



HEALTH IMPACTS OF LARGE DAMS

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Large dams have been criticized because of their negative environmental and social impacts. Public health interest largely has focused on vector-borne diseases, such as schistosomiasis, associated with reservoirs and irrigation projects. Large dams also influence health through changes in water and food security, increases in communicable diseases, and the social disruption caused by construction and involuntary resettlement. Communities living in close proximity to large dams often do not benefit from water transfer and electricity generation revenues. A comprehensive health component is required in environmental and social impact assessments for large dam projects. © 1999 Elsevier Science Inc.

Introduction

The environmental, social, and health consequences of large dam projects are receiving increasing international attention (Baviskar and Singh 1994; McCully 1996; IUCN and World Bank 1997). Although dams are important for water and energy supply, flood management, and irrigation, millions of people, mostly in less-developed countries, are exposed to their adverse health and social impacts (Goldsmith and Hildyard 1984; Hunter et al. 1982; Scudder 1997a). In the industrialized world, river developments such as those on the Mississippi and Rhine have resulted in substantial ecosystem damage. During the last 10 years, more than 40 million people have been resettled involuntarily due to large dam projects (World Bank 1996). If completed, the Three Gorges Dam in China will require the relocation of more than 1 million people. Water projects have resulted in vector-borne diseases, loss of food security, pollution, and social problems that negatively influence health (Goodland 1995; Hunter et al. 1982, 1983; Scudder 1997a). Large dams provide cogent examples of the impact of large-scale infrastruc-

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ture and development on health (Cooper-Weil et al. 1990; Hughes and Hunter 1970). They also are a paradigm for globalization in poorer countries, hence generating debate on equitable resource allocation.

Globalization, or the liberalization of world commerce, has caused much suffering, as vast amounts of physical and human resources have been transferred from less-developed to industrialized countries (Benatar 1998; Shafaedin 1995). At best, the benefits of globalization are distributed unevenly and economic growth often occurs at the expense of the poorest countries and communities (Soros 1998). In the case of large dams, the benefits of hydropower and water usually are transferred long distances from the project site, to cities and industrial areas. Benefits to local populations may be limited to the provision of roads and temporary employment. Those living in a large dam catchment areas can be left worse off than they were prior to construction. About two-thirds of all large dams are being built in less-developed countries and, because the private sector is playing an increasing role, water and electrification for surrounding communities are not regarded as priorities.

The Lesotho Highlands Water Project (LHWP), currently one of the five largest dam projects globally, is an example. The first phase of the LHWP, costing over US \$2.4 billion, will provide water to the heavily populated Gauteng Province of South Africa and ensure Lesotho's self-sufficiency in electricity. Approximately 7,000 people have been employed in construction, to a limited extent compensating for the loss in labor remittances from the decline of the South African mining industry. Dam and tunnel work in the poorest districts of Lesotho has brought the benefits of roads and infrastructure, employment, and some direct funding of rural development and poverty alleviation (LHDA 1996). The long-term revenue stream of water royalty payments has been allocated to national development projects.

Health Issues

Large dams influence health at not only the reservoir site but also upstream, downstream, and at national or even regional levels (Table 1). Increases in the prevalence of schistosomiasis, malaria, encephalitis, hemorrhagic fevers, gastroenteritis, intestinal parasites, and filariasis (including onchocerciasis and bancroftosis) have been documented after dam and irrigation projects. Although not dealt with in this paper, large dams also influence the health of animals through increases in diseases such as river fluke in cattle and changes in the distribution of trypanosomiasis (Stanley and Alpers 1975). Changes in water flow, river ecology and salinity, easier travel due to navigable dams and rivers, human proximity, pollution, canalization, and agriculture allow vector-borne diseases to flourish in the tropical or subtropical environments of less-developed countries, where most current

TABLE 1. Potential Health Impacts of Large Dam Projects

Impact Area	Effect of Dam	Health Impact
Upstream catchment and river	Loss of biodiversity, increased agriculture, sedimentation and flooding, changes in river flow regime	Changes in flood security, water-related diseases, difficulties with transportation and access to health facilities
Reservoir area	Inundation of land, presence of large man-made reservoir, pollution, changes in mineral content, decaying organic material, pollution	Involuntary resettlement, social disruption, vector-borne diseases, water-related diseases, reservoir-induced seismicity
Downstream river	Lower water levels, poor water quality, lack of seasonal variation, loss of biodiversity	Food security affected on flood plains and estuaries (farming and fishing), water-related diseases, dam failure and flooding
Irrigation areas	Increased water availability and agriculture, water weeds, changes in flow and mineral content, pollution	Changes in food security, vector-borne and water-related diseases
Construction activities	Migration, informal settlement, sex work, road traffic increase, hazardous construction	Water-related diseases, sexually transmitted diseases, HIV/AIDS, accidents and occupational injuries
Resettlement areas	Social disruption, pollution, pressure on natural resources	Communicable diseases, violence and injury, water-related disease, loss of food security
Country/regional/global	Reduced fuel imports, improved exports, loss of biodiversity, reallocation of funding, sustainability	Macro-economic impacts on health, inequitable allocation of revenue, health impacts of climate change

Source: Based on Oud and Muir 1997.

dam building is taking place (Brantly and Ramsey 1998; Hunter 1992; Hunter et al 1982). For further discussion of dam and irrigation-related diseases, the reader is referred to Stanley and Alpers (1975), Brinkman et al. (1988), Parent et al. (1997), Vercruyse et al. (1994), N'Goran et al. (1997), and Brantley and Ramsey (1998).

Households living close to reservoirs may lose access to river water, and natural springs can be destroyed or dry up. The failure of water supply leaves communities with unsafe water sources, a sad consequence of a water-transfer project. Villages often are given only the most basic water and sanitation options (such as covered springs and VIP latrines), although they may be situated adjacent to construction camps that have a reticulated water supply. Communities resettled due to dam construction mostly are moved inland, away from rivers that previously provided a reliable water supply. Rural resettlement areas may have insufficient water for both the preexisting local population and newcomers, and this can cause outbreaks of cholera (such as those that have repeatedly occurred in the Lake Kariba resettlement areas) and other water-related diseases. Dam construction results in the loss of fields and grazing land. In areas where nutritional status already is poor, food supplements may be necessary to protect infants and children.

The in-migration of construction workers to dam sites may result in an increase in sexually transmitted diseases and human immunodeficiency virus (HIV). Although sex work is a recognized consequence of large infrastructure, often it is difficult to quantify the effects of a project on the prevalence of HIV in surrounding communities (Kravitz et al. 1995). In the case of Lesotho, labor migrancy and the acquired immune deficiency syndrome (AIDS) epidemic in South African mines have contributed to the increasing prevalence of HIV (Gish 1982). When a construction workforce is based in an area that already has high levels of HIV, aggressive health promotion measures such as condom distribution and syndromic management of sexually transmitted diseases are required (World Bank 1997). Informal settlements often are established close to dam sites by work seekers providing goods and services, such as alcohol and sex, to employed workers. These settlements require basic environmental health services.

Although roads built to the construction site decrease isolation and promote economic activity, an increase in accidents can be expected. Local police often do not have the capacity to enforce speed limits and ensure that vehicles are roadworthy. Communities may be isolated and cut off from local clinics by the new dam, and bridges and access roads are not often constructed as part of the dam project. The impoundment of large bodies of water can result in reservoir-induced seismicity. These tremors usually cause only minor structural damage to dwellings, but result in considerable psychological distress.

One of the first health maintenance organization in history was established in the 1930s by Henry Kaiser for workers on the Grand Coulee Dam

in Washington State (Starr 1982). In the case of the LHWP, contractor clinics provide curative services for local communities, and a surgical intensive care unit has been established at a district hospital. Although Lesotho as a whole has benefited from the only intensive care unit in the country, the unit's future depends on government capacity to take over the facility upon completion of the dam project. In light of the constraints faced by Lesotho's health system, extensive capacity building and financial support will be required to ensure that health services, established during dam construction, are maintained.

Large dams can have serious downstream health impacts (IUCN and World Bank 1997; Joyce 1997). The amount of downstream water flow and periodic controlled releases (instream flow requirements) are important ecological and health issues. On the Niger, the overall effect of dams has been to impoverish large downstream populations by damaging flood-recession agriculture and fishing (Scudder 1997a). As downstream communities do not benefit directly from the positive development associated with large dam construction, an ethical imperative exists to mitigate negative health impacts.

Dams have to be weighed against alternative energy projects in terms of environmental, social and health costs, sustainability and climate effects (IUCN and World Bank 1997). If the world is to attain a meaningful reduction in greenhouse gas emissions, an important role exists for well-planned, environmentally sound, and socially equitable large dam projects, at least until such time as truly renewable energy sources are widely available (Goodland 1995).

Macroeconomic Impacts

The relationship between health status and macroeconomic factors is complex, and often it is difficult to measure the health benefits of economic growth in developing countries (Sen 1994; WHO 1993). The LHWP has raised Lesotho's gross domestic product, a macroeconomic factor that directly influences health indicators such as infant mortality. As the gap between mean household income and the poverty line in Lesotho is small, many families have been aided in that the LHWP is large enough to protect the economy from a recession requiring economic adjustment. The LHWP area has a large number of ultra-poor households, high levels of migration, and adverse agricultural conditions. Any poverty reduction associated with the project assists in lowering the high levels of communicable disease and substance abuse inextricably linked with poverty. However, large dam projects result in substantial social disruption to which the poor are the most vulnerable. Funding for the mitigation of health and social impacts is difficult to target; often it reaches those most in need too late to make a major difference to health status. Many sub-Saharan African countries that have undergone economic structural adjustment programs have had

TABLE 2. Resettlement due to Large Dams

Project	Country	Number of Resettlers
Three Gorges	China	1,250,000
Upper Krishna II	India	220,000
Sardar Sarovar	India	127,000
Aswan High Dam	Egypt	100,000
Kossou	Ivory Coast	85,000
Akosombo	Ghana	84,000
Longtan	China	73,000
Mahaweli I-IV	Sri-Lanka	60,000
Kariba	Zambia and Zimbabwe	57,000
Sobradhino	Brazil	55,000

Note: In a ranked table based on the number of resettlers, the top 10 dams would be in China and India.
Source: Based on Scudder (1997a).

problems targeting special funds appropriately for poverty mitigation and the creation of a social “safety net” (Bijlmakers et al. 1996). Due to a lack of suitable structures, Lesotho is having difficulties in spending appropriately the first water royalty payments of the LHWP. The clearest winners in dam construction are invariably the engineering consortiums that, with the support of their respective national credit agencies and private banking institutions, obtain the bulk of project funding (Horta 1996). As most future dam projects will be privately funded and thus not automatically open to at least the scrutiny of organizations such as the World Bank, it is vital that governments set rigorous goals for controlling health and social impacts.

Resettlement, Compensation, and Development

Involuntary resettlement remains one of the most serious outcomes of large dam projects (Table 2). Those forced from their homes by construction and inundation often are ignored; it is assumed that they somehow will benefit from the dam. There are numerous cases where dam resettlement has been carried out under the threat of violence and little, if any, compensation was provided. Resettled families lose homes, land, food sources, and employment, and they are exposed to social dislocation (Baviskar and Singh 1994; Cernea 1990). Communities that host the resettlers face increased population densities, which places severe pressure on natural resources and water and sanitation infrastructure and results in an increased incidence of communicable diseases. Resettled families, unable to plant seasonal crops for subsistence agriculture, are forced to purchase foodstuffs. There is evidence, from a long-term study of the Kariba Dam, that resettlement causes an early increase in mortality rates (Clark et al. 1995).

The World Bank (1990) has provided guidelines on resettlement to ensure that the population displaced by a project also benefits from it. Although

pioneering when first proposed in the 1980s, the guidelines are problematic. While the World Bank emphasizes that resettlement should be implemented as a development program (in which project-affected people become better off), borrowers are required only to restore living standards. Programs aimed at restoring living standards tend to leave the majority worse off, because the emphasis shifts from development to compensation and mitigation. A large dam may be a poor country's largest development effort, yet the reactive focus on mitigation and compensation precludes a "developmental" approach to the needs of project-affected communities.

Even in the case of the LHWP, where the number of resettlers is small and a world-class compensation policy is in place, resettlement is a complex and often controversial exercise. It is difficult to measure the income of a poor, rural household, to value communal assets, and to assess compensation for the loss of crops such as marijuana, an important source of income for poor households in the LHWP area. When the amount of compensation has been agreed upon, then the form that such compensation should take must be considered. Whereas it may be easy to rebuild houses, it is difficult to provide new fields in areas where most of the agricultural land is of poor quality. Compensation options such as fodder and grain provision are expensive and difficult to implement. The LHWP has introduced innovative compensation methods such as annuities. Annuities have been criticized as generating long-term dependency and damaging the status of women. Such an argument may not be valid in Lesotho, where there is a long history of households being reliant on remittances from men working on the South African mines. The success or failure of resettlement and compensation may become apparent only many years after the completion of a dam. Long-term follow-up is required, especially targeting the most vulnerable households (Marc et al. 1993; Scudder 1997b). It often is difficult to evaluate the health impacts of large dam development, as baseline data may not be accessible or available (Myaux et al. 1997; N'Goran et al. 1997).

Conclusions

Large dams demonstrate the interaction between public health and large-scale engineering projects. Although development generally has positive health impacts, the link between project expenditure and improved health is indirect and often tenuous. Roads and construction activity bring benefits, but generally, improvements in water supply, employment, and agriculture are short-lived, and their termination can have catastrophic consequences. Dams often are justified as essential for "flood control." Unfortunately, this assumes that all floods are bad and precludes an ecosystem-based management approach where natural flood regimes not only sustain habitats, but also support millions of people through flood-recession agriculture, grazing, and fishing.

Regions such as sub-Saharan Africa require support to develop infrastructure, transportation and administrative systems to compete in the global economy (Sachs 1996). Large dams are justified, based on the long-term development they bring and their potential for improving water and food supplies. In Africa, they often result in increased disease and undernutrition (Parent et al. 1997). Funds for mitigation measures and direct compensation are allocated often toward development programs such as small enterprise promotion and agricultural demonstration projects, in the belief that people are willing to forego immediate benefits in return for sustainable employment. This position is grounded in a development discourse that results in communities being blamed when most of these poverty alleviation projects fail (Ferguson 1992; Hughes and Hunter 1970). Communities are heterogeneous, and it is difficult to build the social structures required to participate in poverty alleviation projects, especially at times of social disruption, as when a large dam is being built.

Health depends on society's capacity to manage the interaction between human activities and the physical and biological environment in ways that safeguard and promote health. The failure to foresee the health consequences of development limits the potential for ensuring that large-scale infrastructure is health promoting. To ensure that development promotes rather than endangers health, comprehensive impact assessments are required to integrate health and ecological risk with meaningful community consultation (Scott-Samuel 1996; World Bank 1994). A detailed baseline health survey should be part of the environmental assessment and a comprehensive action plan implemented, especially when substantial health and social impacts are anticipated. The health benefits of large dams can be ensured better through health interventions, local participation, well-designed and implemented irrigation schemes and fisheries, and appropriate measures to limit adverse downstream impacts (Scudder 1997a).

Whether improved health, environmental and social standards for large dams will be forthcoming depends in good part on the deliberations and actions of the recently established World Commission on Dams (IUCN and World Bank 1997). Concerned with the adversarial relationship that had developed between "pro" and "anti" dam advocates, the World Bank and IUCN/The World Conservation Union invited representatives of all viewpoints to attend a workshop in Gland, Switzerland, in April 1997. At this meeting, participants unanimously recommended that a World Commission on Dams be established to propose new guidelines for deciding whether a particular dam should be built and, in the event that a dam was approved, the nature of the development process.

Professor Kader Asmal, South Africa's Minister of Water Affairs and Forestry, was appointed as chairman of the Commission. Now based in South Africa and completely independent of the World Bank and IUCN, the Commission has its own Secretariat and funding for a 2-year program.

Carefully selected to represent all sides of the “large dams debate,” all 12 Commissioners attended the first meeting in May 1998. The Commissioners agreed on three key objectives. The first is to complete a global review of the development effectiveness of large dams and an assessment of alternatives. The second is to formulate a framework for assessing options and making decisions when dealing with water resource development. The third is to formulate internationally acceptable criteria and guidelines for planning, design, construction, operation, monitoring, and decommissioning of dams. It is hoped that this initiative will go some way toward ensuring appropriate and sustainable water resource use and protecting future generations from the potential ecological, social, and health hazards of large dams.

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