WATER RESOURCES—SCIENCE AND VALUES

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The theme of this issue raises many questions beyond the technical problem of providing more fresh water where it is needed, whether for agriculture or domestic use. The problem is clear: water supplies, particularly groundwater supplies, are diminishing as a result of pollution and depletion of aquifers by extracting more water than the natural recharge. In many instances, the current rate of recharge is essentially zero and we are extracting "fossil" water that was recharged under previous more humid climatic regimes. At the same time, the human population is expanding, its diet is changing in a way that demands more water for agriculture, and climate change adds a level of uncertainty: current predictions include increased aridity in the subtropics.

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How can we address the problem? The nature of the problem, and thus its solution, varies greatly from region to region. Overall, the United States has a surplus of water and the economic resources to build systems, notably in California, to transport water long distances. Although this may "solve" the problem of water shortage in the drier areas, the environmental impacts in the contributing areas can be severe. Modern sensitivities to environmental issues, particularly endangered species, are placing limits on such diversions. These constraints and high costs make it unlikely that we will see more grand-scale projects like those in southern California. Also, each U.S. state jealously guards "its" water and fights transfers to any other state. The situation is very different in subtropical Africa, where there are few nearby sources of surplus water and limited economic resources. In Western Europe, by contrast, the problem is not so much water shortage as pollution, particularly by nitrate from agriculture. The solution here is likely to be the modification of agricultural practices and water treatment where necessary. Some progress is being made in both areas.

Vaux (in this issue) stresses the importance of establishing markets for water so that it is allocated towards the most beneficial (highest-value) use. It is hard to argue with this in principle, but it does raise some philosophical questions: how does one assign a value (ultimately a monetary value) to a commodity that is essential for human survival? We could draw an analogy to food: food is also essential for human survival, and few would disagree that an agricultural system based on private producers and a free market (well, reasonably free) is more efficient and productive than one based on central planning. But food and water are not the same. Food can be transported long distances with existing infrastructure at relatively modest cost, whereas water, generally speaking, cannot. The authors of this issue argue that the cost of desalination is going down and that desalination may be an economically viable source of fresh water. This may be true for places like California and the oil-rich countries of the Middle East, but I have my doubts about the poorer countries of the world. And desalination requires energy, which has implications for greenhouse gases and potential costs in the future.

The question of assigning a monetary value to water is complex. In the United States it does not matter much if water is diverted from agriculture to golf courses because golfers are willing and able to pay more. But how does one assign a monetary value to maintaining in-stream flow? Or to sport fishing and recreation? I have listened to economists giving talks on these subjects but I come away with the feeling that ultimately these are issues of personal values. They are best decided by elected governments, who are, realistically, the only people in a position to make such judgments. We may see their judgments as unwise or shortsighted: in such cases we, as professionals, have an obligation to try to educate the public and the politicians, but we must recognize that many problems are a matter of values rather than a matter of science.

The situation is very different in subtropical regions, where subsistence agriculture represents a major use of water and where, as discussed in this issue, supplies are decreasing even as the population is increasing. A poor person in a developing country is not in a position to pay much for water, and the product of his subsistence agriculture may, according to standard economic analysis, have little commercial value. From a narrowly economic perspective (which tends to discount the future in favor of the present), the best use of the water is likely to be commercial farming for the export market, but this would have the effect of eliminating some traditional ways of life and driving people to the cities and to emigration. We need to take a broader view of economic value: the disruption of traditional agriculture may have all sorts of societal costs.

There is no easy solution to this problem. The most obvious conclusion is that we need to manage existing supplies efficiently to minimize aquifer drawdown and to minimize the salination that often accompanies diversions for irrigation. Decisions in the political arena need to be based on a sound understanding of the consequences, particularly the long-term consequences, of alternative strategies for the utilization of ground and surface waters. As Earth scientists we have much to contribute.

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