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Commentaries

Peering into the Fog: Ecologic Change, Human Affairs, and the Future

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For millennia, humans from diverse cultures have used oracles and omens, from entrails to comets, to try to read the future. Science and mathematics have long contributed to this effort, originally through astronomy but increasingly through the use of supercomputers allied with ever more sophisticated theories and datasets. For a while (before modern computers), the universe was likened to an enormous mechanical clock, and a conceit arose that given sufficient data, theory, and computational power, science might one day refine the prediction of human affairs to an accuracy approaching the plotting of planetary orbits. The more recent discoveries of relativity, quantum mechanics, and chaos theory have shown the fallacy of this thinking and have even challenged the precision of astronomic forecasts.

Postmodernism has questioned other fundamentals, so that in some circles, definitive statements about even the present can seem audacious. However, the quest for the perfect should not obstruct forays in search of the helpful. The failure to develop a widely accepted science of history does not negate the existence of useful and durable historical principles, and the fact that the future can never be known with certainty does not mean that little of value can be said about it.

The futurist and systems thinker Hartmut Bossel has usefully likened the range of future possibilities as constrained within ''riverbeds'' of likelihood (Bossel, 1998). Many properties of human and natural systems compose these riverbanks. As well as the laws and principles of physics, genetics, biology, evolution, and so on, perhaps the most fundamental determinant of the future is that it must evolve from the present. This means not only that future human society will be strongly influenced by current and recent economic and social trends and theories, but also that past alliances, injustices, resentments, and enmity cannot be wished away. Historical facts, transmitted in the culture and contained within the psychology and memory of billions of people, will inevitably influence the future. There are a myriad of such facts and memories, and together they act to significantly restrict the range of possible futures.

Similarly, existing institutions—social conventions, interpersonal networks, rules, agencies of government, markets, laws, and norms—are embedded in the memory, customs, and behavior of the 6.4 billion souls who exist at the start of this future. Institutions will change, but their rate of change will be inevitably be slowed by the complex conceptual, legal, and psychological elements through which change must be filtered.

Other identifiable components of the riverbeds include demographic and infrastructural inertia and the plausible rate of technologic evolution. For example, barring calamity, such as nuclear war or an asteroid impact, the human population in 2020 will inevitably be larger than 7 billion. Similarly, there are maximal rates of technologic transition, such as the development and diffusion of a solar- and hydrogen-fueled energy system, that cannot be plausibly exceeded.

Although daunting, the generation of plausible futures is not impossible, and many spheres of science—especially

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physical, ecologic, and social—have made and will continue to make important contributions to this developing field. Perhaps one day scientific disciplines of both the future and history will be mature and respected.

The Evolution of Scenario Theory

To peer further into the fog, futurists have developed a tool called *scenarios*. Formally, scenarios are described as plausible but simplified descriptions of how the future may develop, according to a coherent and internally consistent set of assumptions about key driving forces and relationships (Swart et al., 2004).

To an extent, all humans build scenarios and create mental models of the future. We all know that the sun will rise tomorrow, and we project many other elements of the present into the short-term future, such our plans for a holiday or even retirement. Clearly, however, as the length of focus and the variety of possible outcomes increase, the confidence we can have in our projections quickly diminishes nonlinearly.

There are two main kinds of modern formal scenarios. Some are purely imaginative narratives, whereas others involve an interaction between narratives and computerized models. Narratives of the future, often developed by groups, are used to develop and justify different key assumptions. In the case of modeled scenarios, these assumptions are then applied to data that simulate the present, to produce quantifiable forecasts of elements that will exist at a given point of the future.

For example, scenario builders may imagine a world of extremely rapid technologic innovation and transformation. It is possible to conceive of a future full of energy- and greenhouse gas emission–sparing devices, of new crops that reduce cultivation pressure on marginal land, of techniques that harness biology to large-scale industrial processes, and of new forms of communication that enable the rapid diffusion of information, literacy, and education. Such a scenario can then be used to justify and to forecast optimistic rates of hunger alleviation, of slowed greenhouse gas accumulation, of adequate water quantity and quality, and so on.

As scenario expertise has developed, its participants have accepted ever more difficult tasks. Early versions evolved from war games to the "limits to growth" studies of the 1970s (Swart et al., 2004). In the 1990s, economic and technologic forecasts were used to inform and to develop complex projections of future greenhouse gas emissions, concentrations, and climatic effects. Now, the scenarios working group of the Millennium Ecosystem Assessment is trying to incorporate first-order ecologic feedback into the global biosocial system. Also, as the accompanying article shows, mainstream scenario exercises have shied away from an explicit consideration of health, although the burden of disease studies performed by the World Health Organization have estimated the future scale of some diseases, such as depression and heart disease, and other studies have been performed to forecast the range of vectors and populations at risk of vectorborne disease, including under different regimens of climate and demographic change.

As a consequence of the number, background, and separate histories of the various working groups involved in their construction, many scenarios have been developed and have a bewildering and potentially off-putting variety of labels. This diversity suggests a high degree of complexity within the range of scenarios, but in fact most scenarios are based on a small set of key differences, and the numerous species occupy similar conceptual niches.

Most of the different driving forces that determine different scenarios can be grouped along one of just a few axes. Major axes include an intensification or dilution of the global market, the centralization or diffusion of political power, the acceleration or slowing of technologic innovation, and the degree of commitment to sustainable development.

Lay Scenarios and Social Thresholds

Planning, whether for the next hunt, crop, or corporate takeover, is an ancient human characteristic and indeed has often formed the basis for attempts to enlist celestial help. In well-governed societies, sophisticated economic and social planning is routine. As large as the formal scenario literature is, an even larger mass of lay scenarios exists within the imagination of people. Less prosaically than the estimation of future electricity needs, the collective imagination of the near-term future by large numbers of people can sometimes mobilize society in ways that significantly influence that future, such as by large-scale protests and revolution.

In some cases, social thresholds are passed that seem beneficial to society, freedom, and population health. For example, the peace movements in Western countries in the 1980s arose in part because millions of ordinary people

became sufficiently concerned about a potential nuclear Armageddon (a lay scenario) to vehemently protest. In turn, this probably reduced the risk of global nuclear war. Shortly after, mass social movements in Eastern Europe led to the peaceful fall of several governments. However, in other cases, such as in the Tiananmen Square protest in Beijing in 1989, collective imagination has proven misguided or, at least, premature. This case can be conceptualized as an approach to a threshold that was not fully crossed.

The Rwandan genocide of 1994, in which one-sixth of the country's population was brutally and rapidly slaughtered, illustrates the exceeding of a social threshold that was immensely damaging to population health. Although this event may seem an inexplicable example of barbarity, other workers have suggested that the genocide was in fact a foreseeable and understandable consequence of resentment and resource scarcity leavened by the rapid growth in the number of largely unemployed, landless, manipulable, and desperate young men (Mesquida and Wiener, 1996; André and Platteau, 1998; Butler, 2000).

Problems with Scenario Theory

The existence of large-scale thresholds, whether social or environmental, is a major problem for scenario theorists. By definition, thresholds followed by the emergence of quantitatively and qualitatively altered postthreshold states are very difficult to predict. Yet although the nature of thresholds is uncertain and contested, their occurrence is well understood, not only by scenario workers, but also by the lay public. Evidence for the lay understanding of threshold events exists in the plethora of sayings in many languages and cultures, such as "a chain is only as strong as its weakest link" and "it is the last straw that breaks the camel's back."

Most scenario builders work in groups, and the task of reaching a consensus about the scale and timing of thresholds introduces another layer of difficulty. In some cases, this may be complicated by a desire to not be seen as too negative, because of the comparative marginalization of some of the more pessimistic forecasts, such as the limits to growth work or work from the WorldWatch Foundation. The precise prediction of most thresholds (rather than of their general existence) will almost certainly be wrong, and this may thus be seen as reducing the credibility of scenario theory. Consequently, there may be a tendency for most scenarios, especially those developed by groups of diverse individuals, to understate the frequency and severity of threshold events.

The existence of thresholds is particularly problematic for quantitative modelers, who, at least at present, can rarely (if ever) factor thresholds into their models even if their general existence is accepted. Imagine, for example, the political difficulty of introducing an equation that specifies a population-reducing calamity such as a civil war or epidemic once population density, poverty, and inequality exceed preset levels. Excluding such factors can instead produce implausibly optimistic scenarios. For example, the United Nations Population Division has long provided forecasts of the global population that are based purely on demographic factors such as birthrates and average life expectancy. The possibility of large-scale war or emergent diseases is entirely absent from consideration. This has led to absurdly high projections of maximum global population. Although more recent United Nations population projections have been reduced in response to the scale of the human immunodeficiency virus/acquired immune deficiency syndrome epidemic, this has been reactive; their projections continue to assume, implausibly, an absence of other adverse threshold events.

However, in other cases, the inability to factor in positive social thresholds may lead to excessively pessimistic scenarios. One such overly pessimistic scenario posits the almost complete loss of civil society, especially in developing countries, thus leading to a world of "barbarisation" (Kaplan, 1994; Raskin et al., 2002). Countering forces are actually likely to limit the full-blown emergence of such scenarios, although circumstances such as in Haiti after its recent (2004) flooding, in turn aggravated by its massive deforestation, poor infrastructure, and poor governance, suggest that small-scale barbarisation is not necessarily fanciful (Sontag and Polgreen, 2004).

This leads to another major problem with scenario theory. Almost all scenario groups claim that their visions are equally plausible, although not all scenario theorists are as finicky about the desirability of certain scenarios (Raskin et al., 2002).

In fact, virtually all scenarios are equally implausible. The exaggeration of existing tendencies that allows the conceptualization of clearly distinct futures is inherently unlikely, and the future instead seems far more likely to be a blend of the various scenarios that have been developed, rather than a delectable or detestable extreme.

Conclusions

Many problems with scenario theory have been outlined. Most scenarios are exaggerated caricatures that almost certainly will not occur. In general, modern scenarios are biased toward optimism and the privileging of Western values, and they understate the likelihood of adverse social and environmental thresholds. However, despite these limitations, scenarios can still be of value.

The imagination of alternative futures can provide insight into policy formulation. Just as we look before we leap, the description of adverse consequences may cause some decision makers to alter their policies. Desirable scenarios may inspire decision makers to work constructively. Also, whether scientific scenario workers like it or not, governments, corporations, and defense organizations will continue to explore diverse scenarios. The addition of social, environmental, climatic, ecologic, and health aspects to the scenario literature can only be of benefit.

More place is probably warranted for scenarios that are explicitly desirable, such as a world in 2050 in which there is *x*% less hunger and poverty than today, in which the prospects for sustainability look *y*% brighter than at present, and in which there is *z*% less violent conflict. Scenario workers could then work backward from this imagined future to the present to see how it might be achieved. The wide involvement of civil society in the process of imagining such a future (though not one that is utopian) could be a useful exercise. Such a study has recently been undertaken for a world in 2050 that manages to avoid a doubling in greenhouse gas concentrations (Pacala and Socolow, 2004).

In many ways, global social affairs are like an enormous juggernaut, beyond control and operating in a competitive global market on a planet with limited resources and a human population that is beginning to realize its collective footprint and, perhaps, its collective responsibility. If one technologic or social avenue is closed here, then market forces will prize open another opportunity there. If one coffee company adds a premium for fair trade, then its competitor down the street may offer a cheaper product. Although ideally we will look before we leap, ''he who hesitates is lost'' may reflect the competitive pressure that most people work with. In reality, these competitive forces greatly constrain the power of decision makers to influence the future; collectively, society seems like a marathon runner trying to juggle balls in mid stride.

Similarly, the global environmental system has tremendous inertial and self-organizational properties. Although humans have long influenced the global environment (Ruddiman, 2003), it seems hubristic to think we can develop geo-engineering or other strategies to radically and beneficially alter this environment within just a few generations. At best, our influence will probably be painfully limited, although a small contribution could still prove very valuable, given that we really do not yet know the full biosocial capacity of the planet (although one senses that that we are rapidly approaching such a limit).

Despite these many limitations, and despite (or because of) the fact that the ideas of most natural scientists reflect a far from universally accepted worldview, I think that workers in health, ecology, and other fields related to sustainability can collectively make one crucial contribution toward sustainability. This is to challenge the view that limits are neither real nor close. The excessively optimistic counterview, found especially in some economic and demographic literature (Johnson, 2001), has been characterized as one that ''lays stress on new ideas as a source of progress, supposing that the growth of ideas is capable of circumventing any constraint the natural-resource base may impose on the ability of economies to grow indefinitely'' (Dasgupta, 2000). This counterview is extant and powerful in the worldview of many currently influential people. Taken to extremes, it is a kind of magical thinking.

Alan Greenspan, for example, has very recently proclaimed faith in the capacity of the market to generate solutions to the current high cost of oil solutions (Andrews, 2004). I too have some faith in the capacity of society to solve its problems. However, left to the market alone, such solutions are likely to be at a very high social cost. Technology is not the only crucial element for the future, especially for health. The quality of our institutions, culture, aspirations, rules, norms, and resource distribution is of at least equal importance. Science needs to contribute to both. Peering into the fog, it is still possible to discern a future that is better than the present, but it will take much hard work, the change of some fundamental values, and, probably, a good measure of luck.

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