DAMS AND SUSTAINABLE DEVELOPMENT

A BRIEF HISTORY OF DAMS

> The debate about dams is a debate about the very meaning, purpose, and pathways for achieving sustainable development…and the equitable distribution of costs and benefits.
>
> *(World Commission on Dams Report, 2000)*

The urge to divert and dam rivers and streams seems to be one of man's most insistent impulses. More than 8,000 years ago, people in the ancient empire of Mesopotamia, in the region of modern-day Iran, channeled rivers into irrigation canals. The Romans are famous for their engineering feats, diverting and conveying water for great distances. The first known dams were constructed about 5,000 years ago on the Tigris and Euphrates rivers in Mesopotamia, in Egypt on the Nile, and the Indus River in what is now Pakistan. All the early dams were built mainly to supply water for irrigation of agricultural land and for flood control. Construction of dams to generate electricity began about 1890.

By the middle of the 20th century, 5,000 large dams had been built around the world. By definition, a large dam is one that is more than 15 metres high, or one that is between 5 and 15 m high with a reservoir volume more than 3 million m^3. In the 1970s, two or three large dams were being commissioned every day, and by the end of the century the total of large operating dams was 45,000. In addition, there are about 800,000 other dams worldwide that do not meet the definition of a large dam. The total cost of dam construction in the 20th century has been estimated at US$2 trillion.

Through much of the last century, dams were seen as a symbol of industrial progress, of man's ability to tame rivers, and harness nature. Dams symbolised various kinds of power – political, economic, social, and electrical. For many governments, building large dams was perceived as a demonstration of their nation's strength. The result is that more than half the world's major rivers are now affected by dams, and a estimated minimum 40 million people have had to move to make room for dams and reservoirs. China has the most large dams, with over 22,000, the United States has about 6,400, India 4,000, and Japan and Spain have over 1,000 each.

However, a reversal of the dam-building trend has started in the US, where more than 500 small dams have been decommissioned in the past few years. This change has been driven by growing public opposition in recent years to some of the direct effects and indirect consequences of dams.

Mekong River Basin Dams

In its earlier existence as the Mekong Committee, advocacy for dam construction on the Mekong River and many of its tributaries was a top priority. To date three large dams have been completed in the lower Mekong River Basin (MRB): the Nam Ngum and Nam Theun-Hinboun in Lao PDR, and Yali Falls in Vietnam. Several small dams have also been constructed. So far only one dam, the Manwan in

China's Yunnan Province has been built on the mainstream Mekong. The Mekong River Commission (MRC), established in its present form in 1995, has different priorities from its predecessors, though strategic recommendations on dams still form part of the MRC mandate as component of the Basin Development Plan and Water Utilization Program.

World Commission on Dams

As a result of increasing concern by non government organizations (NGO), governments, and communities around the world about the harm caused by some dams, in 1998, the World Bank and the International Union for the Conservation of Nature and Natural Resources (IUCN) convened a panel of experts representing the world's regions and stakeholder groups to:

- Review the effectiveness of large dams in facilitating development
- Assess alternatives to them
- Develop criteria, guidelines, and standards for planning, design, construction, operation, monitoring, and decommissioning of dams.

After two years of hearings at public forums around the world, hundreds of submissions, including one by the MRC, and many detailed reviews, the World Commission on Dams (WCD) published its report in November 2000. Much of the information in this lesson is from that report.

BENEFITS FROM DAMS

Dams are usually built for one or more of the following engineering and socio-economic purposes:

- To generate electricity for domestic and industrial uses, and/or for export to obtain income from foreign sources. Electric power is essential for industrial development and to raise community standards of living.
- To store water for irrigation of farmland to improve crop yields and increase the security of food supply.
- To hold back water during times of high river flow to prevent flooding downstream and for release during low-flow periods.

Additional benefits of dams can potentially include:

- Rural electrification and development
- Job creation during dam construction and in subsequent industrial and community development
- Expansion of social services and improved infrastructure in the region served by the dam, for example schools, hospitals, roads
- Fishing and recreational potential of reservoirs.

Benefits such as these have made substantial contributions to human development in many countries. But there are many examples of dams that have not delivered the technical or financial performance expected, nor the predicted economic benefits, especially compared with alternative courses of action which could have been taken.

PROBLEMS WITH DAMS

Too often, the benefits of dams have been less than those that were promised, and the adverse effects far

greater than anticipated. In many cases, impacts on the environment and on people displaced by dam development have been far worse than project proponents had stated. Often, economic benefits take place far from the dam site, while local communities, indigenous people, and other vulnerable groups are forced into worse living conditions than before the development.

> Dams fundamentally alter rivers and the use of natural resources, frequently entailing a reallocation of benefits from local riparian users to new groups at a regional or national level. At the heart of the dams debate are issues of equity, governance, justice, and power – issues that underlie the many intractable problems faced by humanity.
>
> *World Commission on Dams Report*

Many large dams have failed to deliver the electrical and water control or distribution benefits which were promised, and on the basis of which the project received approval. As a result, projected economic advantages and financial returns have not been achieved. The economic viability of dams built to provide electricity for export depends on guarantees of continuing demand from the countries and industries buying the power. But political and economic influences can quickly change the plans and schedules of power users, as was seen in the recent Asian monetary crisis. Power-exporting countries are then faced with an enormous capital debt-load and ongoing operating costs for dams from which power is no longer needed at the predicted rate.

Even before a dam is put into operation, construction costs and time-frames often have been far greater than scheduled, due to a multiplicity of unforeseen, unplanned, or ignored problems. The delays cost money and shake the confidence of financiers, potential customers, and local communities.

After a dam is in operation, adverse environmental and socio-economic impacts often have exceeded the predictions of dam proponents, with many unwanted results. For example, irrigation can cause increases in soil salinity that reduce rather than increase crop yields. Dams drastically affect aquatic and terrestrial components of ecosystems by cutting off the downstream flow of a river from its source, and inundating areas that were occupied by humans and animals. The loss of aquatic and terrestrial habitats results in population decreases or localised extermination of plant and animal species.

Why Problems with Dams Occur

The worldwide surge in opposition to dams in recent years has come about through the realisation that many of the processes leading to development of dam projects have been seriously flawed. Some of the issues will be outlined in this section.

Probably the most significant adverse effect of dams has been their effect on people unfortunate by a mere accident of birth to be in their way. The main reason this has been allowed to occur, as for other significant impacts, is the systematic failure by dam proponents and government agencies to properly assess the negative effects and necessary mitigation measures in advance of the development proceeding. Principle

areas where these omissions are evident are:

- In programs for relocating and resettling 'oustees' – the people who must be moved from their homes to make way for dam development
- Effects of altered and fluctuating river flows on the livelihood of people in downstream communities
- Lack of appreciation for the personal suffering and deprivation of people directly affected by dam development, who are almost always rural, poor, and powerless
- Loss of vital components of ecosystems, both aquatic and terrestrial, through flooding of land by reservoirs, and disruptions to the rhythms of river and sediment flows due to separation of the river from its source.

Underlying Reasons for Problems

Some of the systemic causes of the problems related to dam developments will be outlined in this section.

In the 20th century, large dams have often been monuments to politicians, governments, engineers, and financial aid agencies. They have symbolised a dominant ideology of size, technology and the conquering power of man over nature. The prospect of immortality in the form of a dam, and of financial gain have seduced decision makers into setting terms of reference that required only that a future demand for power or irrigation water be covered by the least-cost choice from various engineering and economic alternatives. Having selected the cheapest solution, environmental and social impacts were then mitigated to a level that would not jeopardise the project. Opportunities for capital cronyism, corruption, nepotism, and poor science in such situations are legion.

Even if concerns were raised during planning or construction, once a decision to proceed was made, projects gained momentum and took on a life of their own, ignoring even obvious social and environmental problems because they would have slowed progress and cost money. Only by externalising these costs and passing them on to others were many projects able to proceed. The narrow focus on engineering and traditional economics, and the absence of systems thinking are at the core of unsustainable development.

Project-level environmental impact assessments (EIA) and socio-economic assessments have been generally biased in favour of development, proposing least-cost mitigation measures to ensure financial success for a development that is going ahead regardless of EIA results. Frequently, they have been done too late in a project for the findings to be implemented, done inadequately, or the results have been ignored. Details on EIA will be presented in Courses D and E , but it must be said here in advocacy for truly sustainable development that in far too many cases, EIA, if done at all, have been merely token exercises to satisfy a government requirement.

As a result of inadequate EIA, hydraulic, and engineering studies, project proponents in many instances have underestimated:

- Rates of reservoir sedimentation, resulting in accelerated loss of storage capacity
- Risks of hillside erosion and landslides causing dam overtopping

- Loss of water from reservoirs through leakage and evaporation.

Cumulative effects assessment (CEA) of watersheds or river basins have not been done, with the result that each development usually has been considered in isolation, so the effects of future upstream and downstream water use have not been considered. In short, neither river basin nor ecosystems thinking has been used.

Significant Issues

There are three interconnected specific issues that have had particular significance in dam projects, and which need to be dealt with differently in future developments. They are resettlement of displaced people and related socio-economic issues; changes to existing fisheries and local resource uses; and effects on ecosystems.

In many instances of dam development, resettlement of people living in communities in the area of the dam itself, and on the land that will be inundated and become a reservoir, has been often carried out by government edict, not through consultation. The dominant attitude has been that some people must suffer inconvenience and make sacrifices for the benefit of many (though the benefits eventually realised have frequently been far less than promised). The magnitude and scope of the dislocation and socio-economic effects have not been adequately assessed beforehand. These effects include conflicts between resettled 'oustees' (displaced people) and original residents of the area to which they are relocated (called 'hosts') due, for example, to competition over land, jobs, and resources; powerlessness of settlers and hosts as a result of dependence on government support because of insufficient local resources and jobs; loss of traditional livelihoods and customs by settlers in their new environment; hosts' resentment of traditions and ways of life imported by new settlers.

Other project-affected people (OPAP) are also vulnerable to adverse effects of dam operations. OPAP include those who are upstream or downstream of the dam site and do not need to relocate, but whose livelihoods are changed by alterations in the hydrology of the river – flow volumes, times of peak and low flows, and short-term fluctuations – and by changes in the landscape, for example caused by transmission lines, roads, townships, irrigation schemes, a reservoir, loss of forest resources or riparian agriculture, which alter their traditional means of subsistence. Numbers of OPAP often exceed oustees who are resettled.

Although dam proponents usually promise that the construction phase will provide local employment, in practice the skilled jobs and many unskilled ones are taken mostly by immigrants to the area who already have experience in such projects. Local people are left out of the prosperity that accompanies these jobs. Similarly, when a dam blocks the flow of a river and a reservoir forms, the species of fish in a reservoir environment and the fishing techniques needed to catch them are quite different from those in the free-flowing river with which the local residents were familiar. Again, often new arrivals from other areas, who already have the skills and know-how quickly exploit the new resource and establish themselves. Local communities are thereby further disadvantaged and impoverished, becoming a problem for, and burden on, government.

Dams block upstream migration of fish to spawning areas; fish ladders, which are used with moderate success for salmonid species in temperate climates have been found to be largely ineffective for tropical fish.

Dams also alter the water chemistry in the reservoir and downstream of the dam compared with the original free-flowing river. The turbulent water immediately below the dam spillway may be supersaturated with dissolved oxygen and nitrogen, which can cause gas bubble disease in fish. Temperature, turbidity, nutrients, and suspended solids are all altered by the residence time of water in reservoirs compared with the natural river flow.

Fish in a reservoir are different from those in a natural river, as noted previously and, because of different physical and chemical characteristics of water downstream of the dam, fish surviving in those reaches of the river may be in poorer health, and the species and numbers of fish altered.

In general, fish catches peak early in the life of a reservoir, then decline, because of lower overall productivity. Introduction of non-native fish (termed 'exotic' species) can devastate what is left of native fish stocks, and thereby alter the ecology of a river.

Whether resettlement is successful or not cannot be reliably judged for two generations after relocation has taken place. Only if the grown children of the initial settlers and hosts have successful livelihoods and are fully integrated, contributing members of communities can the resettlement be considered successful.

As a principle and policy, developers and governments need to provide the financial and physical resources to implement relocation programs in ways that lead to immediate improvements in living standards and lifestyle for oustees and hosts. Poverty must be alleviated promptly. Otherwise, benefits and costs will continue to be inequitably allocated between local and distant stakeholders.

In recent years it has been discovered that, contrary to earlier claims, hydropower development is not free of pollution. Reservoirs that are not cleared of vegetation are sources of significant emissions to the atmosphere of the greenhouse gases, carbon dioxide and methane, from aerobic and anaerobic decomposition of underwater organic matter. In addition, the static water at the fringe of reservoirs provides habitat for snails, the host for the schistosomiasis parasite, and malaria-carrying mosquitoes. The incidence of disease caused by these vectors can increase significantly after a dam development.

The transport and deposition of silt and sediment by a river is as ecologically important as the movement of water. Dams profoundly alter the movement of sediment, which settles in the reservoir, often at rates much greater than predicted, causing premature loss of holding capacity. This sediment is no longer available to replenish soil and nutrients in downstream flooded areas, or in the Mekong Delta, nor to provide habitat for aquatic species in the river.

Terrestrial ecological systems including forests, wetlands, and mountain valleys and their associated wildlife habitats are always eliminated in whole or in part by a reservoir. There is no way to mitigate these impacts, though sometimes developers are required to finance the setting aside

of natural habitat in the same or other areas, which might otherwise be lost for one reason or another.

SOME SOLUTIONS FOR FUTURE DAM DEVELOPMENTS

Early in a project, at the concept stage, before site selection or engineering plans have been determined, governments, dam proponents, and planners need to actively involve all constituents whose lives and rights may be significantly affected by the proposed dam development. Stakeholders who may bear the risks of a development are entitled to be consulted on whether and how the project should proceed. In this way, ideas that are flawed can be eliminated before commitments are made, and the best option can be negotiated with justice and fairness for those who will bear many of the risks and costs, but in the past have not had influence on the outcomes.

Learning the lessons from previous dam projects is mandatory before similar new initiatives are undertaken. The WCD found that, after completion, few large dam projects were evaluated properly for economic, financial, environmental, or societal successes and failures. As a result, the same mistakes have been made again and again.

As noted previously, CEA can help to provide the big picture of potential ecosystem effects from multiple developments in a specific watershed or the whole MRB. And a project-specific EIA done thoroughly and early in a proposed dam development can clarify build or no-build decisions, and highlight sensitive issues needing mitigation if the decision is to proceed.

SOME ALTERNATIVES TO LARGE DAMS

When a power shortage exists, before even considering whether or where to build a dam to supply the demand, government should carefully look for opportunities to save on existing use of electricity (called demand-side management), and also to minimise losses that occur in the generation, transmission, and distribution of the power (called supply-side management). Obviously, in developing countries, the prospects for demand-side savings are small compared with large energy users in Western countries. But some economies can almost always be found.

Appropriate technology in the form of small electrical generation units can be used to meet local community needs, perhaps using solar, wind, or biomass technology The construction of several small-scale dams rather than one large dam is being promoted as more cost-effective and financially preferable for supplying local area needs. In general, run-of-the-river dams, in which the river is usually not impounded, but flows unimpeded through generator units are less damaging than dams that detain the river's flow. Such dams are usually built downstream of an impoundment dam to take advantage of the water already captured. They also cause less environmental problems than would a new dam on a pristine river, as the major damage has already been incurred when the original dam was built.

SUMMARY OF KEY POINTS

- The need to re-think how to manage freshwater resources is one of the greatest challenges facing the world in the new century.
- 'Business as usual' is neither feasible nor desirable.
- Ways must be found to share water resources equitably and sustainably, meeting the needs of people, environment, and economic development.
- The future for water resources development is in participatory decision-making using a rights-and-risks approach.
- Open, meaningful participation must be implemented at all stages leading to freely negotiated outcomes.
- The social and environmental effects of dams must be given equal weight to economic factors.
- Governments must screen out inappropriate projects earlier, and facilitate integration across sectors within a river basin.
- Developers must be held accountable by contractual commitments to properly mitigate social and environmental impacts.
- Improvements in compliance may be brought about by independent review of environmental, social, and economic performance.
- Dam proponents must learn lessons from the past and not repeat them.
- Focus should be on:
  - assessment of all options, including 'no build'
  - opportunities to improve performance
  - addressing legacies of existing dams
  - equitable sharing of benefits in sustainable water resources development.

SOME RECOMMENDATIONS OF THE WORLD COMMISSION ON DAMS

The report of the World Commission on Dams (WCD) made many recommendations, and defined criteria and guidelines that it believed should be applied to dams that are currently in the planning stage, those now in the construction phase, and also dams that are already operating. In other words, the WCD intended its findings to apply to all dams whatever their stage of development or operation. Some of the WCD report's key findings, recommendations, criteria, and guidelines are briefly summarised here.

Benefits and Costs of Dams

The WCD concluded that dams have made important contributions to human development, and have provided considerable benefits. But in too many cases, the costs have been unacceptably high in terms of effects on displaced people, downstream communities, other citizens, and the natural environment. The distribution of benefits from dam development has often been inequitable. Dam developments must integrate and balance social, environmental, and economic needs. Unsustainable developments must be eliminated early in the decision process, and the criteria and processes used to select dam developments must be transparent. Co-operation between communities and nations to achieve sustainable, equitable sharing of water resources must be a primary goal.

Severe, irreversible ecological impacts should be avoided by modifying dam design, if necessary. Downstream water flows should meet environmental needs and mitigate or compensate for unavoidable ecosystem impacts. Requirements must be defined for compliance, monitoring, and the consequences of non-compliance.

Rights and Risks Approach to Decisions on Dam Development

This recommendation affirms the principle that people whose rights may be affected, and those who bear risks associated with dam development (especially those on whom risks are imposed), must be involved from the beginning as equal participants in transparent negotiations to resolve competing interests, regardless of their social or economic status. The rights of all legitimate stakeholder groups need to be clarified so that they have a formal role in consultations and decisions commensurate with the risk to which they are exposed. A distribution analysis is required to determine which groups bear the costs and which ones reap the benefits of a project.

WCD STRATEGIC PRIORITIES, CRITERIA, AND GUIDELINES

Strategic Priority 1 – Gaining Public Acceptance
Criteria (-) and Guidelines (–)

- Identify who are legitimate stakeholders
- Develop a negotiated decision-making processes
- Ensure free prior informed consent from participants in decisions
  - Recognise the rights of affected groups, especially tribal, indigenous people, women, and others who are vulnerable
  - Enable informed, consensual participation by all such groups in decisions

Strategic Priority 2 – Comprehensive Assessment of Options
Criteria (-) and Guidelines (–)

- Conduct environmental and socio-economic impact assessments at strategic, cumulative, and project levels
- Conduct a multi-criteria analysis
- Conduct a life-cycle assessment
- Assess potential greenhouse gas emissions
- Conduct a distribution analysis
  - Assess all alternatives to a dam during feasibility studies, and continue through planning, development, and operation
  - Give social and environmental concerns the same weight as economic and financial factors

Strategic Priority 3 – Addressing Existing Dams
Criteria (-) and Guidelines (–)

- Ensure operating rules reflect social and environmental concerns
- Improve reservoir operations
  - Circumstances change with time - re-examine existing dam operations, impacts, mitigation measures, obligations

Strategic Priority 4 – Sustaining Rivers and Livelihoods
Criteria (-) and Guidelines (-)

- Conduct baseline ecosystem surveys
- Assess environmental flow requirements
- Maintain productive fisheries
  - Equitable human development and welfare of all species depend on understanding, protecting, and restoring river basin ecosystems
  - Priorities are: assessment of options, avoidance of impacts, minimization of harm to the health and integrity of the river system, good site selection and project design
  - Downstream ecosystems and communities may be maintained by release of environmentally-tailored flows

Strategic Priority 5 – Recognising Entitlements and Sharing Benefits
Criteria (-) and Guidelines (–)

- Assess baseline social conditions before development
- Analyse risks of impoverishment from development
- Implement a mitigation, resettlement, and development action plan
- Develop mechanisms to share project benefits

– Negotiations with those adversely affected must result in mutually agreeable and legally enforceable mitigation and development
– Successful mitigation, resettlement, and development are responsibilities of the State and the developer
– Livelihoods of affected people should improve promptly

WCD STRATEGIC PRIORITIES, CRITERIA, AND GUIDELINES (Cont'd)

Strategic Priority 6 – Ensuring Compliance
Criteria (-) and Guidelines (–)

- Establish compliance plans
- Establish independent review panels for social and environmental matters
- Post performance bonds
- Set up trust funds
- Make a pact regarding integrity
  - Governments, developers, and operators must meet their commitments
  - All must comply with relevant regulations, criteria, guidelines, and agreements at all stages of development and operation
  - Use of incentives and sanctions can assist response to changing circumstances

Strategic Priority 7 – Sharing Rivers for Peace, Development, and Security
Guidelines (–)

- In trans-boundary river systems, dams and water diversions require co-operation of all affected States
- States must agree to use and manage resources to promote regional co-operation and peaceful collaboration
- There must be a shift from allocating water resources to sharing the river system and its associated benefits