

# The Environmental Impacts of Large Dams

Land and water are ecologically linked in a natural system called a watershed. From the smallest droplet to the mightiest river, water works to shape the land, taking with it sediment and dissolved materials that drain to watercourses and, in most cases, eventually to the sea. So, too, is the river a product of the land it inhabits—the type of rock and soil, the shape of the land, and the amount of vegetation are some of the factors that determine the river's shape, size and flow.

When these ties between the land and the river are broken by a large dam, the consequences are felt throughout the watershed, as well as by the web of life it supports. Of all the ways to tamper with or harm a river, a large dam usually has the most immediate and far-reaching effects because of the huge changes it causes to river hydrology—its very circulation system.

Some 40,000 large dams, most of which were built in the past 50 years, now obstruct the world's rivers. More than 400,000 square kilometers—an area larger than Zimbabwe, and 13 times the size of Lesotho—have been inundated by reservoirs worldwide. The world's largest impoundment, the 8,500 sq.km. Volta Reservoir behind Ghana's Akasombo Dam, flooded 4% of that nation's land area. In the United States, whose 5,500 large dams make it the second most dammed country in the world, we have stopped building large dams, and are now spending great amounts of money trying to fix the problems created by existing dams.

## The Environmental Consequences of Big Dams

Although the impacts of large dams have been well documented for some time now, in case after case, new ones are proposed whose environmental impacts are downplayed or even ignored. A 1990 internal survey of World Bank hydroelectric dam projects showed that 58% were planned and built without any consideration of downstream impacts, even when these impacts could be predicted to cause massive coastal erosion, pollution and other problems.

The following are some of the more serious environmental impacts of dams on rivers and the life they support. I have concentrated on the kinds of impacts that might affect

the Orange River watershed, leaving out other major dam–caused problems that have affected rivers under different ecological circumstances.

### Effects on River Systems

Reducing the flow of water from a river changes the landscape it flows through, which in turn can affect the ecosystem's flora and fauna. A dam holds back sediments, especially the heavy gravel and cobbles. The river, deprived of its sediment load, seeks to recapture it by eroding the downstream channel and banks, undermining bridges and other riverbank structures. Riverbeds are typically eroded by several meters within a decade of first closing a dam; the damage can extend for tens or even hundreds of kilometers below a dam. Within nine years of closing Hoover Dam in the US, the riverbed below the dam had lowered by more than 4 meters. Riverbed deepening will also lower the groundwater table along a river, threatening vegetation and local wells in the floodplain and requiring crop irrigation in places where there was previously no need. The depletion of riverbed gravels reduces habitat for many fish that spawn in the gravelly river bottom, and for invertebrates such as insects, mollusks and crustaceans. Changes in the physical habitat and hydrology of rivers are implicated in 93% of freshwater fauna declines in North America.

Before the Aswan High Dam, the Nile River carried about 124 million tons of sediment to the sea each year, depositing nearly 10 million tons on the floodplain and delta. Today, 98% of that sediment remains behind the dam. The result has been a drop in soil productivity and depth, among other serious changes to Egypt's floodplain agriculture. The Aswan Dam has also led to serious coastal erosion, another problem stemming from the loss of sediments in a dammed river. Another example of this problem is along the mouth of the Volta River in Ghana. Akosombo Dam has cut off the supply of sediment to the Volta Estuary, affecting also neighboring Togo and Benin, whose coasts are now being eaten away at a rate of 10–15 meters per year. A project to strengthen the Togo coast has cost US\$3.5 million for each kilometer protected. The story is the same on coastline after coastline where dams have stopped a river's sediments.

### Hydrological Effects

Dams also change the pattern of the flow of a river, both reducing its overall volume and changing its seasonal variations. The nature of the impacts depends on the design, purpose and operation of the dam, among other things. All parts of a river's ecology can be impacted by changes to its flow.

A river's estuary, where fresh water meets the sea, is a particularly rich ecosystem. Some 80% of the world's fish catch comes from these habitats, which depend on the volume and timing of nutrients and fresh water. The alteration of the flows reaching estuaries because of dams and diversions is a major cause of the precipitous decline of sea fisheries in the Gulf of Mexico, the Black and Caspian Seas, California's San Francisco Bay, the Eastern Mediterranean and others. The regulation of the Volta River in Ghana by the Akasombo and Kpong dams has led to the disappearance of the once-thriving clam industry at the river's estuary, as well as the serious decline of barracuda and other sport fish.

#### Changes to Flooding

The storage of water in dams delays and reduces floods downstream. River and floodplain ecosystems are closely adapted to a river's flooding cycle. The native plants and animals depend on its variations for reproduction, hatching, migration and other important lifecycle stages. Annual floods deposit nutrients on the land, flush out backwater channels, and replenish wetlands. It is generally recognized by biologists that dams are the most destructive of the many abuses causing the rapid disappearance of riverine species. About 20% of the world's recognized 8,000 freshwater species are threatened with extinction.

The floodplain itself is also affected by dams. Studies on the floodplain of the Pongolo River in South Africa has shown a reduction in diversity of forest species after it was dammed. And forests along Kenya's Tana River appear to be slowly dying out because of the reduction in high floods due to a series of dams.

#### Conclusions

Fifty years ago, the United States rushed into a water development program with little understanding of the negative impacts it would have on its rivers and all who depend on them. Today, we are beginning to "pay the piper" in depleted fisheries, damaged

ecosystems, receding coastlines and many other problems linked to the damming of our rivers. We are now being forced to manage our dams differently, allocating more flow to the environment in an effort to stop further dam-related destruction of ecosystems and taking other costly steps to save valuable fisheries. We are even preparing to take down some particularly bad dams, at enormous expense. And we no longer build big dams. Although it has now become very difficult to build destructive river projects in the US and many other highly dammed countries, our hydro industry and financial institutions continue to export this obsolete technology, much in the same way the chemical industry continued to export pesticides long after they had been banned in the country of origin. At dam conferences, the talk these days always centers around finding "fresh markets" to exploit and new ways to sell dams to a skeptical public.

The new South Africa has the opportunity to devise a water policy that builds on what the world has learned in the past fifty years of unchecked river development, and that involves civil society in the decision-making process. In the long term, such an approach is the only one that doesn't diminish one of Africa's most treasured resources—its rivers.