THE FORGOTTEN INFRASTRUCTURE: SAFEGUARDING FRESHWATER ECOSYSTEMS

Sandra L. Postel

The water strategies of the 20th century helped to supply drinking water, food, flood control and electricity to a large portion of the human population. These strategies largely focused on engineering projects to store, extract and control water for human benefit. Indeed, it is hard to fathom today's world of 6.6 billion people and more than $65 trillion in annual economic output without the vast network of dams, reservoirs, pumps, canals and other water infrastructure now in place. These projects, however, have often failed to distribute benefits equitably and have resulted in the degradation, or outright destruction, of natural freshwater ecosystems that in their healthy state provide valuable goods and services to society.

As water stress and the risks of climate change deepen and spread around the world, policies and strategies designed to meet human needs, while protecting ecosystem health, will become increasingly critical to human well-being. Scientific understanding of the components of freshwater ecosystem health has advanced markedly over the last decade, but incorporation of this knowledge into water policy and management has lagged. A number of nations and regions—including Australia, the European Union, South Africa and the Great Lakes—are pioneering policies that establish boundaries on human degradation of freshwater with an aim of safeguarding ecosystem health. Although imperfect, and facing tough implementation obstacles, these policies offer promising ways of better harmonizing human uses of water with protection of valuable ecosystems.

The Decline of Ecological Infrastructure

Water infrastructure typically refers to the collection of dams, levees, canals, pipelines, treatment plants and other engineering works that help provide water services to the human population. There is another class of infrastructure that also delivers valuable services to society: the aquatic ecosystems that perform nature's work. Healthy rivers, floodplains, wetlands and forested watersheds supply much

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more than water and fish (see Table 1). When functioning well, this "eco-infrastructure" stores seasonal floodwaters, helping to lessen flood damages. It recharges groundwater supplies, which can ensure that water is available during dry spells. It filters pollutants, purifies drinking water and delivers nutrients to coastal fisheries. Perhaps most importantly, it provides the myriad habitats that support the diversity of plants and animals that perform so much of this work.

For millennia, human societies grew and flourished by relying on this time-tested work of nature. The ancient Egyptians, for instance, thrived for several thousand years on the ecological services provided by the annual flood of the Nile River, which delivered water and nutrients to their farm fields, carried off harmful salts that had accumulated in the soil and supported a diversity of fish.[1] During the 20th century, however, such reliance on nature's services was supplanted by engineering projects that provided hydroelectric power, intensive irrigation, flood control and other benefits demanded by burgeoning populations and economies.

Since most of nature's services lie outside of commercial markets and are not priced in conventional ways, they are grossly undervalued. While the benefits of dams and other water projects are measured in familiar metrics—kilowatt-hours generated and hectares irrigated and populations served—the ecological downsides of these engineering approaches have largely been left out of the cost-benefit calculus. As a result, ecological infrastructure has been dismantled and degraded at a rapid rate. An estimated 25 to 55 percent of the world's wetlands have been drained, 35 percent of global river flows are now intercepted by large dams and reservoirs and more than 100 billion tons of nutrient-rich sediment that would otherwise have replenished deltas and coastal zones sits trapped in reservoirs.[2] River flows are turned on and off like plumbing works, eliminating the natural flow patterns and habitats upon which myriad life forms depend.[3]

It is difficult to place a dollar value on any one piece of eco-infrastructure, but in 2005, scientists participating in the Millennium Ecosystem Assessment estimated that wetlands alone provide services worth $200 to 940 billion per year.[4] Following the Great Midwest Flood of 1993, U.S. researchers estimated that restoration of 5.3 million hectares of wetlands in the upper portion of the Mississippi-Missouri watershed, at a cost of $2 to 3 billion, would have absorbed enough floodwater to have substantially reduced the $16 billion in flood damages that resulted from that one major flood episode.[5] And when Hurricane Katrina struck the U.S. Gulf Coast in August 2005, an important piece of nature's protective infrastructure was partially missing: coastal wetlands and barrier islands that could reduce the power of storm surges. The state of Louisiana alone has lost 492,000 hectares of coastal wetlands since the 1930s, and continues to lose them at a rate of more than 6,200 hectares per year—approximately one football field every forty-five minutes.[6] It is impossible to know