "environmental determinism". Such research not only has the potential to better integrate the social and physical sciences, but it also provides a platform for better integration among social scientific disciplines. It is reasonable to assume that this would also make it easier to communicate the results to the public.

Despite the considerable promise of modified Malthusian theories, fundamental challenges remain. Most if not all existing Malthusian theories operate at the macro-level, whereas work on common-pool resources (Ostrom 1990) operates on a smaller scale. While work on common-pool resources can hardly be scaled up to the macro-level (Levin 2010), it is equally challenging to scale Malthusian theories down to the micro-level. Despite the best efforts made by the International Association for the Study of Society and Natural Resources, the greatest challenge remains to formulate convincing theories that work at an intermediate level, perhaps connecting Malthusian theories with work on common-pool resources.

Postscript

At a conference, one person from the audience objected that Malthusian theories were discredited because of repressive policies that had in the past been justified in their name. This is a serious objection. Nevertheless, the complex neo-Malthusian theories presented in this chapter are a far cry from the original theory formulated by Thomas Malthus. Moreover, shall we not ask the tough questions because we fear that we might not like some of the answers? Is it not better to intrepidly confront those questions, precisely in order to ensure the humane character of the policies and intellectual frameworks formulated in response to them?

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