

Solving the human predicament

PAUL R. EHRLICH* AND ANNE H. EHRLICH

Department of Biology, Stanford University, Stanford, CA 94305, USA

The authors offer an ecological frame of reference for political action to change the economic and social trends now deepening the human predicament: overpopulation and continuing population growth, overconsumption by rich societies, resource depletion, environmental degradation, and inequitable distribution of wealth within and between societies. Certain points often overlooked include: the demographic contribution to environmental deterioration; climate disruption, global toxification, and a decay of biodiversity and ecosystem services; and economic growth of the rich, which hurts everyone in the long term. Perpetual economic growth is biophysically impossible; the culture gap impedes solutions; and all the factors are intertwined. Potential solutions include: empowering women and providing family planning services to all sexually active people; reducing overconsumption and helping the poor; overhauling education systems, including universities; adapting to changes that are inevitable; and improving food production and distribution systems. Hope comes from growing worldwide grassroots movements.

Keywords: Overpopulation; Excess consumption; Environmental deterioration; Economic growth; Culture gap; Empowerment of women

Introduction

Civilisation has reached a scale at which it has begun to influence dramatically the crucially important planet-wide system that supports us: the biosphere. Human efforts have generated a population size and level of material consumption that are now significantly beyond what the planet can support indefinitely, even with at least 2 billion people condemned to destitution [1]. As the world population has passed 7 billion and basic human needs are denied to so many, it is folly to ignore the complex nexus of problems, including population growth, overconsumption by the rich, resource depletion, environmental degradation, and lack of equity in society, all of which have been clearly described by the scientific community over several decades [e.g. 2–7].

Rather than try to summarise the entire predicament, we first discuss aspects that remain generally unappreciated but must be understood if the predicament is to be resolved. Clearly, there is no single magic bullet that can save civilisation. We then propose a series of behavioural changes that in combination could lead to real solutions to the interconnected challenges that society faces today.

*Correspondence address: pre@stanford.edu

Points on the predicament

Population growth is a major contributor to environmental deterioration

For instance, climate disruption, one of the gravest threats we face, cannot be decoupled from population growth. Although it is almost never mentioned in the mass media, the flow of greenhouse gases into the atmosphere from driving cars, transporting goods, running agricultural systems, heating and lighting homes and businesses, and from deforestation increases as the number of people on this planet grows. Overall, population size multiplies with per capita consumption to produce a level of aggregate consumption whose environmental consequences are already unsupportable in the long term.

Population growth disproportionately increases degradation of human life-support systems

Human beings are smart and pick the 'low-hanging fruit' whenever possible. Therefore each person added to the population typically will end up eating food grown on more marginal land, drinking water transported farther or requiring more purification, using metals won from poorer ores, and so on. Those are examples of 'nonlinearities' (situations where input produces disproportionate results). They mean that it requires more energy to get the same amount of food, water, or metal as it did when there were fewer people; thus population growth causes disproportionate environmental deterioration. Population growth and globalisation are also degrading our epidemiological environment. The more people, and especially the more hungry (and thus immune-compromised) individuals there are, the greater the chances of a novel disease transferring from an animal reservoir, establishing itself in the human population, and causing a lethal pandemic [8].

A warming atmosphere and disrupted climate are not necessarily the most serious environmental threat

Dangerous as changing the climate is, other problems may prove more catastrophic, such as the loss of biodiversity, toxification of the planet, or the ecological effects of a nuclear war between, say, India and Pakistan [9]. Moreover, the effects of global toxification and a mass extinction event may prove impossible to reverse, even on a time scale of millennia. At least if climate disruption becomes intolerable, several semi-insane geo-engineering 'solutions' have been proposed that could be deployed. But no such proposals have been put forward to deal with potentially lethal synergisms – deadly interactions among tens of thousands of toxins and hormone mimics [10] – that now poison our planet from pole to pole.

Economic growth among the already rich hurts everyone

Even with a substantial portion of Earth's population living in poverty, more than one planet would be needed to sustain today's population indefinitely. Consequently, the more that consumption by the rich grows, the less there will ultimately be for others – and eventually for the rich themselves.

Perpetual growth as imagined by some economists is biophysically impossible

Simple mathematics shows that a 'long' history of exponential growth (which is actually only about 250 years of industrialising societies) does not imply that a long future of such

growth is possible [11]. Many economic works today, for example, Spence [12] seem to share the implicit belief that the physical economy can expand indefinitely. But, as distinguished economist Kenneth Boulding said in 1966, 'Anyone who believes that exponential growth can go on forever in a finite world is either a madman or an economist' [13].

The culture gap [14], the extreme compartmentalisation of education and knowledge that keeps most people from understanding the basics of how the world works, makes finding solutions extremely difficult

Few grasp how fundamental this problem is. Even well-educated people are in a poor position to make sound political decisions if they do not understand such things as the functioning of the climate system, the decay of biodiversity and ecosystem services, and those environmental nonlinearities associated with population growth.

Nonlinearities, including declining marginal returns to complexity, involved in resource extraction were dramatically underlined by the 2010 BP Deepwater Horizon blowout in the Gulf of Mexico. The first oil well in the United States, drilled in Pennsylvania in 1859, went only 69.5 feet below the ground surface. The Deepwater Horizon drilling began under almost a mile of water and had penetrated more than two miles below the sea floor when the explosion occurred. The difference between the simple Pennsylvania well and the technically complex one in the Gulf is just one sign of the declining marginal returns that Joseph Tainter [15] suggested is one of the main signals of social collapse. Such declining returns now increasingly typify humanity's resource situation [16], but that fact has yet to enter public discourse.

The discipline of economics is a poster child for the cultural gap. While some economists have done crucial work on dealing with environmental problems [17,18], many remain sadly ignorant about them. Consider a paper by economist David Lam [19] about the demographic driver of environmental destruction, entitled 'How the world survived the population bomb: Lessons from 50 years of extraordinary demographic history.' The title itself implies that the projected addition of 2.5 billion people in the next 40 years (equal to the entire population of Earth in 1950), with the inevitable nonlinearities greatly escalating their environmental impact, is not part of that 'bomb'. Unhappily, some economists think in terms of decades about the situation of an organism with billions of years of history behind it, some 200,000 of those years as *Homo sapiens*. The Lam paper did not explain that twice as many people are hungry today as in the 1960s when the 'Population Bomb' was written, that conservatively more than 300 million have starved or died of starvation-related disease since then, that today one child in four is too malnourished to grow properly [20], or that the short-term success of the Green Revolution may have been bought at the price of long-term disaster, which could now be unfolding. But the greatest oversight in such mainstream economics articles lies in ignoring the extreme seriousness of environmental problems and their dynamic connections with demography [21,22].

All of these factors are intertwined

The interactions among them are daunting [7]. Agricultural production must be increased some 70–100% by 2050 if humanity hopes to meet the demands of population growth, including the rising demand in emerging economies for meat-rich diets and increasing demand for biofuels, both of which will require a larger fossil fuel subsidy to agriculture and a takeover of more land for farming. Relatively rich nations such as China, Saudi

Arabia and South Africa are already purchasing large tracts of land in countries such as Ethiopia and Senegal in order to produce food for their people and portable fuels for their vehicles as the crunch hits [16]. The results will be more greenhouse gas emissions, more land degradation, and higher food prices, as well as the displacement of many thousands of African farmers and villagers.

The increased emissions will likely further alter precipitation and temperature patterns, threatening agricultural productivity worldwide. Increasing both yields and total food production will be made more difficult by the environmental effects of moving to more intensive and extensive agriculture, including accelerated losses of biodiversity, soil erosion, and depletion of vital aquifers, as well as further toxification of aquifers, surface freshwater, soils, and oceans, not to mention all living beings, including ourselves. The enhanced probability of famines is not the only likely consequence of the population explosion; others include the growing risks of epidemics, resource wars, terrorism, and deaths from violent climatic events.

Some solutions

Business as usual is an increasingly dangerous option for civilisation. If some form of collapse is to be avoided, determined action on many fronts will be required and must be mobilised with the same urgency that swept the United States at the start of World War II. What follows are some of the steps we think should be taken, starting with two important ones that target the principal drivers of environmental deterioration: overpopulation and overconsumption. Then we point out symptoms that need to be addressed and finally note the most important solution: changing the fundamentals of human behaviour and human institutions.

Empower women and promote and finance greater access to family planning and child health care

Women do not have equal rights, equal job opportunities, or equal rewards in *any* nation, although there are large differences between countries in the status of women. Correcting those inequities must be a top priority, both in the name of simple justice and because, in general, liberated women have fewer children and produce many other social benefits. Indeed, no society has successfully modernised without substantial participation by women. The size of the unmet demand for contraception is controversial [23], but it is likely that as many as 50 million unwanted pregnancies and tens of millions of abortions (many dangerous) could be avoided each year with an investment of just \$4 billion, well under the cost of one aircraft carrier. The investment would be amply repaid by lowering the costs, financial and human, of poor health and loss of life.

Moreover, families with fewer children can invest limited resources in education and health, producing future generations who are better able to understand the complexities of population, environment, and development. Making modern contraception and backup abortion available to all sexually active individuals and educating and empowering women and giving them equal rights are perhaps the most important elements in the solution of the human predicament. Combined, they alone might move humanity toward desperately needed shrinkage of the global population to a sustainable level. The human enterprise is already much too large to be safe for long, and it must be rescaled [24].

Reduce overconsumption by the rich and create greater access to resources for the poor to help them rapidly emerge from poverty

The super-consuming society must be brought to an end. But while solutions to overpopulation have been thoroughly examined by scholars, the issues of overconsumption have barely been discussed [25]. How to deal successfully, efficiently, and humanely with the necessary redistribution from rich to poor needs careful consideration, which has been lacking thus far.

Completely overhaul educational systems

We do not believe that large-scale redistribution will be easy, and neither will be a thorough revision of a key institution, the education system, from kindergarten up [26], which seems required, especially in the United States. In primary school, 'see Spot run' should be replaced with 'see the rose bush grow in the sun'. In elementary and middle school, such topics as how ecosystems and Earth's climate system function and how people interact with their environments, the difference between renewable and nonrenewable resources, the laws of thermodynamics, and clarifying how human power relationships influence resource allocation, should be introduced. These could go a long way toward encouraging the needed change in norms and discouraging overconsumption. In developing countries, establishing universal education would also work towards enhancing equity, especially for women and the poor, while reducing inherited advantage of all kinds.

The need to drag universities into the twenty-first century is manifest in their departmental structure, some of which originated with Aristotle [27, p. 111ff]. Here we return to the discipline of economics, since it deals with the allocation of scarce resources and perhaps is the most influential discipline in policy circles. Much of the human predicament has been generated by the organisation of the global economy, the resultant power relationships, and a black box called 'technological change' in economic growth models that can allow economists and politicians to ignore the laws of nature.

A good place to start would be to reconsider how the crucial topic of economics is taught. Lam said in his paper: 'I'm optimistic not because the problems posed by continued population growth are simple or because they will take care of themselves, but rather because the last 50 years have demonstrated our capacity to recognise the challenges and to tackle them with hard work and creativity' [19, p. 1259]. Ironically, part of today's dilemma is the failure of economists to comprehend and teach their students about the environmental challenges to the economic system, or to counter publicly the simplistic assumptions about 'free' (unregulated) markets that still infest the brains of pundits and politicians [28,29].

If all economists were exposed early on to ecological footprint analysis [30], their technological optimism might disappear. Perhaps faculty members (especially young professors in ecology, natural resources, and behavioural and experimental economics) could be reassigned to new units within restructured universities, say, associating a resource economist with fisheries biologists or a behavioural economist with philosophers. Through such cross-disciplinary associations, students outside of economics could gain a wider perspective [31], and economists could learn to apply their skills to important human problems.

Fixing the education system is necessary but not sufficient, however. In order to transform economic thinking rapidly, we must also expose adults to continuing ecological-economic education. One important step, for instance, would be to push through social

media for the adoption of 'green accounting', in which the flawed indicator of gross domestic product (GDP) – which equates progress with continual increases in production and consumption – is replaced by other metrics that reflect the state of natural, human, and social capital. Such measures could drive home understanding of the constraints imposed by our finite planet. There are encouraging efforts in this direction, such as the Natural Capital Project [32], but their educational impact must be expanded.

It is essential to reduce population size and levels of consumption by the rich

Dealing with these two prime drivers of environmental deterioration presents very different challenges. It is not possible to make significant changes in the population trajectory humanely (or sensibly), except on a time scale of decades. But we have the knowledge to accomplish it; what has been missing is sufficient political will and funding.

Deciding how to manage the vexed problems of overconsumption and redistribution, however, will be an unprecedented challenge. Still, societies have shown that they can change their patterns of consumption virtually overnight, given sufficient incentives [14], as was demonstrated by the mobilisations and demobilisations in the United States connected with World War II. A revised discipline of economics could be put to work on finding the most feasible, efficient, and equitable ways of radically changing consumption patterns within a few decades so that the poor could consume more, the rich would consume less, and aggregate consumption could be substantially reduced.

Treating the symptoms

Dealing with the drivers of the population-environment-equity dilemma will be critical to prevent escalating catastrophes in the midrange future, but we must also devise ways to adapt to the disasters that we can no longer prevent. Symptoms of global overshoot are already becoming obvious: a climate that is changing faster than expected, biodiversity disappearing at a rate unprecedented in human history, unusual changes in animal and human development, and an inability to feed everybody.

Much attention has been given to the tasks of rapidly reducing the flux of greenhouse gases into the atmosphere and adapting to the impacts that are already inevitable [33,34], but there has been too little action so far. The crucial effort to overhaul quickly the world's energy-mobilising infrastructure has scarcely begun, and has been hindered by unnecessary controversy. And necessary adaptations such as re-engineering the world's water-handling infrastructure for flexibility, so that water can be easily redirected to crops in a world of continually changing precipitation patterns, have barely been discussed.

Society also needs to strengthen the world's defences against epidemics. In addition to curbing the population driver and feeding malnourished people, much more attention should be given to measures for isolating the ill, developing new vaccines, inventing new antibiotics and rationalising their use to impede the development of resistant bacteria, stockpiling medical supplies, and planning to handle huge numbers of patients under emergency conditions.

The scale of what is needed is exemplified by humanity's most important activity: feeding itself. A recent analysis of food production and the environmental damage caused by agriculture [35] recommends halting the expansion of farmland in the tropics, compensating for this loss by increasing production on land that has already been cultivated, while reducing unsustainable uses of nutrients, water, and agricultural chemicals and shifting

diets away from excessive meat consumption and reducing waste. This is a monumental challenge, but the study points in a direction that, if taken, could go a long way toward solving the human food problem. Of course, following the political correctness that strangles sensible discussion of much of the global predicament, the report makes no mention of the need to end and reverse population growth humanely, yet this is a key driver of agricultural expansion. Similar comments could be made about a set of partial solutions to both human health problems and climate change risks through abating the emission of black carbon and ozone precursors into the troposphere [36], an area where real action is more likely.

Bottom-up reform of governance systems and institutions

In the United States, and to some extent other nations, governance is increasingly controlled by the rich and the corporations they own, abetted by global institutions such as the International Monetary Fund and the World Bank. The interests and resource needs of industrial nations govern policies at the international level, to the detriment of weaker societies. In the United States, where the infamous *Citizens United v. Federal Election Commission* decision in the US Supreme Court (2009) gave corporations the rights (but not the responsibilities) of flesh and blood citizens, the needed discussions, for example, about the degree to which a nation of more than 300 million people can be governed democratically are not occurring. Meanwhile, Brazil, Russia, India, and China, along with a few other countries, are racing to embrace unsustainable development and use newfound economic and military power to exploit the world's poor in a new brand of colonialism [37]. China and Saudi Arabia's land grabs in Africa are an outstanding example.

The main hope for diverting society from its headlong rush toward some form of global collapse may well rest with bottom-up pressure from civil society. There are already many efforts to move toward equity and sustainability. These include the Occupy movements, the Arab Spring, Extreme Citizen Science (www.ucl.ac.uk/excites), and numerous other organisations recruiting ordinary people to reform their societies and to gather and analyse scientific data relevant to our predicament. There are also major efforts to press society to deal with climate disruption (e.g. www.350.org). Independent filmmakers are pitching in (www.growthbusters.org; <http://callofflife.org>), and many new journals and educational websites (www.dailyclimate.org) are involved in the struggle. The multiplicity of groups working on solutions is heartening, but they are largely uncoordinated and powerful forces oppose them (<http://heartland.org>; <http://www.trueorigin.org>).

One new bottom-up organisation is attempting to coordinate civil society efforts, building on a union of scholars from the natural and social sciences and the arts and humanities to work with decision makers and the general public. The MAHB (Millennium Alliance for Humanity and the Biosphere; <http://mahb.stanford.edu>) is striving to implement the behavioural, institutional, and cultural changes necessary for human beings to ensure a sustainable and equitable future for all. It is especially focused on developing foresight intelligence in an effort to counter millions of years of genetic and cultural evolution in which there was little impetus for selection to favour long-term planning. Whether it will be successful is an open question, but we are convinced that a near total reorganisation and rescaling of industrial societies are required if we are to create a safer, sustainable, and more equitable world for our descendants.

Acknowledgments

We thank Ken Arrow, Lisa Daniel, Tim Daniel, Partha Dasgupta, Joan Diamond, Larry Goulder, Nadia Diamond-Smith, and Kirk Smith for very helpful comments on this article.

References

- [1] Global Footprint Network, 2012, World footprint. Available online at: http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/ (accessed 7 February 2012).
- [2] Brown, H., 1954, *The Challenge of Man's Future* (New York: Viking).
- [3] Ehrlich, P.R., Ehrlich, A.H. and Holdren, J.P., 1977, *Ecoscience: Population, Resources, Environment* (San Francisco, CA: W.H. Freeman and Co).
- [4] Union of Concerned Scientists, 1993, *World Scientists' Warning to Humanity* (Cambridge, MA: Union of Concerned Scientists).
- [5] National Academy of Sciences USA, 1993, A Joint Statement by Fifty-eight of the World's Scientific Academies. In *Population Summit of the World's Scientific Academies* (New Delhi, India: National Academy Press).
- [6] Millennium Ecosystem Assessment, 2005, *Ecosystems and Human Well-being: Synthesis* (Washington, DC: Island Press).
- [7] Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, III, F.S., Lambin, E., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., De Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J., 2009, Planetary boundaries: exploring the safe operating space for humanity. *Ecology and Society*, **14**(2): 32, available online at: <http://www.ecologyandsociety.org/vol14/iss2/art32/>.
- [8] Daily, G.C. and Ehrlich, P.R., 1996, Global change and human susceptibility to disease. *Annual Review of Energy and the Environment*, **21**, 125–144.
- [9] Toon, O. et al., 2007, Consequences of regional-scale nuclear conflicts. *Science*, **315**, 1224–1225.
- [10] Vandenberg, L.N., Colborn, T., Hayes, T.B., Heindel, J.J., Jacobs Jr. D.R., Lee, D.-H., Shioda, T., Soto, A.M., vom Saal, F.S., Welshons, W.V., Zoeller, R.T., Peterson, J. and Myers, J., 2012, Hormones and endocrine-disrupting chemicals: low-dose effects and nonmonotonic dose responses. *Endocrine Reviews*, **33**(3), doi: 10.1210/er.2011-1050.
- [11] Bartlett, A., 1993, The arithmetic of growth: methods of calculation. *Population and Environment: A Journal of Interdisciplinary Studies*, **14**(4), 359–387.
- [12] Spence, M., 2011, *The Next Convergence: The Future of Economic Growth in a Multispeed World* (New York: Farrar, Straus, and Giroux).
- [13] Boulding, K.E., 1966, The economics of the coming spaceship Earth. In: H. Jarrett (Ed.) *Environmental Quality in a Growing Economy* pp. 3–14. (Baltimore, MD: Johns Hopkins University Press).
- [14] Ehrlich, P.R. and Ehrlich, A.H., 2010, The culture gap and its needed closures. *International Journal of Environmental Studies*, **67**(4), 481–492.
- [15] Tainter, J.A., 1988, *The Collapse of Complex Societies* (Cambridge: Cambridge University Press).
- [16] Klare, M.T., 2012, *The Race for What's Left: The Global Scramble for the World's Last Resources* (New York: Metropolitan Books).
- [17] Arrow, K. et al., 1995, Economic growth, carrying capacity, and the environment. *Science*, **268**, 520–521.
- [18] Dasgupta, P., 2001, *Human Well-being and the Natural Environment* (Oxford: Oxford University Press).
- [19] Lam, D., 2011, How the world survived the population bomb: lessons from 50 years of extraordinary demographic history. *Demography*, **48**, 1231–1262.
- [20] Rawe, K., 2012, *A Life Free from Hunger: Tackling Child Malnutrition* (London: Save the Children UK).
- [21] Harte, J., 2007, Human population as a dynamic factor in environmental degradation. *Population and Environment*, **28**, 223–236.
- [22] Ehrlich, P.R., 2008, Key issues for attention from ecological economists. *Environment and Development Economics*, **13**, 1–20.
- [23] Casterline, J.B. and Sinding, S.W., 2000, Unmet need for contraception in developing countries and implications for population policy. *Population and Development Review*, **26**(4), 691–723.
- [24] Ehrlich, P.R., Kareiva, P. and Daily, G.C., in press, Securing natural capital and expanding equity to rescale civilisation. *Nature*.
- [25] Arrow, K. et al., 2004, Are we consuming too much? *Journal of Economic Perspectives*, **18**(3), 147–172.
- [26] Ehrlich, P.R., 2011, A personal view: environmental education – its content and delivery. *Journal of Environmental Studies and Sciences*, **1**, 6–13.
- [27] Ehrlich, P.R. and Ornstein, R.E., 2010, *Humanity on a Tightrope: Thoughts on Empathy, Family, and Big Changes for a Viable Future* (New York: Rowman & Littlefield).
- [28] Tversky, A. and Kahneman, D., 1981, The framing of decisions and the psychology of choice. *Science*, **211**, 453–458.
- [29] Galbraith, J.K., 2008, *The Predator State: How Conservatives Abandoned the Free Market and Why Liberals Should Too* (New York: Free Press).
- [30] Rees, W.E., 2001, Ecological footprint, Concept of. In: S.A. Levin (Ed.) *Encyclopedia of Biodiversity*, Volume 2 (San Diego, CA: Academic Press), pp. 229–244.
- [31] Dasgupta, P., 2007, *Economics: A Very Short Introduction* (Oxford: Oxford University Press).
- [32] Kareiva, P. and et al. (Eds), 2011, *Natural Capital: Theory and Practice of Mapping Ecosystem Services* (Oxford: Oxford University Press).
- [33] Solomon, S. et al., 2009, Irreversible climate change due to carbon dioxide emissions. *Proceedings of the National Academy of Sciences*, **106**(6), 1704–1709.
- [34] Hansen, J. et al., 2008, Target atmospheric CO₂: Where should humanity aim? *The Open Atmospheric Science Journal*, **2**, 217–231.
- [35] Foley, J.A. et al., 2011, Solutions for a cultivated planet. *Nature*, **478**, 332–342.
- [36] Shindell, D. et al., 2012, Simultaneously mitigating near-term climate change and improving human health and food security. *Science*, **335**, 183–189.
- [37] Knaup, H. and von Mittelstaedt, J., 2009, The new colonialism: foreign investors snap up African farmland. *Der Spiegel*, available online at: <http://www.spiegel.de/international/world/0,1518,639224,00.html> (accessed 12 February 2012).