Humanities **2013**, 2, 119–127; doi:10.3390/h2020119

OPEN ACCESS

humanities

ISSN 2076-0787

www.mdpi.com/journal/humanities

Article

Sustainability—What Are the Odds? Envisioning the Future of our Environment, Economy and Society

Stephen J. Jordan

National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, 1 Sabine Island Drive, Gulf Breeze, FL 32561, USA; E-Mail: jordan.steve@epa.gov; Tel.: +1-850-934-9350; Fax: +1-850-934-9201

Received: 15 January 2013; in revised form: 21 March 2013 / Accepted: 21 March 2013 / Published: 26 March 2013

Abstract: This article examines the concept of sustainability from a global perspective, describing how alternative futures might develop in the environmental, economic, and social dimensions. The alternatives to sustainability appear to be (a) a catastrophic failure of life support, economies, and societies, or (b) a radical technological revolution (singularity). The case is made that solutions may be found by developing a global vision of the future, estimating the probabilities of possible outcomes from multiple indicators, and looking holistically for the most likely paths to sustainability. Finally, an intuitive vision of these paths is offered as a starting point for discussion.

Keywords: catastrophe; singularity; forecasting; technology; natural resources; probability

1. Introduction

Sustainability—the word is everywhere these days. Cities, transportation systems, energy producers, agriculture, fisheries, businesses, even mines (!), are making claims or making plans for sustainability. Several formal definitions of sustainability have been offered [1]; here is one adopted in a recent National Research Council report [2], quoted from the National Environmental Policy Act of 1969 [3]: "*. . .to create and maintain conditions, under which humans and nature can exist in productive harmony, that permit fulfilling the social, economic, and other requirements of present and future generations.*" This seems to be a good idea, at least if one cares about humans, nature, and future generations. Sustainability also means using natural resources no faster than nature can provide them, maintaining the production of ecosystem services by conserving natural capital and critical functions of ecosystems, and generating no more waste than the environment can process effectively,

while maintaining or improving the quality of human life [1]. In this essay, I first explore diverging paths through the three dimensions of sustainability—environmental, economic, and social—then offer some suggestions for advancing our understanding of future probabilities.

To take a deeper look at the sustainability paradigm, we must first acknowledge that human society has been sustained for tens of thousands of generations, or we would not be here. So why is there this rush to sustainability? The concern, of course, is that the world's resources cannot indefinitely support an exponentially growing human population and its increasing demands on nature. In my lifetime, the Earth's human population has more than tripled, from about 2.1 billion to more than 7 billion, and is expected to reach 9–10 billion by 2050. We do not know exactly how many are too many, but we can be confident there is such a number. The implication is that the population, their demands, or both must be curbed for the human enterprise to be sustainable. Skeptics would retort that technological advances have promoted a thriving population far larger than earlier estimates of the Earth's carrying capacity. Why should it not be so in the future?

Taken literally, sustainability is inevitable, if humans and their societies are to survive at all, but sustainability as it is generally defined is much more than survivability. Will humans and ecosystems will have the resilience not only to survive, but to thrive in the future and what will be the trajectory of change? Let us hypothesize three paths to the future: (1) an incremental path, whereby the concepts and practice of sustainability gradually take hold in various sectors of economies and societies, leading to a gentle arrival in a more sustainable world; (2) a catastrophic path, characterized by environmental, economic, and social breakdowns, at the extreme including world-wide socio-political devolution and a greatly reduced global population; and (3) the path known as a 'singularity,' where exponential advances in technology suddenly lead us to a barely imaginable future world, in which the natural environment becomes irrelevant to human survival and well-being. In his recent book [4], the archaeologist and historian Ian Morris predicts that society will experience either a catastrophe (a 'black hole' in his terms) or a singularity before the middle of this century.

These hypothetical paths are abstractions of a great variety of possible future scenarios. Although less specific than the global scenarios analyzed by, for example, the Millennium Ecosystem Assessment [5] and the International Panel on Climate Change [6], they are intended to bracket the full range of possibilities. In the following, I briefly explore the implications of the three scenarios for each of the dimensions of the sustainability paradigm.

2. The Environmental Dimension

The Earth's environment may not support the needs of the human population through the 21st century. Drastic shortages of food, freshwater, energy, and materials could result as natural resources are depleted. Can gains in resource extraction, along with increased efficiencies of production, resource use, and reuse combine to meet the needs of billions more people in a changing climate? If the answer is yes, then we are on the incremental path. Otherwise, barring a singularity, we are on the catastrophic path, with the prospect of billions starving, deprived of other basic needs, and competing violently for diminishing resources. We would be left with a barren, polluted world, stripped of natural resources and biodiversity, which could support only some fraction of the current population. Symptoms of the catastrophic outcome can be found in the world as it is today.

The outcomes of a singularity are by definition unpredictable, but could any technological development separate human needs from the natural world? What would replace water supplies, breathable air, and arable soils? What would be the quality of life in a totally engineered world? Experience of nature has been shown to have positive effects on physical and psychological health. I suspect that many older people are nostalgic for the less crowded, more natural world of their youth. When I was a child, my friends and I played in woods and fields and streams now long lost to the sprawl of a great city. Perhaps in a technological future we will all enjoy virtual nature—will it satisfy, or suffice?

3. The Economic Dimension

Are there incremental solutions to economic problems that will shape a gentle path to sustainability? It is easy to define the end point: maximum sustainable economic utility worldwide. Even so, the means to a solution are intensely controversial, endlessly debated (by politicians, advocates, economists and just about everyone), and perhaps unknowable. Thus, we grope through the complexities of a global economy without knowing what path we are on, or what poorly informed policy or action might destroy it.

The world's economy appears to be on an unsustainable course—toward greater consolidation of wealth, financial systems that do not serve society at large, impoverishment of middle classes, and lack of opportunities for the most disadvantaged. Monetary systems, always based on trust, are being manipulated by bankers, brokers and governments to the point where trust is lost and the systems are failing. These challenges to sustainability may be even more urgent than those of a depleted, degraded environment. At the cost of great pain, past societies and economies have recovered from catastrophic financial crises over years or decades. The scale and apparent weaknesses of the present world economy suggest the possibility of a collapse that could last for a very long time.

What would a singularity look like in the economic realm? In a Star Trek future, there is no money, yet everyone seems to have whatever they need. Presumably, this sustainable non-monetary economy will be made possible by inexhaustible sources of energy (fusion?) and materials—through exploitation of a galaxy's worth of planets—distributed by superluminal transportation. Can technology triumph over need and greed?

4. The Social Dimension

In a sustainable worldview, societies evolve toward greater cooperation and equity. War, crime, and violence diminish, social justice becomes universal, and every person's well-being is the concern of every other. This vision may not appeal to those humans who thrive on competition [7], a trait that I suspect is unlikely to disappear in the foreseeable future. Nevertheless, there is more than one kind of competition. Competition for such things as wealth and power is a zero-sum game that creates winners and losers. But with constructive competition, society at large is the winner and there are no losers. Scientists, artists, and entrepreneurs compete to be first with a great idea, create the finest products, and have the most impact, without anyone suffering tangible losses, while society gains the benefits of all their efforts. Could a shift toward more constructive competition be a plausible trajectory for social

(and biological?) evolution? In a more crowded world, constructive competition may have advantages for collective and even individual fitness.

In the catastrophic scenario, competition, coupled with polarization along political, religious, and ethnic lines (encouraged by aggressively ignorant or cynical leaders) causes breakdowns in social and political cooperation. Wars and catastrophic failures of social systems result. There are plenty of examples over the past century: fascism in Europe and Japan, China's Cultural Revolution, the violent breakup of Yugoslavia, anarchy in Somalia, and most recently, political upheaval in the Arab nations (which may, at this writing, have benign, catastrophic, or mixed outcomes). Yet society survived even the monstrosity that was World War II, and after a decade or two, almost everyone was better off than before the war. Could the next major conflict be of such a scale that there would be no recovery, at least not for centuries?

A singularity along the social dimension is particularly hard to conceive. Science fiction scenarios include the human-machine merger mentioned above, and contact with far-advanced aliens who teach or coerce us to behave better. If some marvelous technology were to overcome scarcity and the need for money, would people and nations still engage in violent competition, discrimination, and domination? An end to evil would be a singularity indeed!

5. Probing the Future

There is no reason to rehash the debates that have been going on since Malthus about whether and when the population will outstrip the Earth's carrying capacity. Predictions based on simple extrapolations of food production or energy supplies have proved too pessimistic. If there is any hope for a better glimpse into the future, we need a more nuanced approach that accepts complexity and uncertainty. Therefore, it seems useful to employ the sustainability paradigm, because it offers a more balanced, holistic way to examine the future. It incorporates complexity by encompassing environmental, economic, and social dimensions; most prior analyses have been concerned with one dimension or another (but see [8] and [9] for more comprehensive analyses), or sectors such as energy or agriculture. Sustainability, which can be thought of as an intermediate state between catastrophe and singularity, offers a baseline against which we can contrast alternatives (Figure 1).

The mathematical construct known as catastrophe theory [10] predicts that in complex systems, a small change in the value of one variable can cause a sudden shift of the system (a "tipping point") from one equilibrium state to another, just as one step in the wrong direction can pitch a hiker off a cliff. In catastrophe theory, catastrophe and singularity are qualitatively different interpretations of sudden shifts in equilibrium. An analogy to the singularity might be if our hiker, just at the critical step, suddenly sprouted wings and flew off into the air. Catastrophe theory could provide alternative hypotheses for tests of future sustainability (Figure 2).

Powerful techniques are available for analysis and forecasting of complex systems and for making use of uncertainty to qualify the results. A broad suite of environmental, economic, technological, and social indicators could be used as input data for modeling *probabilities* (not certainties) of alternative futures. Sensitivities of the models to various indicators and combinations may suggest the interventions and policies most likely to lead to sustainable outcomes or prevent catastrophes. Because such developments as super-intelligence, practical energy from fusion, superluminal travel, and visits

by extraterrestrials are not predictable, a direct estimate of the probability of a singularity is not possible. However, the probability of a singularity, if we postulate no other alternatives, is simply the difference between 1 and the sum of the other probabilities; that is, if the probability of catastrophe turns out to be 30% and that of a sustainable outcome 50%, then the probability of a singularity is 20%.

Figure 1. Sustainability as a hypothetical middle ground between alternative outcomes.

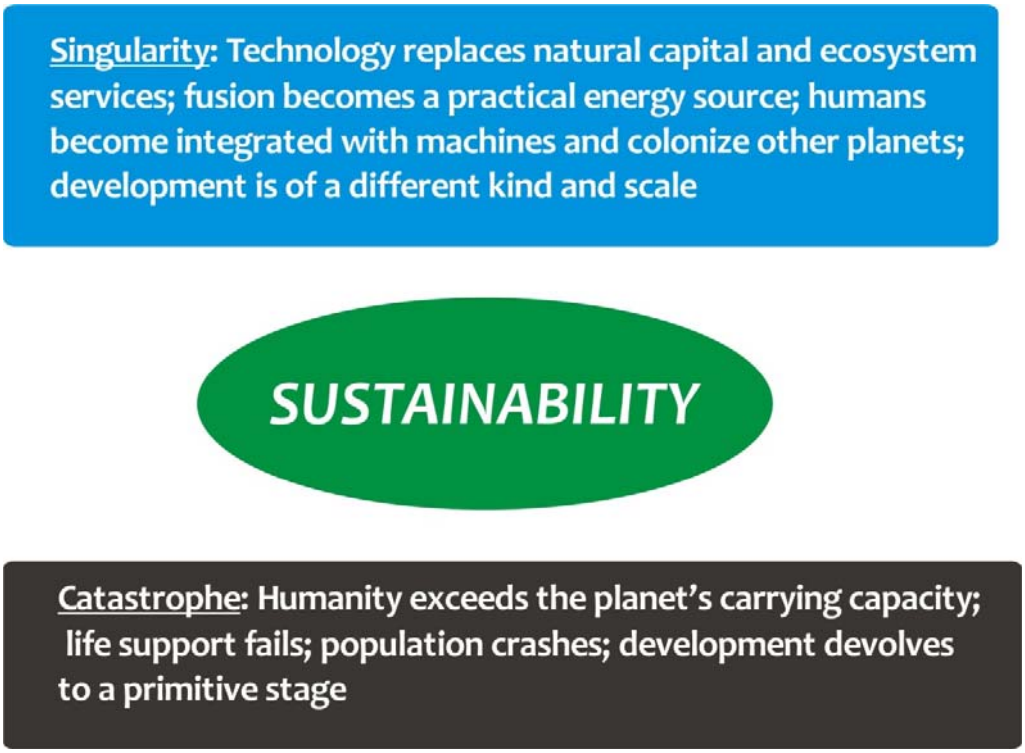
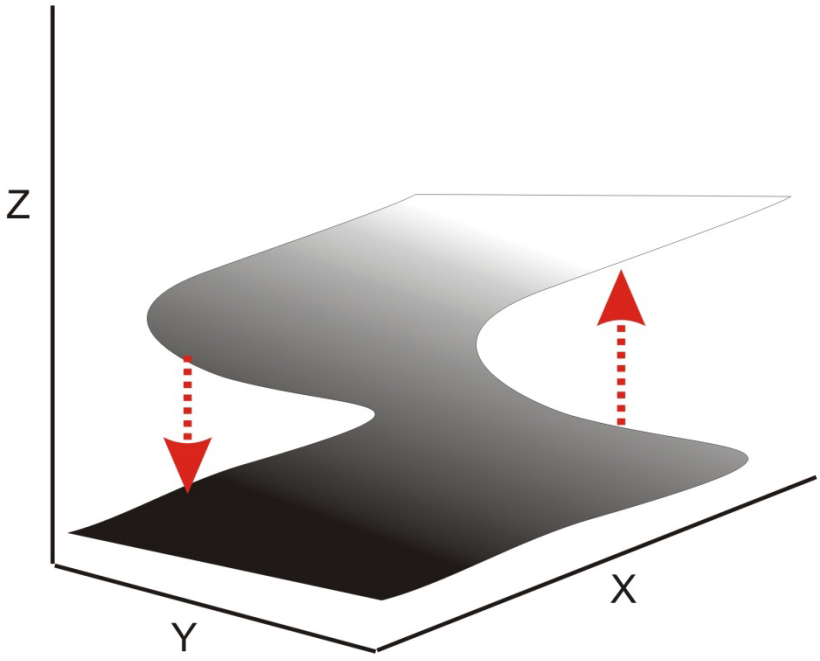


Figure 2. A representation of catastrophe theory [10]. We could interpret the down arrow as a catastrophe and the up arrow as a singularity.



Forecasting is not prediction; predictive models are based on cause-effect relationships, whereas forecasting typically depends on correlations. For example, if a stock price index historically has been down 70% of the time on Monday, we might assume that this pattern will continue into the future and include the probability in a forecast, without knowing the cause of the phenomenon. This critical assumption often does not hold up when we compare forecasts to actual outcomes, so forecasts can fail quantitatively (we get more or less than we forecast), and even qualitatively (the direction of the outcome is opposite that of the forecast). If we forecast that the stock index will increase by 20 percent over five years and miss by five or ten percent, the damage is modest. But if we finance this bet and the index decreases by 20 percent, it could be quite a blow.

So if forecasting is risky, why not develop a predictive model? The problem here is to know all of the multiple, complex cause and effect relationships involved in determining environmental, economic, and social futures. We do not. Many assumptions would have to go into such a model, making it perhaps more risky, and definitely less transparent, than a simpler forecasting model. Yet the December 2011 issue of *Scientific American* describes the proposed Living Earth Simulator, a €1 billion project "*. . .to model global-scale systems—economies, governments, cultural trends, epidemics, agriculture, technological developments, and more—using torrential data streams, sophisticated algorithms, and as much hardware as it takes*" [11]. Skepticism that such a model will provide a clear window into the future is justified, but the effort can be expected to contribute a lot of new knowledge, regardless of its success in prediction. Moreover, this is a fine example of the kind of thinking we need to approach the problem of solving the future.

There is a middle course—a hybrid between correlational and deterministic models. If we observe that multiple indicators follow patterns over time that are related in some way (parallel, anti-parallel, or in more complex patterns), we may not know the underlying causes, but can have some confidence that they are there. In other words, we are modeling causes indirectly, through their emergent properties. We observe that our garden grows well when we supply water and fertilizer in moderation, but not when it is parched, starved, drowned, or glutted. A degree in plant physiology is not necessary to make predictions about our vegetables.

Forecasting the probability of a sustainable future could employ a comprehensive suite of environmental, economic, social, and technological indicators with consistent historical records extending well into the past, along with reputable predictions for population growth, climate change, and nonrenewable resources. Quantitative definitions of sustainability and catastrophe in terms of the indicator set would supply the theoretical basis, such that environmental, economic, and social dimensions would have *a priori* thresholds for each case. Such an analysis could be accomplished for a small fraction of the €1 billion cost of Dirk Helbing's Living Earth Simulator.

6. The Fortune Teller's Solution

Regardless of the approach, we should be attempting a holistic vision of the future. I propose global sustainability as a way to frame the vision and as a hypothesis to guide analysis. Solving environmental, economic and social problems piecemeal and locally may get us to a better future, but should we not try to see the whole picture? Perhaps there are implications and solutions that cannot be grasped otherwise. The world is, of course, heterogeneous, with a great diversity of environments,

economies and cultures, bringing into question the idea of a global analysis. Paths to the future and how they affect people and the environment will differ from one place to another, as will the pace of change. Nevertheless, current trends toward economic and social globalization can be expected to continue and accelerate, implying the necessity of a global vision.

In the absence of big models, we can peer into a crystal ball. Although we see nothing in the crystal but the reflection of our intuitions, intuition is constructed from a vast, though fuzzy, store of knowledge about the past and present states of the world. A reasonable qualitative image can emerge. A forum of fortune tellers could be convened, where a group of knowledgeable people shares hunches about the future and tries to reach a consensus; the process could be formalized by using decision analysis methods, or semi-structured methods [12] and updated periodically. While we can learn much from quantitative methods, collective intuition may turn out to be more powerful in creating a sound vision of the future than the formal tools used by modelers and futurists.

The challenge of applying intuition is to envision without analyzing, as eloquently described by the late Donella Meadows in her talk, Envisioning a Sustainable World: *"Visioning is the first step, and a continuous step, because visions continue to get revised and shared and built and elaborated and made more rich and true"* [13]. Thus, I present my personal vision in bullets, without background, context, or citations. Consider it a challenge to those who would develop a sounder vision.

7. A Sustainable Future

- Exploitation and conservation of ecosystems and natural resources will gradually reach a dynamic equilibrium. In the interim, some species, ecosystems, and natural environments will continue to be lost or irreversibly altered.
- Nonrenewable resources will be depleted, phased out, and replaced by renewable resources, recycled materials and novel technologies. As a corollary, wastes and pollution will be attenuated.
- Renewable energy will replace fossil fuels on a gradual course over decades. Climate change will not be averted soon enough to avoid major impacts on coastal infrastructure, agriculture and ecosystems, but societies, economies, and ecosystems will adapt to the altered climate.
- Inefficient transportation systems—private automobiles, freight carriers, and giant airliners—eventually will be replaced by more sustainable technologies and infrastructure, relieving the burdens of vast quantities of fossil fuels, concrete, asphalt, and pollutants.
- Conservation, reuse, efficiencies and desalinization will avert a global water supply disaster, but local and regional shortages will cause displacements and varying amounts of suffering.
- At the global scale, fisheries, forestry, agriculture, and energy production will become sustainable through the combined forces of enlightened national and international policies, adaptive management, technological advances, and individual actions. Exceptions at finer scales will persist.
- After much turmoil, possibly chaos, the global economy will stabilize and become sustainable. Early in the process, globalization will be a major cause for turmoil, but eventually it will become the foundation of a sustainable economy.

- Social welfare will become more equitably distributed. Human well-being will increase in the aggregate, though not everyone will be better off. Poverty, crime, injustice and discrimination will remain, but at lower rates. Victims, a preponderance of whom today are women, children and the poor, will have more and better opportunities for relief, remediation, and justice.

Some of these changes are already underway, though whether they have sufficient momentum and penetration to achieve sustainable results is in question. There also are plausible pitfalls on this semi-smooth road to sustainability. The most dangerous are catastrophic climate change, nuclear war, and cosmic accidents such as a large meteor strike. Other environmental catastrophes, pandemics, or economic and social meltdowns may be no less probable, but seem more likely to delay rather than reverse progress. This prognosticator's relatively benign vision of the future should not be too comforting. Many bad things can and will happen even on the most direct route to sustainability. Yet this goal must be pursued (consider the alternatives!), and we need all the vision we can get to light the way.

8. Conclusions

We need a global vision for the world's future. Sustainability should be the benchmark, and serve as a null hypothesis for testing our vision against alternatives. The alternatives to global sustainability are (1) an environmental-social-economic catastrophe or (2) a radical technological breakthrough, *i.e.*, a singularity. Forecasting models can be used to estimate probabilities of future outcomes. Although they have been proposed, complete simulation models of the world's environment, economy and society may be out of reach. Intuition can provide insights to the future—group intuition could be powerful; I have presented my own intuitive vision of the path society will take toward sustainability. I welcome comments from readers, and hope that some will want to get involved actively in pursuing these ideas.

Acknowledgments

I appreciate preliminary reviews by Jessica Hope Jordan and Sharon E. Hayes, and the insightful comments of two anonymous reviewers. The views expressed in this article are those of the author and do not necessarily reflect the views or policies of the U.S. Environmental Protection Agency, which funded this work.

References

1. Jordan, Stephen J., and J. Kevin. Summers "Environmental sustainability, ecosystem services, and human well-being." In *The Praeger Handbook of Environmental Health.* Edited by Robert Friis. Santa Barbara: Praeger, 2012, vol. 4, 569–87.
2. National Research Council. *Sustainability and the U.S. EPA.* Washington: The National Academies Press, 2011.
3. National Environmental Policy Act. Public Law 91–190, 1969.
4. Morris, Ian. *Why the West Rules – for Now: The Patterns of History, and What They Reveal About the Future.* New York: Farrar, Strauss and Giroux, 2011.

5. Millennium Ecosystem Assessment. *Ecosystems and Human Well-being: Synthesis*. Washington: Island Press, 2005.
6. IPCC. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Edited by Core Writing Team, Rajendra K. Pachauri, and Andy Reisinger. Geneva: IPCC, 2007, 104.
7. Feeley, Drew. "Personality, environment, and the causes of white-collar crime." *Law and Psychology Review* 30 (2006): 201–14.
8. Lehtonen, Markku. "The environmental-social interface of sustainable development: capabilities, social capital, institutions." *Ecological Economics* 49 (2004): 199–214.
9. Graymore, Michelle L.M., Neil G. Sipe, and Roy E. Rickson. "Regional sustainability: how useful are current tools of sustainability assessment at the regional scale?" *Ecological Economics* 67 (2008): 362–72.
10. Zeeman, Erik Christopher. "Catastrophe theory." *Scientific American* 234 (1976): 65–83.
11. Weinberger, David. "The machine that would predict the future." *Scientific American* 305 (2011): 52–57.
12. Evans, Martyn and, Simon Sommerville "A design for life: futures thinking in the design curriculum." *Futures Research Quarterly* 23 (2007): 5–20.
13. Meadows, Donella. "Envisioning a sustainable world: Transcription of a talk at the International Society for Ecological Economics, 1994." *Solutions* 3 (2012): 11–14.