State of the World 2013

IS SUSTAINABILITY *Still Possible?*

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CHAPTER 4

Getting to One-Planet Living

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In *Collapse: How Societies Choose to Fail or Succeed*, Jared Diamond asks the obvious question of a forest-dependent society: "What was the Easter Islander who cut down the last tree thinking?" For those familiar with the human tendency to habituate to virtually any conditions, the answer might very well be "nothing much." The individual who cut down Easter Island's last significant tree probably did not noticeably alter a familiar landscape. True, that person was likely standing in a scrubby woodland with vastly diminished biodiversity compared with the dense forest of earlier generations. Nevertheless, the incremental encroachments that eventually precipitated the collapse of Easter Island society were likely insufficient in the course of any one islander's life to raise general alarm. Some of the tribal elders might have worried about the shrinking forest, but there is no evidence that they did—or could have done—much to reverse the inexorable decline of the island's ecosystem.[1]

Too bad. With the felling of the last "old-growth" trees on the island, the forest passed a no-return threshold beyond which collapse of the entire socio-ecosystem was inevitable. No doubt several factors contributed to this tragic implosion—perhaps a combination of natural stresses coupled with rat predation of palm nuts, human "predation" of adult trees, overpopulation of both rats and humans, the misallocation of resources to an intertribal competition to construct ever bigger *moai* (the famous sacred monolithic stone heads), or perhaps even some tribal invincibility myth. But there is little doubt that human overexploitation of the limited resources of a finite island was a major driver. The wiser members of the community probably saw what was coming. In slightly different circumstances the islanders could conceivably have responded to reverse the decline, but in the end Easter Island society was unable to organize effectively to save itself.

Fast forward. We might well ask ourselves what the Canadian govern-

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ment was thinking in the early 1990s when it ignored scientists' warnings and a well-documented 30-year decline in spawning stock biomass and allowed commercial fishers to drive the Atlantic Cod stock to collapse. What are North Americans thinking today as they strip the boreal forest to get at tar-sands crude or jeopardize already shrinking water supplies by "fracking" oil-shales for natural gas and petroleum, even as burning the stuff threatens to push the global climate system over the brink? And what are Brazilians, Congolese, Malaysians, and Indonesians thinking as they harvest the world's great rainforests for short-term economic gain (through rare tropical hardwoods, cattle farms, soy production, or oil-palm plantations, for instance)?

Certainly the governments and corporate leaders of these nations know that their actions are destroying the world's greatest deposits of biodiversity, increasing the atmosphere's carbon burden, and accelerating long-term climate change. Nevertheless, as the U.N. Department of Economic and Social Affairs notes, because "so many of the components of existing economic systems are 'locked into' the use of non-green and non-sustainable technologies, much is at stake in terms of the high cost of moving out of those technologies." Result? A world in policy paralysis. [2]

System collapse is a complicated process. Ecosystem thresholds are not marked with signs warning of impending danger. We may actually pass through a tipping point unaware because nothing much happens at first. However, positive feedback ensures that accelerating changes in key variables eventually trigger a chain reaction: critical functions fail and the system can implode like a house of cards. Complexity theory and ecosystems dynamics warn of the dangers of overexploitation and explain observed cycles of climax and collapse. Yet the world community is in effect running a massive unplanned experiment on the only planet we have to see how far we can push the ecosphere before it "flips" into an alternative stability domain that may not be amenable to human civilization. Examples of inexorable trends include the loss of topsoil, atmospheric greenhouse gas accumulation, acidification of oceans with negative impacts on fisheries, coastal erosion, and the flooding of cities.[3]

We can illustrate the human pressure on nature using Ecological Footprint accounting. (See Box 4–1.) Ecological Footprints estimate the productive ecosystem area required, on a continuous basis, by any specified population to produce the renewable resources it consumes and to assimilate its (mostly carbon) wastes. There are only 11.9 billion hectares of productive ecosystem area on the planet. If this area were distributed equally among the 7 billion people on Earth today, each person would be allocated just 1.7 global hectares (gha) per capita. (A global hectare represents a hectare of global average biological productivity.)[4]

Box 4–1. What Is the Ecological Footprint?

The Ecological Footprint compares a population's demand on productive ecosystems—its footprint—with biocapacity, the ability of those ecosystems to keep up with this demand. The Global Footprint Network's National Footprint Accounts tracks the footprints of countries by measuring the area of cropland, grazing land, forest, and fisheries required to produce the food, fiber, and timber resources being consumed and to absorb the carbon dioxide (CO_2) waste emitted when burning fossil fuels. When humanity's Ecological Footprint exceeds the planet's biocapacity, harvests are exceeding yields, causing a depletion of existing stocks or the accumulation of carbon dioxide in the atmosphere and oceans. Such overuse potentially damages ecosystems' regenerative capacity. Locally, demand can exceed biocapacity without depletion if resources can be imported.

In 1961, humanity's Ecological Footprint was at about two thirds of global biocapacity; today humanity is in ecological overshoot—requiring the equivalent of 1.5 planets to provide the renewable resources we use and to absorb our carbon waste. Local overshoot has occurred all through history, but global overshoot only began in the mid-1970s. Overshoot cannot continue indefinitely; ultimately, productive ecosystems will become depleted. Global productivity is further at risk because of potential climate change, ocean acidification, and other consequences of the buildup of CO_2 in the biosphere.

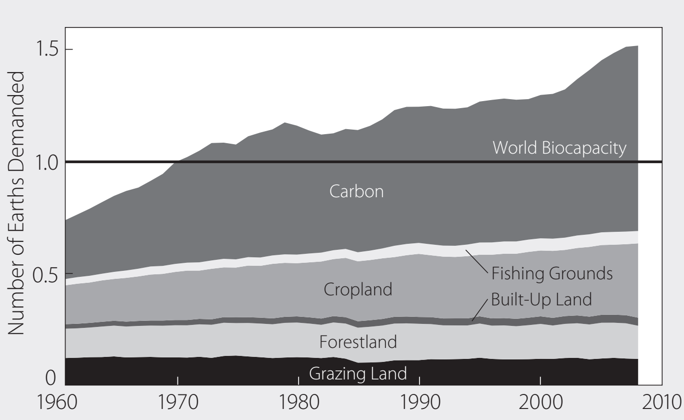
Most nations demand more biocapacity than they have available within their own borders. This means they are liquidating their national ecological wealth, relying through trade on the biocapacity of others, or using the global commons as a carbon sink. This increases the risk of volatile costs or supply disruptions. For example, the Mediterranean region has a rapidly widening ecological deficit: in less than 50 years, demand for ecological resources and services has nearly tripled, expanding its ecological deficit by 230 percent. But it is not just high-income countries where Ecological Footprints exceed biocapacity. The Philippines has been in ecological deficit since the 1960s. In 2008, people there demanded from nature twice the country's capacity to provide biological resources and sequester carbon emissions.

The United Arab Emirates, Qatar, Kuwait, Denmark, and the United States have the largest per capita footprints among countries with populations over 1 million. If everybody consumed like residents of these countries, we would need more than four Earths. Other nations, such as China, have lower per capita footprints but are rapidly pursuing consumption habits that are trending in the direction of high-income, high-footprint nations. And although China's footprint per person is low, we would still need slightly more than one Earth if everyone in the world consumed at that level. Despite relatively small per capita Ecological Footprints, countries with large populations, like India and China, have significant biocapacity deficits and large total Ecological Footprints, similar to that of the United States.

—*Global Footprint Network*

Source: See endnote 4.

Global Ecological Footprint by Component, 1961–2008



Comparing Fair Earth-Share and High-Consumption Societies

Ecological Footprint studies reveal that the world is in ecological overshoot by as much as 50 percent. The growth of the human enterprise today is fueled in large part by the liquidation of natural capital, including essential ecosystems, and the overfilling of waste sinks. In short, the human enterprise is exploiting natural systems faster than they can regenerate. Would a truly intelligent species risk permanently disabling the very ecosystems that sustain it for the increasingly questionable benefits of unequal growth?[5]

Ironically, the main perpetrators of this global experiment are the relatively well educated 20 percent of the human population who live in high-income consumer societies, including most of North America, Europe, Japan, and Australia, along with consumer elites of low-income countries. Densely populated, high-income countries typically exceed their domestic carrying capacities by a factor of three to six or more and thus impose a growing burden on other countries and the global commons. This wealthy minority of the human family appropriates almost 80 percent of the world's resources and generates most of its carbon emissions from fossil fuels.[6]

To achieve sustainability—that is, to live within the ecological carrying capacity of Earth—on average, people would have to live on the biologically productive and assimilative capacity of just 1.7 gha per capita. (If, as good stewards, we reserved more biocapacity solely for wild species, our Earth-shares per person would be even smaller.) In this chapter we use this amount of globally available per capita biocapacity as a starting point to consider the implications of living with a more equitable distribution of Earth's resources. In short, for policy and planning purposes, we consider 1.7 gha/per capita to be each person's equitable or "fair Earth-share" of global biocapacity.

More than half the world's population lives at or below a fair Earth-share. These people are mostly in Latin America, Asia, and Africa. As Table 4–1 shows, such fair Earth-share societies enjoy comparable longevity but have somewhat larger households and lower per capita calorie intake, meat consumption, household energy use, vehicle ownership, and carbon dioxide emissions than average world citizens. The differences between people living at a fair Earth-share and those in high-income countries (which typically need three planets) are much greater.[7]

The data for fair Earth-share societies used in this analysis are based on Cuba, Ecuador, Ethiopia, Guatemala, Haiti, India, Mali, the Philippines, Uzbekistan, and Vietnam. While some of these countries stay within the one-planet parameter due to low socioeconomic development (which also explains lower life expectancy than in the high-consumption societies), others—like Cuba and Ecuador—have high levels of development even with

Table 4–1. Comparing Fair Earth-Share, World Average, and High-Consumption Countries

Consumption Measures	Fair Earth-Share: 1 Planet	World Average: 1.5 Planets	High-Consumption: 3 Planets
		(per person)	
Daily calorie supply	2,424	2,809	3,383
Meat consumption (kilograms per year)	20	40	100
Living space (square meters)	8	10	34
People per household	5	4	3
Home energy use in gigajoules (per year)	8.4	12.6	33.5
Home energy use in kilowatt-hours (per year)	2,300	3,500	9,300
Motor vehicle ownership	0.004	0.1	0.5
Motor vehicle travel (kilometers per year)	582	2,600	6,600
Air travel (kilometers per year)	125	564	2,943
Carbon dioxide emissions (tons per year)	2	4	14
Life expectancy (years)	66	67	79

Source: See endnote 7.

their modest incomes and ecological footprints. In fact, an average Cuban's life expectancy is equivalent to that of an average American (at 78 years). (See Chapter 30.)[8]

The high-consumption societies used in this analysis are Australia, Canada, Germany, Israel, Italy, Japan, Kuwait, New Zealand, Norway, Russia, Spain, Sweden, the United Kingdom, and the United States. While these countries enjoy comparable levels of longevity, education, and quality of life, people in North America, Australia, and the oil-producing states in the Middle East tend to consume twice as much as their three-planet counterparts in other parts of the world. These comparisons show that beyond a certain point, income and consumption have little effect on quality-of-life outcomes compared with other sociocultural factors.

Learning to Live within the (Natural) Law

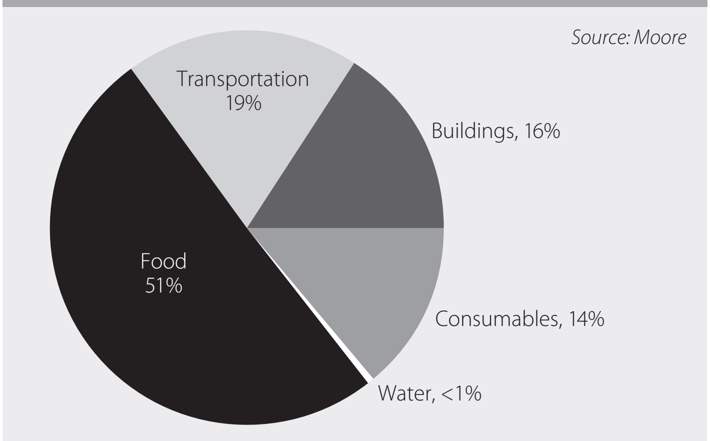
What might life look like for a high-income consumer society that decided to get serious about sustainability and implement strategies to live on its equitable share of Earth's resources? While this answer will depend on specific geographic, climatic, and cultural realities, a sense of the magnitude of change is available by looking at how one city could make this transition—Vancouver, Canada, which has aspirations to be the "world's greenest city."

The City of Vancouver proper (not the broader metropolitan area), in

British Columbia, is home to approximately 600,000 people and covers 11,467 hectares. Using data compiled by the city, by the Metro-Vancouver region, and by provincial, national, and international statistical agencies, the city's Ecological Footprint is conservatively estimated at 2,352,627 global hectares, or 4.2 gha per person.[9]

The average Vancouver Ecological Footprint can be attributed to various sectors as follows (see Figure 4–1): food (2.13 gha per person) accounts for 51 percent of the footprint, buildings (0.67 gha per person) account for 16 percent, transportation (0.81 gha per person) is 19 percent, consumables (0.58 gha per person) are 14 percent of the footprint, and water use is less than 1 percent.[10]

Figure 4–1. Summary of Vancouver's Ecological Footprint



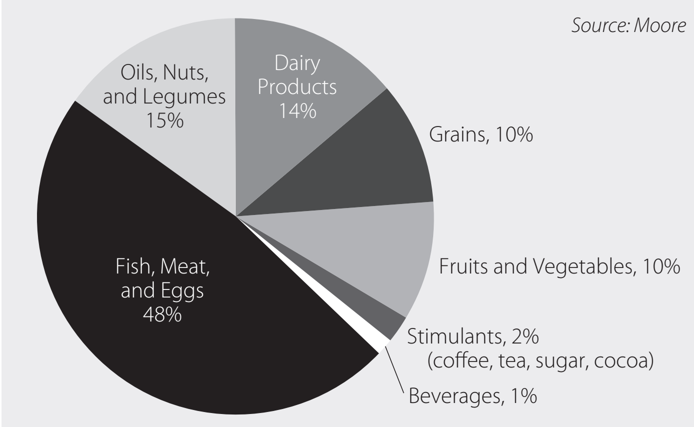
These data do not include contributions from provincial and national government public services (such as the treasury and military) that take place outside the city for the benefit of all Canadians. Vancouver city staff estimate that these services add an additional 18 percent to the per person eco-footprint. This would be equivalent to approximately 0.76 gha per person, bringing Vancouver's total Ecological Footprint per person to 4.96 global hectares. To achieve one-planet living, the average Vancouverite would need to reduce his or her Ecological Footprint by 66 percent. Note, however, that this is still a minimum number. Ecological Footprint estimates err on the side of caution because they cannot account for elements of consumption and waste assimilation for which data are unavailable or for such things as the fact that much "appropriated" ecosystem area is being degraded.[11]

Food represents half the footprint and includes cropland as well as carbon-sink land associated with processing, distribution, retailing, and consumption. Although many people are concerned about the carbon emissions associated with "food miles" (transporting food from farm to plate), this accounts for less than 3 percent of the food-footprint component and is mostly associated with imported fruits and vegetables. Animal protein production, however, constitutes most of the food footprint (see Figure 4–2), due mostly to cropland used to produce livestock feed.[12]

Transportation is the next largest contributor to the average Vancouverite's Ecolocial Footprint at 19 percent; personal automobile use accounts for 55 percent of this, followed by air travel at 17 percent. Buildings contribute 16 percent to the total Ecological Footprint. Operating energy (mostly natural gas used for water heating and space conditioning) accounts for 80 percent of the buildings footprint and is split equally between the residential and commercial-institutional sectors. The buildings component is smaller than might be expected because 80 percent of Vancouver's electricity is hydroelectric. Moreover, British Columbia was the first jurisdiction in North America to introduce a carbon tax and require all public institutions to be greenhouse-gas neutral in their operations.[13]

Fourteen percent of the Vancouver Ecological Footprint is attributable to consumer products, with paper accounting for 53 percent of this. Fortunately, Vancouverites recycle most of the paper they use (78 percent), reducing its potential Ecological Footprint by almost half. The material content of consumer goods accounts for only 7 percent of the total quantity of energy and material used to produce them; 91 percent of the Ecological Footprint of consumer goods is associated with the manufacturing process and another 2 percent with managing the products as wastes at the end of their life cycle.[14]

Figure 4–2. Food Component of Vancouver's Ecological Footprint



Clearly, lifestyle choices have a significant impact on our Ecological Footprint. However, even if average Vancouverites followed a vegan diet; avoided driving or flying and only walked, cycled, or used public transit; lived in a passive solar house that used almost no fossil-based energy; and cut their personal consumption by half, they could only reduce their per capita Ecological Footprint by 44 percent (from 4.96 to 2.8 gha per capita). That seems like an impossible challenge already—and yet it is still a full global hectare beyond the one-planet threshold.[15]

That said, the City of Vancouver is willing to wrestle with this challenge, and in 2011 it launched its *Greenest City 2020 Action Plan*, including a goal to reduce the city's Ecological Footprint 33 percent by 2020 and 66 percent by 2050. Actions in the plan span 10 areas: food, transportation, buildings, economy, waste, climate change, water, access to nature, clean air, and the Ecological Footprint. Indeed, almost all the planned actions contribute to the lighter footprint objective. Nevertheless, the plan falls short of what would be required to achieve stated Ecological Footprint reduction targets.[16]

Through the planning process, city staff explored various approaches, including reducing consumption of high-impact foods (such as meat and dairy products) by up to 20 percent, lowering consumption of new products by up to 30 percent, and cutting the amount of waste sent to landfills and incinerators in half. Note that Vancouver already recycles more than 50 percent of its wastes, so *Greenest City 2020* would achieve a total waste diversion rate of up to 75 percent. Vehicle kilometers travelled would be reduced by up to 20 percent and air travel by up to 30 percent. Building energy efficiency would be improved by up to 30 percent, and all new construction would be zero emissions starting in 2020.[17]


Jennie Moore

Bicycling infrastructure on Clark Street in Vancouver.

Implementation of these actions is estimated to reduce Vancouverites' Ecological Footprints by 20 percent. Even though the changes in consumption and waste production are substantial (ranging from 20 to 50 percent), this does not directly translate into equivalent reductions in Ecological Footprint. Take the following comparison, for example. Meat and dairy consumption accounts for nearly 23 percent of Vancouver's Ecological Footprint (and 21 percent of food consumed by weight). Reducing that by 20 percent translates into an approximate 4.5 percent reduction in the total Ecological Footprint. Indeed, this is one of the most effective actions that could be taken to achieve one-planet living. Municipal solid waste, on the other hand, only accounts for 1 percent of Vancouver's total Ecological Footprint. So cutting the total tonnage of municipal waste in half has an almost insignificant impact on the Ecological Footprint (assuming there are no upstream impacts on the supply chain of energy and materials used to produce consumer products).[18]

Getting to one-planet living therefore requires strategic consideration of which lifestyle changes can have the most significant impacts. Unfortunately, in the final *Action Plan* some of the actions that would have the greatest impact—such as reducing meat and dairy consumption—were omitted, largely because their implementation relied on people's voluntary actions that could not, and perhaps should not, be regulated by government.[19]

The question remains: even if citizens were willing to do all they could, how would Vancouver shave another global hectare off the average Ecological Footprint? Recall that senior government services from which all Canadians benefit account for an estimated 0.76 gha per capita of Vancouver's Ecological Footprint. Changes in senior government policy and practice are therefore also needed and could include efforts toward demilitarization, an emphasis on population health through disease prevention, and a careful public examination of existing rules, regulations, tax incentives, and assumptions about whether the current administration of public funds is aligned with the goals of a sustainable society.

These are bold measures that move past the current emphasis on efficiency gains across society. The latter would, of course, still be needed—indeed, there is considerable room for additional energy/material efficiency gains across the entire building stock and in manufacturing; farmers and food processors could also greatly reduce their reliance on fossil fuels and inputs (fertilizers and pesticides, for instance). One way to induce efficiency gains is to eliminate "perverse subsidies" (including tax breaks to highly profitable oil and gas producers and subsidies to farmers to produce certain food products, such as corn) that facilitate unsustainable industrial practices and generate false price signals in consumer markets. If necessary, this should be accompanied by pollution charges or taxes to address market failures (that is, to internalize negative externalities) and to ensure that market prices reflect the true social costs of production. Policy alignment at the national and provincial government levels to support all such initiatives is essential.[20]

A second challenge involves engaging civil society with political leaders to advance a paradigm of sufficiency, meaning a shared social commitment to consuming enough for a good life but not so much that total throughput exceeds critical biophysical limits. Such a new consumer paradigm is also necessary to avoid the "rebound effect," in which people spend savings from efficiency on other things—canceling the gains. A survey of 65 studies in North America found that this rebound is responsible for 10–30 percent of expenditures in sectors that account for most energy and material consumption: food, transportation, and buildings. Indeed, total resource and energy demand in most of the world's industrial countries has increased in absolute terms over the past 40 years despite efficiency gains of 50 percent in materials and 30 percent in energy use.[21]

Different people will make different lifestyle choices and changes as required. If one-planet living is the goal, these choices will obviously have to entail more than recycling programs and stay-at-home vacations. For success, the world's nations will have to commit to whole new development strategies with elements ranging from public re-education to ecological fiscal reform, all within a negotiated global sustainability treaty.[22]

While it is beyond the scope of this chapter to detail elements of such an economic transformation, others have tried. In *Factor Five*, for example, Ernst von Weizsäcker and colleagues attempt numerous sector studies to demonstrate how an 80 percent reduction in resource intensity could be achieved in agriculture, transportation, buildings, and selected manufacturing industries. They show that many of the technologies needed for one-planet living already exist, but in the absence of global agreements and enforceable regulations, there is insufficient incentive for corporate, government, and consumer uptake. In a global economy, states will not act alone for fear of losing competitive ground. And even international cooperation or agreements do not ensure success: although some global initiatives (such as the Montreal Protocol on ozone depletion) have succeeded, others (such as the Kyoto Protocol on climate change) have succumbed to shorter-term economic considerations.[23]

Jennie Moore

A parking lot adapted for use as an urban farm, Vancouver.

What Lies Ahead

Despite the pressing need for cultural transformation, prospects for real progress toward socially just ecological sustainability are not encouraging. Global society remains committed to the progress myth and to unconstrained economic growth. Indeed, the international community views sheer material growth rather than income redistribution as the only feasible solution to chronic poverty.

In *Our Common Future*, the World Commission on Environment and Development recognized peoples' reticence to contemplate serious measures for wealth redistribution. Such an approach might follow a strategy of contraction and convergence, during which industrial countries reduced their energy and material throughput to allow room for developing countries to grow. Instead, the Commission advocated for "more rapid economic growth in both industrial and developing countries," albeit predicated on global cooperation to develop more equitable trade relationships and noting that "rapid growth combined with deteriorating income distribution may be worse than slower growth combined with redistribution in favour of the poor."[24]

Since that report came out in 1987, economic growth has far outpaced population growth, so there are more dollars per person circulating in the world today than ever before. But while some developing states have prospered in the increasingly global economy—such as Singapore, South Korea, China, and India—others have not. Moreover, income disparity is increasing both among and within countries; even in the richest nations, lower-income groups have seen real wages stagnate or decline. It is now apparent that growth alone is failing as a solution to poverty. Most of the human family is still materially deprived, consuming less than its just share of economic output. This has led to renewed recognition—at least in progressive circles—that policy measures explicitly designed to spread the benefits of economic prosperity are more effective than increasing gross domestic product for alleviating material poverty.[25]

Overall, the combined evidence of widening income gaps and accelerating ecological change suggests that the mainstream global community still pays little more than lip service to the sustainability ideal. The growth economy, now dressed in green, remains the dominant social construct. Rio+20, the latest U.N. conference on economy and development, essentially equated sustainable development with sustained economic growth and produced no binding commitments for anyone to do anything. So it is that 40 years after the first global conference on humanity and the environment (Stockholm in 1972) and 20 years after the first world summit on the environment and development (Rio in 1992), the policy focus remains on economic growth—while ecological decline accelerates and social disparity worsens.

Discouraging, yes, but let us recognize that the notion of perpetual growth is just a social construct, initiated as a transition strategy to reboot the economy after World War II. It has now run its course. What society has constructed it can theoretically deconstruct and replace. The time has come for a new social contract that recognizes humanity's collective interest in designing a better form of prosperity for a world in which ecological limits are all too apparent and the growing gap between rich and poor is morally unconscionable. Our individual interests have converged with our collective interests. What more motivation should civil society need to get on with the task at hand?[26]

The major challenges to sustainability are in the social and cultural domains. The global task requires nothing less than a rewrite of our prevailing growth-oriented cultural narrative. As Jared Diamond emphasized in *Collapse*, societies can consciously "choose to fail or succeed," and global society today is in the unique position of knowing the dismal fates of earlier cultures that made unfortunate choices. We can also consider the prospects of those who acted differently. Indeed, in contrast to the fate of Easter Islanders, the people of Tikopia—living on a small South Pacific island—made successful choices to reduce their livestock populations when confronted with signs of ecological deterioration. Today the Tikopian culture serves as an example of conscious self-management in the face of limited resources. Of course, Tikopia has the advantage of being a small population with a homogenous culture on a tiny island where the crises were evident to all and affected everyone. Contrast that with today's heterogeneous global culture characterized by various disparities (tribal, national, linguistic, religious, political, and so on) and the anticipation of uneven impacts.[27]

Meanwhile, our best science is telling us that we are doing no better than previous failures: staying our present course means potential catastrophe. The (un)sustainability conundrum therefore creates a clear choice for people to exercise their remaining democratic freedoms in the name of societal survival. Difficult though it may be, ordinary citizens owe it to themselves and the future to engage with their leaders and insist that they begin the national planning processes and draft the international accords needed to implement options and choices for an economically secure, ecologically stable, socially just future.

2011, amended 2012); Statistics Sweden, System of Environmental and Economic Accounts, *CO_2 Emission per Income Deciles 2000* (Stockholm: 2000); China from Jie Li and Yan Wang, "Income, Lifestyle and Household Carbon Footprints (Carbon-Income Relationship), a Micro-level Analysis on China's Urban and Rural Household Surveys," *Environmental Economics*, vol. 1, no. 2 (2010).

Chapter 4. Getting to One-Planet Living

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5. Wackernagel and Rees, op. cit. note 4; William E. Rees, "Ecological Footprint: Concept of," in S. A. Levin, ed. in chief, *Encyclopedia of Biodiversity*, 2nd ed. (Amsterdam: Elsevier/Academic Press, forthcoming); WWF et al., *Living Planet Report 2010*, op. cit. note 4; WWF, *Living Planet Report 2012*, op. cit. note 4.

6. Anup Shah, "Poverty Facts and Stats," citing *World Development Indicators*, World Bank, 2008, at www.globalissues.org/article/26/poverty-facts-and-stats; William E. Rees, "Ecological Footprints and Biocapacity: Essential Elements in Sustainability Assessment," in J. Dewulf and H. Van Langenhove, eds., *Renewables-based Technology: Sustainability Assessment* (Chichester, U.K.: John Wiley and Sons, 2006); WWF et al., *Living Planet Report 2010*, op. cit. note 4.

7. Table 4–1 from the following: Global Footprint Network, at www.footprintnetwork.org/en/index.php/GFN/page/world_footprint; U.N. Food and Agriculture Organization, "Nutrition Country Profiles," at www.fao.org/ag/agn/nutrition/profiles_by_country_en.stm; Peter Menzel, *Material World* (San Francisco: Sierra Club Books, 1994); World Bank, "Indicators," at data.worldbank.org/indicator; International Civil Aviation Organization, "Special Report: Annual Review of Civil Aviation," *ICAO Journal*, vol. 61, no. 5 (2005); Worldmapper, at www.worldmapper.org; World Resources Institute, "EarthTrends: Environmental Information," at earthtrends.wri.org; WWF, "Footprint Interactive Graph," at wwf.panda.org/about_our_earth/all_publications/living_planet_report. Global average statistics for living space and motor vehicle travel are estimated assuming two thirds of the global population consumes at the one-planet level and one third consumes at the three-planet level.

8. Life expectancy from World Bank, op. cit. note 7.

9. Land area data from "Understanding Vancouver," at vancouver.ca/commsvcs/planning/census/index.htm; 2006 population from Statistics Canada, "Census Data: Community Profiles: Vancouver, British Columbia (Census Metropolitan Area)" (Ottawa).

10. Figure 4–1 from Jennie Moore, *Getting Serious About Sustainability: Exploring the Potential for One-planet Living in Vancouver*, submitted in partial fulfillment of requirements for PhD degree (Vancouver: School of Community and Regional Planning, University of British Columbia, forthcoming).

11. City of Vancouver, *Greenest City 2020 Action Plan* (Vancouver: 2011), pp. 48–53.

12. Figure 4–2 from Moore op. cit. note 10.

13. Moore, op. cit. note 10; British Columbia (The Province of), *Carbon Neutral BC, A First for North America*, press release (Victoria: 30 June 2011).

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15. Ibid.

16. City of Vancouver, op. cit. note 11.

17. City of Vancouver, *Greenest City 2020 Action Plan (GCAP): Council Report* (Vancouver: 2011), pp. 110–11.

18. Ibid.

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25. Emmanuel Saez, *Striking it Richer: The Evolution of Top Incomes in the United States* (updated with 2009 and 2010 estimates) (Berkeley: University of California, 2012); U.N. Development Programme, *Human Development Report 2010* (New York: 2010); U.N. Department of Economic and Social Affairs, op. cit. note 2; U.N. Department of Economic and Social Affairs, *World Economic and Social Survey 2006* (New York: United Nations, 2006).

26. Rees, "What's Blocking Sustainability?" op. cit. note 22; Rees, "The Way Forward," op. cit. note 22.

27. Diamond, op. cit. note 1.

Chapter 5. Sustaining Freshwater and Its Dependents

1. Figure of 250 million is approximate, per Joel E. Cohen, *How Many People Can the Earth Support?* (New York: W. W. Norton & Company, 1995), p. 77; 7 billion from U. S. Census Bureau, "U.S. & World Population Clocks," at www.census.gov/main/www/popclock.html; gross world product estimate for 2011 from U.S. Central Intelligence Agency, *The World Factbook*, at www.cia.gov/library/publications/the-world-factbook/index.html.

2. For analysis and sources, see later text.

3. Figure of 800 million from UNICEF and World Health Organization (WHO), *Progress on Drinking Water and Sanitation: 2012 Update* (New York: United Nations, 2012).

4. Igor A. Shiklomanov, *World Water Resources: A New Appraisal and Assessment for the 21st Century* (Paris: UNESCO, 1998). Box 5–1 based on National Academy of Sciences, Water Science and Technology Board, *Desalination: A National Perspective* (Washington, DC: National Academy Press, 2008); 15,000 figure from Quirin Schiermeier, "Purification with a Pinch of Salt," *Nature*, 20 March 2008, pp. 260–61.

5. Sandra L. Postel, Gretchen D. Daily, and Paul R. Ehrlich, "Human Appropriation of Renewable Fresh Water," *Science*, 9 February 1996, pp. 785–88.

6. Figures of 19 percent, 42 percent, and 15,600 cubic kilometers from ibid., adjusted for rise in water captured by dams to 10,800 cubic kilometers, from B. F. Chao, Y. H. Wu, and Y. S. Li, "Impact of Artificial Reservoir Water Impoundment on Global Sea Level," *Science*, 11 April 2008, pp. 212–14, and assumption that 64 percent of this storage capacity is actively used in the regulation of runoff, per Postel, Daily, and Ehrlich, op. cit. note 5; amount used by each sector from United Nations, *Water in a Changing World: United Nations World Water Development Report*, 3rd ed. (Paris: UNESCO, 2009).

7. Figure of 82 percent from U.N. Food and Agriculture Organization (FAO), *Aquastat Database*, at www.fao.org /NR/WATER/AQUASTAT/main/index.stm.

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