The Decision-Making Machinery Behind Environmental Policy

Review of PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING. By Frank Ackerman and Lisa Heinzerling. W.W. Norton & Co., 2004. 277 Pages.

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Priceless, by Frank Ackerman and Lisa Heinzerling, focuses on the question of whether there is a scientific decision-making method that will guarantee affordable protection of public health and the environment. The book discusses, and in the process exposes the flaws of, the currently dominant practice of cost-benefit analysis. *Priceless* suggests a more integrated approach. This Review will examine the two methodologies and measure their merits in relation to the chief environmental problem of the twenty-first century: the possible impacts of global warming.

The scientific method has triumphed in everyday life because it seems to offer myriad advantages in decision making, advantages that have led to the impressive technology we now enjoy. The method revolves around experiments and equations that quantify the contributions from different terms, compare them, and provide a clear result. For example, if one knows both how much heat is being added to a system and the heat capacity of the system, one can calculate precisely the expected temperature change. The calculation is theoretically independent of subjectivity. It doesn't matter if one is biased, or angry that particular day, or an optimist, or whether the calculation is being done in New York or Calcutta; as long as it is done correctly it is reproducible everywhere by anyone. To the extent that such calculations reveal the "truth" about a particular physical situation, we can build on the results, and the net effect of employing these various "truths" is that we have flat-screen TVs, microwave ovens, smallpox vaccines, and a host of other innovations that have raised the quality of our lives.

This would then seem to be the appropriate methodology for making all sorts of decisions—evaluate the different terms in an equation, calculate the net result, and, presto, we have an unambiguous answer. The practice of forming such equations for economic and policy questions, known as cost-benefit analysis, has taken hold of decision-making in Washington.[1] If we know the cost of an activity, such as an environmental or health regulation, and the level of its

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1. *See generally* FRANK ACKERMAN & LISA HEINZERLING, PRICELESS: ON KNOWING THE PRICE OF EVERYTHING AND THE VALUE OF NOTHING (2004).

benefits, we can see which is greater, that is, whether the regulation is worth it.

On the surface, nothing could seem more "scientific." But, as *Priceless* details, the practice is anything but scientific, especially when it is applied to health and the environment. There are two problems with cost-benefit analysis, both of which concern the inaptness of the analogy with the scientific method.[2] First, while we may know the cost of doing something in these particular fields, we really have very little idea of the benefits, especially for activities with effects far into the future. Second, we have no way of putting a monetary value on existence itself, whether it be our existence, or that of fish or trees or Planet Earth. When a person is hit by a car, we do not stand around debating whether he should be taken to the hospital, whether it is "worth" it. We assume that life is sacrosanct and that cost considerations should be dealt with later. We thereby guarantee for ourselves the possibility of rescue if we are the ones hit by the car. We do not make cost-effectiveness our highest priority at all times.

If we don't know the likely benefits of an activity, and cannot place a monetary value on the "priceless" aspects of life, the technique of cost-benefit analysis quickly sinks to the level of pseudo-science. As the authors of *Priceless* note, the costs of policies are generally somewhat more discernible than the benefits, though they tend to be overestimated.[3] Once a regulatory action is decided upon, human ingenuity usually achieves it at less than the expected cost. For instance, as the book indicates, the cost of sulfur removal when burning coal is now one-tenth of the original estimates.[4] In addition, environmental protection is often good for business, potentially resulting in increased energy efficiency, decreased use of raw materials, and the generation of new jobs—factors that are not taken into account in calculating the costs.

The benefits, on the other hand, are mostly made up, using ridiculous analogies, polls of how people think they would act in a given situation, or other completely indefensible measures.[5] For example, *Priceless* notes that in the late 1980s, the Environmental Protection Agency (EPA), when calculating the benefit of reducing arsenic levels in water—a cause of bladder cancer—used an approach called "willingness to pay."[6] The EPA asked people in a shopping mall in Greensboro, North Carolina how much lower a cost of living they would demand if they were asked to live in an area in which chronic bronchitis (not bladder cancer) was more prevalent. One third of the answers were deemed inappropriate and thrown out. Then, extreme opinions were dismissed. On the basis of this irrelevant and filtered comparison, the EPA decided the cost-effective level of arsenic in drinking water in the United States because it assumed bladder cancer was as serious as bronchitis.

In addition, the calculation of benefits has been consistently underplayed. For

2. *Id.* at 35–40.
3. *Id.* at 37.
4. *Id.* at 38.
5. *Id.* at 94–95.
6. *Id.* at 97.

health-related regulation issues, economists have largely ignored the benefit of avoiding risks other than death (such as ill health, reduced IQ, or suffering).[7] The lives of the elderly, and the future lives of everyone, are devalued.[8] Ultimately, the calculations have become so arbitrary in nature that any desired conclusion is possible.

This is the antithesis of science—one of the two major terms in the equation is basically unknown, and becomes subject to personal biases, held captive to the intentions of the individual(s) making the assessment. Under the guise of the scientific method, cost-benefit analysis is employed to carry out a specific agenda. When it comes to the environment, many economists, believing that the free market knows best, have an agenda of advancing unfettered market activity.[9] Even though monopolies and lack of information prevent the market from being a free one in which everyone acts in the optimal way,[10] any attempt to regulate it must be inefficient, they believe. The authors provide many examples of the manipulation of cost-benefit analysis to produce results consistent with the free market paradigm.[11] Because of the the free-market insistence on treating environmental integrity as private property, we end up having to pay people not to destroy the environment, as if we are taking something from them by denying them that right.[12] The authors note that this approach is built into the North American Free Trade Agreement (NAFTA), the trade agreement between the U.S., Mexico, and Canada: When one country attempts to prevent another country's company from damaging the environment, that company now has the right to sue for compensation for what is deemed tantamount to an expropriation.[13] Economists and policymakers are currently pressing for the adoption of this model within the U.S. as well.[14]

In practice, the approach taken by economists is not just pseudo-scientific, it is antiscientific. Many economists have a deep skepticism about any science that concludes that economic activity is hurting the environment.[15] With little training in scientific issues, these economists employ a subjective use of science, ignoring or altering the results as they see fit.[16] Scientists specifically criticize economists for the recent dropping of carbon dioxide (the major contributor to climate change[17]) from the EPA's list of man-made pollutants.[18]

7. *Id.* at 102–04.
8. *Id.* at 104.
9. *Id.* at 18–19.
10. *Id.* at 16–18.
11. *See, e.g., id.* at 43–44.
12. *See id.* at 21, 23.
13. *Id.* at 22–23.
14. *Id.* at 21.
15. *Id.* at 20
16. *Id.* at 120–22.
17. *See, e.g.*, Andrew C. Ravkin, *Bush vs. the Laureates: How Science Became a Partisan Issue*, NY TIMES, Oct. 19, 2004 at F1.
18. *See id.*

The free-market bias undermines the intellectual honesty of cost-benefit analysis.

As the authors note, even if we were able to put an unbiased price tag on all the benefits we foresee, it would still not be sufficient. Most of the benefits are unimaginable—and invaluable. Consider the result of the administration's opening for development more than fifty-eight million acres of federal forest.[19] We can estimate the cost of not doing this—the value of lumber not processed. But what is the benefit of allowing a forest to exist? Perhaps a man walking through it to relieve stress becomes more productive on the job; perhaps he communicates with his children better, and they in turn improve in their schoolwork, and become doctors, scientists, or job-creating entrepreneurs. Or perhaps, in his relaxed state, his coordination is enhanced, and he avoids running down the CEO of a major company who stumbles in front of his car, saving both that company and its insurance company considerable payments. And of course, the value of the forest's existence itself is unquantifiable. After all, trees have no buying power. To carry this one step further, how do you quantify the value of having the human race exist?

The desire for a one-approach-fits-all solution ignores the complexity of daily existence. In the place of an unobtainable quantification technique, the authors of *Priceless* offer a more demanding approach that does not rely on any specific formula. They recommend that we make choices consistent with the known values of the American people, using a variety of inputs, of which the cost of regulation is but one. Let us consider an example of both approaches in dealing with the question of whether we should do anything about global warming.

Humans are currently changing the atmospheric composition by adding "greenhouse" gases to the atmosphere, principally carbon dioxide (CO_2). This will warm our planet, as these gases trap the energy that the Earth, having absorbed it from the Sun, is attempting to radiate out to space. This "greenhouse" trapping of energy is not just a theory—the temperature on the surface of Venus, which actually receives less sunlight than Earth owing to its thick cloud cover, is some 700°F at its surface. Venus has an atmosphere of CO_2; the greenhouse effect has greatly warmed the planet. The climate on Earth more than 3 million years ago was apparently much warmer than it is today, owing to higher CO_2 levels in the atmosphere.

We have been adding CO_2 primarily through the burning of fossil fuels.[20] In pre-industrial times, the carbon dioxide concentration in the atmosphere was about 270 parts per million (ppm); it has now risen to above 370ppm, with most of the increase in the past fifty years.[21] If CO_2 levels continue to grow at the current rate, we will reach double the pre-industrial concentration by the end of

19. *See* Douglas Jehl, *On Environmental Rules, Bush Sees a Balance, Critics a Threat*, NY TIMES, Feb. 23, 2003 at 1.

20. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: SYNTHESIS REPORT 180–82 (2001) [hereinafter SYNTHESIS REPORT].

21. Id. at 155.

this century. However, it is estimated that by 2050 our energy needs will be double to triple what they are today, which means associated CO_2 emissions will double in that time if fossil fuels continue to represent our prime energy source.[22] This prognosis suggests we are likely to reach that doubled atmospheric CO_2 level even earlier, probably around the middle of this century.

There is little doubt that the atmosphere is now warming up, and that the warming will continue and even accelerate as long as humans continue to add greenhouse gases to the atmosphere. The Intergovernmental Panel on Climate Change estimates that a doubling of atmospheric carbon dioxide will lead to a temperature rise of 1.5-4.5°C,[23] and that by the end of this century the global temperature may rise between 1.4° and 5.8°C.[24] The warming in the last 150 years has been about 0.6°C,[25] so we are looking at warming of up to ten times that amount in the next 100 years. To provide perspective, the average global temperature during the last ice age was some 5°C colder[26]—and ice sheets extended as far as New York City. The American Geophysical Union, the leading group of scientists studying climate change, has expressed the concerns of the scientific community:

> It is virtually certain that increasing atmospheric concentrations of carbon dioxide and other greenhouse gases will cause global surface climate to be warmer. . . The unprecedented increases in greenhouse gas concentrations, together with other human influences on climate over the past century and those anticipated for the future, constitute a real basis for concern.[27]

How much would it cost to prevent this from happening? While we cannot really know, the Kyoto Protocol, which intends to reduce greenhouse gas emissions by about 5% compared to 1990 values, would probably have reduced U.S. gross domestic product by 0.5% in 2010 if the U.S. had joined the protocol (though that figure could be lower if technological advances and emission trading were factored in).[28] To keep CO_2 levels from doubling will require a roughly 33% reduction from expected carbon emission levels (and 50% from a

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22. SHELL INTERNATIONAL, ENERGY NEEDS, CHOICES AND POSSIBILITIES: SCENARIOS TO 2050 (2001), *available at* http://www.shell.com/scenarios.

23. SYNTHESIS REPORT, *supra* note 20, at 93.

24. *Id.* at 69.

25. *Id.* at 2.

26. *Id.* at 93.

27. American Geophysical Union, *Human Impacts on Climate* (2004), *available at* http://www.agu.org/sci_soc/policy/climate_change_position.html.

28. SYNTHESIS REPORT, *supra* note 20, at 341.

29. *See* SYNTHESIS REPORT, *supra* note 20, at 315. To stabilize atmospheric CO_2 at less than double the preindustrial level (that is, at less than 550 ppmv) would require cumulative carbon emissions to not exceed some 1000 GtC. The SRES models project there to be releases of from 1000 to 2000 GtC by 2100 AD. Taking a mid-value of some 1500 GtC, we would require a reduction of some 500 GtC, or a reduction of 33%.

"business as usual" approach).[29] One can see that the costs would be considerable.

What about the benefits? If we cannot estimate the costs very well, we are in much worse shape concerning the benefits. Climate changes of the magnitude discussed above would likely affect every aspect of our lives. Consider first the possible health impact associated with the warmer, and perhaps more humid, conditions to be expected. These changes are already happening: from 1949 to 1995 the number of heat waves in the U.S. increased about 20%, with the largest effects in the eastern and western parts of the country.[30] This may be the result of both the global warming that has already taken place and an increase in the heat island effect due to urbanization.[31] Both situations are likely to get worse as time goes on. It is an example of how the effects of climate change can interact with other changes and become amplified.

Extreme summer temperatures have a greater impact on human health than any other severe weather in the U.S., with a particular impact on the elderly.[32] The 35,000 deaths in Europe associated with the heat wave of 2003 fell disproportionately among the elderly.[33] This should have particular relevance to the aging populations in the U.S. and Western Europe. Also affected are the very young.[34] Both vulnerable age groups are medically underinsured.[35] It is therefore likely that the government would have to step in and provide for their care as warming intensifies.

A less obvious impact on health concerns disease vectors, in particular mosquitoes. Mosquitoes transmit various viruses, including malaria, West Nile Fever, and dengue fever. Mosquitoes are highly sensitive to climate factors—warmer temperatures within survivable ranges and sufficient moisture will increase mosquito populations, activity, and abundance.[36] Enhanced extreme weather events in the context of global climate change, such as floods, foster fungal growth and provide additional breeding places for mosquitoes.[37] Warmer temperatures increase biting frequency while decreasing mosquito mortality and

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30. D. J. Gaffen & R. J. Ross, *Increased Summertime Heat Stress in the U.S.*, 396 NATURE 529, 530 (1998).

31. *Id.*

32. *See* Stanley A. Chagnon et al., *Impacts and Responses to the 1995 Heat Wave: A Call to Action*, 77 BULL. AM. METEOROLOGICAL SOC'Y 1497, 1498–99 (1996); Laurence S. Kalkstein & Robert E. Davis, *Weather and Human Mortality: An Evaluation of Demographic and Interregional Responses in the United States*, 79 ANNALS ASS'N AM. GEOGRAPHERS 44, 62 (1989).

33. *See* Jo Johnson, *Paris Continues To Feel the Heat from a Deadly Summer*, FINANCIAL TIMES (London), Dec. 24, 2003, at 6 (reporting that 87% of heat-related mortality was among those over 75).

34. *See generally* Jonathan A. Patz et al., *The Potential Health Impacts of Climate Variability and Change for the United States*, 64 J. ENVTL. HEALTH 20 (2001) (children's vulnerability is heightened because of their size, behavior, and factors related to their physiological immaturity).

35. *See* David T. Shapin, *The Remission of ERISA Preemption*, 28 CONN. L. REV. 917, 948 (1996).

36. *See* Paul R. Epstein et al., *Biological and Physical Signs of Climate Change: Focus on Mosquito-Borne Diseases*, 79 BULL. AM. METEOROLOGICAL SOC'Y 409, 413–14 (1998); Willem J. M. Martens et al.., *Sensitivity of Malaria, Schistosomiasis and Dengue to Global Warming*, 35 CLIMATIC CHANGE 145 (1997).

37. Epstein, *supra* note 36, at 414.

parasite-incubation time.[38]

Such changes are already being reported: Mosquito-borne diseases are now being reported at high elevations in the highlands of Asia, Central Africa and Latin America, consistent with the increasing temperature and upward plant distribution displacement in the tropics.[39] And again, unexpected effects enter the equation. Not only will warmer temperatures by themselves permit the spread of these diseases (the minimum bearable temperature for most malaria parasites is 16°C),[40] they will also lengthen the transmission season. As temperatures rise at high elevations, mountains will no longer act as effective barriers to disease transmission.[41] As diseases spread to new areas, they could threaten people without resistance or experience in disease prevention. And again, this process will be occurring on top of other changes: Insect resistance continues to compromise the effectiveness of pesticide control, while diseases are becoming increasingly resistant to antibiotics.[42]

As a final example, water-borne diseases will likely increase. Heavy rainfall events can transport terrestrial microbes into drinking water sources; an increase in polluted area water bodies will almost certainly lead to an increase in outbreaks of water-related diseases, such as schistosomiasis (water-snail), amoebiasis, typhoid, and other infections. Micro-organisms that cause cholera and certain types of zooplankton put coastal regions (especially flood-prone countries like Bangladesh) at risk for cholera outbreaks and epidemics.[43] A good rainy season in Africa thus coincides with the increase of cholera and water-borne diarrhea diseases due to infected lakes. Heavy rainfall events are already occurring with increasing frequency in the U.S. and around the world.[44]

Such effects can be prevented, at least somewhat, but at a cost. The U.S. may have to help modernize the water supply for less wealthy nations, in the interest of protecting itself from communicable diseases as well as averting disaster-relief scenarios. Once the temperate mid-latitudes, where most of the world's well-off live, start becoming affected, there will be significant pressure for funding increases to find suitable vaccines or treatments. Increased disease prevalence and severity will affect productivity, health, and lives. The costs of containment or treatment are hard to quantify ahead of time, but will surely be

38. Martens, *supra* note 36, at 148.

39. Epstein, *supra* note 36, at 413.

40. L. Molineaux, *The Epidemiology of Human Malaria as an Explanation of Its Distribution, Including Some Implications for Its Control, in* MALARIA: PRINCIPLES AND PRACTICES OF MALARIOLOGY 913–22 (Walter H. Wernsdorfer & Sir Ian McGregor eds., 1998).

41. *See* Rita R. Colwell, *Global Climate and Infectious Disease: The Cholera Paradigm*, 274 SCIENCE 2025 (1996).

42. WORLD HEALTH ORGANIZATION, SHADOW EPIDEMIC: THE GROWING MENACE OF DRUG RESISTANCE (2004), *available at* http://health.news.designerz.com/bacterias-increasing-resistance-to-drugs-worries-international-experts.html.

43. Colwell, *supra* note 41, at 2026–27.

44. INTERGOVENMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: THE SCIENTIFIC BASIS 158–59 (2001) [hereinafter SCIENTIFIC BASIS].

immense.

Climate change will likely have a negative impact on ecosystems, especially in the short run. Marked changes in the phenology of plant and animal species are already occurring with only the 0.6°C warming discussed above.[45] For 80% of the plant and animal species studied, this includes speeding up the timing of breeding or blooming by five days per decade.[46] Many species may not be able to keep up with these changes as warming continues.[47] While ecosystems may also be feeling the influence of other factors, 80% of species are shifting in the direction associated with climate warming and precipitation changes.[48] Other challenges species face include pollution, land-use change, over-harvesting, and effects of invasive species, all of which make biodiversity more vulnerable to climate change.[49] The net effect is likely to be a reduction biodiversity: One study has estimated that between 15% and 37% of a sample of 1,103 land plants and animals will eventually become extinct by 2050, with climate change the greatest threat.[50] The decreases in biodiversity, as increased instances of monocultures and low-diversity ecosystems become more prevalent, will result in greater outbreaks of diseases and the wider spread of pests, further affecting human health.[51]

What is true for natural ecosystems is also applicable for managed ecosystems, such as agriculture. Many crops are C3 plants that yield more complex and higher-quality nutrients, such as protein and oil.[52] C4 crops, while using less water, produce more sugars and starches. C3 plants show enhanced net photosynthesis and growth with increasing partial pressure of CO_2, whereas C4 species are generally less affected because of their lower CO_2 saturation point for photosynthesis. C3 plants previously were thought to have the advantage in

45. *See* Terry L. Root et al., *Fingerprints of Global Warming on Wild Animals and Plants*, 421 NATURE 57, 57 (2003).

46. *Id.* at 59.

47. INTERNATIONAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2001: IMPACTS, ADAPTATION, AND VULNERABILITY 293 (2001).

48. *See* Camille Parmesan & Gary Yohe, *A Globally Coherent Fingerprint of Climate Change Impacts Across Natural Ecosystems*, 421 NATURE 37, 39 (2003).

49. *See* Chris D. Thomas et al., *Extinction Risk from Climate Change*, 427 NATURE 145, 145 (2004).

50. *Id.*

51. UNITED NATIONS ENVIRONMENT PROGRAMME WORLD CONSERVATION MONITORING CENTRE, BIODIVERSITY AND CLIMATE CHANGE (2003), *available at* http://unep-wcmc.org/climate/home.htm.

52. Most higher plants have a "C3" pathway of photosynthesis, as the CO2 absorbed from the atmosphere breaks down into two 3-carbon compounds, before being converted to sugars. Some plants that are adopted to hotter or drier climates have a "C4" pathway, in which a 4-carbon compound is created on the way to sugar production. Associated with this difference in photosynthesis are differences in leaf structure and capabilities. When C3 plants are in danger of dehydration, their stomates close to reduce water loss, lowering CO2 levels in the leaf tissue. When these levels fall below 50 ppmv, photosynthesis stops. In contrast, C4 plants can continue to photolyze until the CO2 level in the leaf tissue drops to 1 or 2 ppm, so they can close their stomates without significantly affecting photosynthesis.

times of rising CO_2 levels.[53] But when water issues are taken into account, C4 plants, which are more widespread at lower, warmer latitudes, win out, partly owing to the likelihood of more frequent and severe droughts.[54] The switch from C3 to C4 crops will lower the nutritional value of agricultural production, as will the more rapid and earlier growing season. While the effects will be felt most severely at low latitudes, agriculture around the world faces an estimated decrease in cereal yields of 11%–20%.[55] And this estimate takes into account improvements in technology and farm-level adaptations, and makes a consistently generous assumption about the effectiveness of CO_2 fertilization of plants—an effect that in various field studies produces an average biomass increase in grasses and crops combined of some 14%, with much variation.[56] Many plants, including rice, are already functioning at their upper temperature limit.[57] Climate-induced decreases in crop yield could raise the price of food by 25%–145% through such factors as decreased availability and necessary increases in irrigation.[58] That would increase the number of people at risk for hunger.

Not only land flora will be negatively affected, but also fauna and ocean organisms. Melting of sea ice and permafrost at high northern latitudes is already affecting the life cycle of polar bears, seals, and walrus, as well as hurting the indigenous human populations.[59] Alaska now spends an estimated $35 million per year on infrastructure maintenance associated with the melting permafrost.[60] Mass mortality and outbreaks of disease have become more frequent and widespread in the ocean in the past few decades.[61] Coral reefs are a good indicator of the health of the ocean, and have shown unprecedented mass mortality in the past few decades.[62] If a coral reef is exposed to prolonged thermal stress (the estimated threshold is about 1°C above mean summer maximum temperatures) the corals will bleach and eventually die.[63]

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53. W. J. Arp et al., *Interactions Between C3 and C4 Salt Marsh Plant Species During Four Years of Exposure to Elevated Atmospheric CO_2*, 104/105 VEGETATION 133 (1993).

54. Joy K. Ward et al., *Comparative Responses Of Model C3 And C4 Plants To Drought In Low And Elevated CO_2*, 5 GLOBAL CHANGE BIOLOGY 857, 865 (1999).

55. *See* Martin Parry et al., *Climate Change and World Food Security: A New Assessment*, 9 GLOBAL ENVT'L CHANGE S51 (1999).

56. SCIENTIFIC BASIS, *supra* note 44, at 195.

57. SYNTHESIS REPORT, *supra* note 20, at 249.

58. *See* C. Rozenzweig & M. Parry, *Potential impact of climate change on world food supply*, 367 NATURE 133–138 (1994).

59. *See* ARCTIC CLIMATE IMPACT ASSESSMENT, IMPACTS OF A WARMING ARCTIC (2004) (comprehensive international survey of major impacts of arctic warming), *available at* www.amap.no/acia/index.html.

60. UNITED STATES GLOBAL CHANGE RESEARCH PROGRAM, U.S. NATIONAL ASSESSMENT OF THE POTENTIAL CONSEQUENCES OF CLIMATE VARIABILITY AND CHANGE, EDUCATIONAL RESOURCES REGIONAL PAPER: ALASKA, *available at* http://www.usgcrp.gov/usgcrp/nacc/education/alaska/ak-edu-3.htm.

61. *See* C. D. Harvell et al., *Emerging Marine Diseases—Climate Links and Anthropogenic Factors*, 285 SCIENCE 1505, 1505 (1999).

62. *See* T.P. Hughes et al., *Climate Change, Human Impacts and the Resilience of Coral Reefs*, 301 SCIENCE 929, 929 (2003).

63. *Id.* at 929–30.

Again, these effects are already happening: Coral reefs have declined by 30%, with a larger percentage already severely damaged by human activity.[64] Sixty percent of coral reefs may be lost in the next thirty years. Coral reefs support large ecosystems that in turn support humans through fishing, harvesting and tourism. And of course, they have an existence value that is unquantifiable.

The monetary value of these changes—which could result in humanitarian and public health crises, as well as geopolitical instabilities associated with food shortages—is probably incalculable. However, the biggest potential societal impact of climate change is on water resources. An increase in the intensity of droughts and floods is a certainty as climate warms, for the air can hold more moisture when it is warmer: On a warmer Earth when it is raining, it will rain more heavily (as noted above, that is already happening), and when it is dry, there will be greater evaporation from soils and reservoirs. Projections using a drought index analogous to the Palmer Drought Severity Index (PDSI), the measure of drought and flood conditions used by the National Weather Service, indicate that global warming of 4°C this century would lead to intense droughts over a good portion of the globe, from mid-latitudes to the equator.[65] At a meeting in California for water resource managers some years ago, the author presented PDSI projections illustrating the extent of the possible drought and flood conditions. The response of the managers was that if the projected changes were to occur, there would be nothing anyone could do.

Changes in water availability will affect every aspect of life, including sanitation, agriculture, hydroelectric power generation, and industry. As in the other areas, the water-based consequences of global warming are beyond our ability to imagine. In 1988, the Electrical Power Research Institute, made up of a consortium of power companies, prepared a thick book about the likely impact of climate change on energy demand and production in New York state.[66] It concluded that climate changes over the next thirty years could increase generating capacity requirements and production costs while reducing hydroelectric supply.[67] During the summer of that very year, a major heat wave hit Canada and the northern portion of the U.S.and the cooling water used in power plants evaporated.[68] The result was that the power plants had to shut down entirely, far exceeding the report's estimated impact.[69] Non-linear effects such as these will be most problematic to deal with, and are certainly difficult to quantify ahead of time.

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64. *Id.*

65. D. Rind et al., *Potential Evapotranspiration and the Likelihood of Future Drought*, 95 J. GEOPHYSICAL RES. 9983, 9988 (1990).

66. ELECTRICAL POWER RESEARCH INSTITUTE, POTENTIAL IMPACTS OF CLIMATE CHANGE ON ELECTRIC UTILITIES (1989).

67. *Id.*, abstract (unpaginated).

68. *See* D. Wilhite & O. Vanyarkho, *Pervasive Impacts of a Creeping Phenomenon*, *in* DROUGHT: VOL. 1, A GLOBAL ASSESSMENT 245-255 (D. Wilhite ed., 2000).

69. *See* SOME ENVIRONMENTAL AND ECONOMIC IMPACTS OF THE 1988 DROUGHT (E.E. Wheaton & L.M. Arthur eds., 1992).

As a final example, the global sea level will rise from the thermal expansion of warming waters and the melting of ice, resulting in altered coastlines and loss of coastal freshwater sources owing to invasion by salt water. The best estimate is that the sea level during this century will rise about three times more than during the last, but the possibility exists of much more extreme changes, with rapid ice drain-off from Antarctica and perhaps Greenland.[70] Many regions would be inundated, with losses again incalculable. One component of this process has already begun: Two of the Larsen Ice Shelves in Antarctica have disintegrated in the past ten years, and ice streams carrying land ice to the ocean from Antarctica have accelerated.[71] If the West Antarctic Ice Sheet slides into the ocean, sea level would rise by five meters, ten times more than current estimates.[72] Much of the British Isles would be under water.

Should we act to minimize the likelihood of extreme climate changes, given the sizable costs that would be necessary? Relying on cost-benefit analysis, the policymakers in Washington have apparently decided that the answer is "no." Of course, that is not explicitly said; what is said is that we need to wait for certainty.[73] But it amounts to the same thing: it is very likely there will be no certainty until it is too late to act. It is exceedingly difficult to estimate the benefit of preventing these changes. The most common form of calculation, as discussed in great detail in *Priceless*, looks at how many "life-years" would be saved.[74] But many of the problems discussed above would primarily affect the elderly, who do not have many years of life left, so the loss, in those terms, would not be very large. And from the economic perspective, it might actually benefit the economy because the majority of health care expenditures are for treating the elderly. Relying solely on cost-benefit analysis produces this type of cruel logic.[75]

Climate change also threatens the health of the very young. To calculate the monetary value of future lives, economists apply an economic principle called "discounting."[76] A dollar saved today, when invested, will be worth more tomorrow—so a dollar gained tomorrow is worth less than one gained (or saved) today. If lives are measured in dollars, then, a life lived tomorrow is less

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70. *See* ARCTIC CLIMATE IMPACT ASSESSMENT, *supra* note 59.

71. Hernán DeAngelis & Pedro Skvarca, *Glacier Surge After Ice Shelf Collapse*, 299 SCIENCE 1560, 1560–62 (2003).

72. *See, e.g.*, Bob Holmes, *Melting Ice, Global Warming: The Sea Level Could Rise Dramatically if Antarctic Ice Keeps Vanishing*, NEW SCIENTIST, Oct. 2, 2004, at 8.

73. *See, e.g.*, *Special Report* (FOX News television broadcast, Aug. 3, 2001) (comments of Vice President Dick Cheney) ("[T]he Kyoto Protocol] is a flawed agreement... It imposes a very harsh solution on a problem that is still only partially understood.").

74. *See* ACKERMAN & HEINZERLING, *supra* note 1, at 52, 74.

75. *See, e.g.*, Thomas S. Ulen, *The Law and Economics of the Elderly*, 4 ELDER L.J. 99, 100–01 (1996) (discussing economic contributions and costs of elderly population and appropriate policy responses); Seth F. Kreimer, *From Black and White to High-Definitional Equal Protection*, 70 TEMPLE L. REV. 1165, 1171 (1997) (same).

76. For a detailed discussion of discounting, see ACKERMAN & HEINZERLING, *supra* note 1, at 179–204.

valuable than a life lived today. At prevailing discount rates, a child who loses seventy years of expected life would really only lose fourteen (discounted) life-years.[77] In this way, future losses of life are diminished in importance.

What about the value of the flora and fauna that will suffer? They have both a "use" value, to those who directly interact with them financially, and an "existence" value for the rest of us, who would presumably pay for them to still be around. However, these values too will be discounted, and if the losses occur sufficiently far in the future, they can be reduced to minimal magnitudes. In reality, it is impossible to assign a cost to existence.

Finally, the direct losses to industrial production caused by water shortages, extreme climate events, and sea level rise, can be ignored by cost-benefit calculations until further research provides exact numbers, because there is no certainty about exactly what will happen at any particular time. In this way, cost-benefit advocates equate ever-present uncertainty with zero cost.

As *Priceless* demonstrates, cost-benefit analysis is a prescription for doing nothing to ward off almost any future environmental catastrophe. It values economic considerations above all others, including human health and the health of the flora and fauna on this planet. Economists would counter by arguing that spending money wisely today (according to their cost-benefit calculations) will allow us to have more money available tomorrow to deal with the problems. Of course, this ignores the fact that the dollar saved today goes into our pockets, while the potentially disastrous impact is felt by our future generations, so there is a question of fairness. The argument also assumes that we will save all the money that today's dollar will earn through compound interest, and bequeath it to our heirs, who will then have money to clean up their environment. Given our habitual low savings rate, this is not likely to be true, and it is also very probable that the environment will not be "clean-up-able."[78] Once the rainforest and associated biodiversity is gone, or the sea ice melted, or the sea level now covering coastal areas, no amount of investment will rapidly reverse the situation (and this is obviously also true for the lives lost). The climate system has a long response time: It takes a long time to change it, but once it changes, it will not come back quickly. It is estimated that the sea level rise we are currently inducing will continue for over 1,000 years.[79] On a cost-benefit analysis, the benefits of preventing the harm are nugatory: The rainforest does not have many easily quantifiable benefits, except for speculation about unfound medical remedies, and sea ice has even fewer. And whatever the harm, discounting minimizes—and thus obscures—its economic impact.

If we are not to depend on cost-benefit analysis, what should we use instead? The authors of *Priceless* offer the following prescription: Of primary importance is adopting a precautionary approach to potentially dangerous risks—act

77. *See id.* at 196.

78. *See, e.g., id.* at 186.

79. *See* SYNTHESIS REPORT, *supra* note 20, at 89.

now, when early warnings have become available, rather than waiting until there is certainty as to what will happen, when it may well be too late.[80] Climate change in particular is an issue that may well be made much worse by waiting for certainty from models that may never come. The truth is that we are pushing the system out of equilibrium, and the farther out it goes, the more likely that extreme, and perhaps rapid, changes will occur.[81] A recent Pentagon-commissioned study on abrupt climate change focused on the possible climatic effects that would ensue if the circulation in the North Atlantic shuts down; there is already indirect evidence that it has started to slow.[82]

As the authors of *Priceless* note, the policy of waiting until the climatic responses are established beyond doubt before acting could easily be applied to other possible calamities—we have no firm indication, for instance, of how many people terrorists are planning to kill in the next few years, so perhaps we should wait until we have a better handle on the "benefits" of avoiding terrorist activities.[83] It has been observed that the cost between 1948 and 1990 of building up our nuclear arsenal to discourage the Soviet Union from starting a nuclear war was approximately equal to the value of every material thing in the United States except for the land itself.[84] Was that cost worth the benefit? How would we go about answering that question? A nuclear war between the Cold War antagonists never happened, and it may well be that our arms buildup—along with that of the Soviet Union—is one reason why.[85] But we don't engage in cost-benefit reasoning when it comes to nuclear war. If an outcome is potentially bad enough, we do not do cost-benefit analyses before deciding to prevent it—we just act.

That is the second principle the authors promote: once we (through our elected representatives) decide that an issue is sufficiently important, "command and control" behavior is called for: a decision is made, it is carried out, and the costs are debated afterwards.[86]

Command and control, though it originated in the military, is not only used

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80. *See* ACKERMAN & HEINZERLING, *supra* note 1, at 225.

81. *See, e.g.*, Richard B. Alley, *Abrupt Climate Change*, SCIENTIFIC AMERICAN, Nov. 5, 2004.

82. *See* PETER SCHWARTZ & DOUG RANDALL, AN ABRUPT CLIMATE CHANGE SCENARIO AND ITS IMPLICATIONS FOR UNITED STATES NATIONAL SECURITY 9-10 (2003), *available at* http://www.ems.org/climate/pentagon_climatechange.pdf.

83. *See* ACKERMAN & HEINZERLING, *supra* note 1, at 146–47.

84. The observation is often credited to Carl Sagan; for an accounting of the total military expenditures between 1948 and 1991, see CTR. FOR DEFENSE INFORMATION, ANNUAL MILITARY SPENDING FROM 1945 TO 1996, *at* http://www.cdi.org/issues/milspend.html (giving the total cost (in 1996 dollars) as $13.1 trillion).

85. This bilateral deterrence is typically referred to as "mutual assured destruction." *See, e.g.*, 150 CONG. REC. S6608 (daily ed. June 8, 2004 (statement of Sen. Kyl) ("The prevailing nuclear standoff between the two superpowers when Reagan came into office was frightening. They were locked in a decades-old equilibrium under which neither attacked the other because each could, at the push of a button, destroy the other's populations with nuclear weapons. President Reagan once commented that this nuclear standoff, which was called mutual assured destruction, was 'a sad commentary on the human condition.'").

86. *See id.* at 219–23.

there. Some major companies have decided that it *is* worth trying to minimize future climate changes, both for their own sake and for humanity as a whole, and they have started using this method.

Twenty businesses plus a number of national governments, cities and U.S. states have recently joined in a new public/private partnership, called the Climate Group; their goal is to lead a "global groundswell of action" to help stabilize climate and reduce the likely negative impacts associated with its change.[87] Firms such as Swiss Re, BP, and 3M have all made concerted efforts to minimize their energy use and promote environmentally friendly policies.[88] Swiss Re, the largest reinsurer in North America, recognizes the potential economic disaster that climate change is likely to wreak on the insurance industry, crossing over all three of its divisions: property and casualty, life and health, and financial service-business opportunities.[89] Of the forty largest insurer events since 1970, only six were not related to weather.[90] The Climate Group recently issued a public announcement decrying the damage that climate change is likely to do to its industries and to humankind, and has pledged to push for zero growth in carbon output over the next fifteen years, through techniques such as improved energy efficiency in buildings.[91] BP has decided that it is a feasible goal to keep CO_2 from doubling in the atmosphere; it has already reduced its CO_2 emissions by 10% below 1990 values, and will maintain them at the 2001 values for the next decade.[92] 3M aims to reduce its greenhouse gas emissions to 50% of the 1990 level by 2007.[93]

All these decisions were made at the highest levels of the companies and mandated to all employees. As noted in *Priceless*, when the Clean Air Act[94] was passed in 1970, it was decreed in a command-and-control fashion that polluters would have to adopt the best emission-control technology and meet strict performance standards.[95] The EPA was established to enforce it. A similar top-down decision by the government could mitigate the impacts of climate change.

I would venture that the vast majority of Americans support and desire government actions taken to prevent illness and environmental degradation, regardless of the monetary value assigned to them by bureaucrats. In some areas

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87. Vanessa Houlder, *Swiss Re Changes the Climate*, FINANCIAL TIMES, Apr. 27, 2004, at 12.

88. *Id.*

89. *Id.*

90. Swiss Re, Presentation at Environmental Change: The Science and Human Health Impacts, A Course for Senior Congressional Staff, at the Airlie Center, Warrenton, VA (April 12, 2004).

91. See http://theclimategroup.org.

92. *See* BP, ENVIRONMENT AND SOCIETY: OUR POSITION, *at* http://www.bp.com/sectiongenericarticle.do?categoryId=2011560&contentId=2016944

93. *See* 3M, REDUCING GREENHOUSE GASES, *at* http://solutions.3m.com/wps/portal/_1/en_US/_s.155/115245/_s.155/115898.

94. 42 U.S.C. §§ 7401-7671 (1970).

95. ACKERMAN & HEINZERLING, *supra* note 1, at 206. The Act is estimated to have saved twenty trillion dollars, about forty times what it cost.

of government we acknowledge this already—for example, the Food and Drug Administration ensures that medicines are safe and effective before allowing them on the market. It is at least doubtful that an unregulated pharmaceutical market would be as safe.[96]

Our elected representatives should be told in no uncertain terms to value health and the environment above all else, and they must held accountable for their actions on each and every one of these issues. With regard to those phenomena that clearly endanger us, whether it be climate change or arsenic in the water supply, these representatives must demand action, providing at least the *opportunity* to solve what may now appear to be intractable problems. The companies noted above all feel that they can protect the environment and provide a good return for their stockholders, that the two are not mutually inconsistent.

The third principle espoused by the authors is fairness.[97] It is consistent with the values of the American people that we promote fairness toward the poor and powerless today, and toward future generations. We are the stewards of the environment, and our descendants will have available only what we leave to them. If we take concerted action now, we may prevent the most serious problems from arising—and if successful, we may never know what would have happened otherwise. But if we fail to act now, and the worst outcomes do come to pass, we will have failed to protect future generations. In addition, the most immediate impacts of climate change will fall hardest on third-world countries, which are the least capable of dealing with them (although we are not insulated from what happens elsewhere). And they will have arisen largely from our activities—the U.S. produces 25% of the world's greenhouse gases.[98] However, whatever is done must also be effective, and while China has not played a leading role in creating the problem, its current coal consumption is 40% of the world's total.[99] It cannot be left out when alternate courses of action are decided. Global warming has all the elements of risks that surveys show Americans are most unwilling to accept: its hazards are unfamiliar, uncontrollable, involuntary, inequitable, dangerous to future generations, irreversible, man-made, and potentially catastrophic.[100] It is consistent with our values and desires that the risks of global warming be minimized.

The final, and most important, principle proposed by the authors, is to approach this and other health and environmental topics in a holistic way. A cost-benefit analysis should be factored into decisions only when it can be performed in an unbiased, knowledgeable fashion in which science is respected.[101] But it must be just one factor. The inestimable values of life, health,

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96. *See, e.g.*, Stacy Lu, *World Medical Community Frets over Unregulated Medicine Sales on Web*, N.Y. TIMES, Mar. 23, 1998, at D3.

97. ACKERMAN & HEINZERLING, *supra* note 1, at 229.

98. See, e.g., http://yosemite.epa.gov/oar/globalwarming.nsf/content/EmissionsInternational.html.

99. *See* N.Y. TIMES, Apr. 18, 2004, at section 4 p.3.

100. *See* ACKERMAN & HEINZERLING, *supra* note 1, at 130-31.

101. *See id.* at 210-11.

the potential for suffering, and the preservation of our natural environment must be considered as well. Our values must be respected; unelected officials cannot devalue the lives of the elderly or discount the future so that nothing matters. If all factors are added in, we are more likely to make decisions that embody our natural common sense and will stand the test of time.

Today, decisions are being made based on a pseudo-scientific cost-benefit approach that may maximize current profits, but appears to have little regard for future well-being. This is not a philosophy we should want to impart to our children; as things are going, they will receive it along with an unhealthy and devalued environment. *Priceless* offers a vital perspective on an alternate approach that will maximize the involvement of the citizenry, in a democratic way, to help best determine the future of our health and the environment, along with our economy. It should be mandatory reading for all who care about the future.