Environmental aspects of dam and reservoir projects — the World Bank's new policy

by Robert Goodland

The Bank seeks to promote sustainability in all relevant projects and sectors. This article outlines the Bank's most recent environmental policy for dam and reservoir projects.

IN MARCH 1989, the World Bank announced a new official policy to be followed by all staff and borrowers involved in any project related to dams and reservoirs. This comprehensive and detailed new policy lays down procedures designed to ensure that all environmental aspects of such projects become routinely and systematically integrated into project design and operation. The overall aim of this policy parallels economic least cost: that is to ensure that borrowers promote their environmentally and socially low-cost project investment options and exclude environmentally and socially high-cost projects, while maintaining optimal environmental and social standards. The strength of the policy is that the Bank will not normally finance projects which do not comply with the policy. The remainder of this article is the official policy, practically verbatim, together with Figure 1.

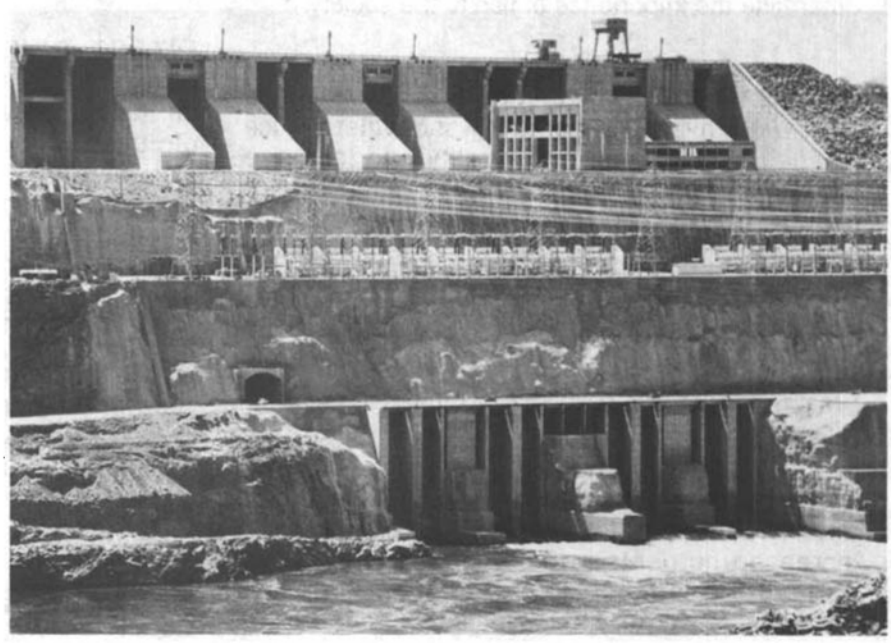
Background

The policy recognizes that dam and reservoir projects improve water supply for irrigation and households, provide power, control floods, and reduce fossil-fuel depletion and the environmental effects of fossil-fuel burning. With careful planning, adverse effects (Figure 1) can be prevented, mitigated, or compensated, and the beneficial effects enhanced. Other existing Bank policies are also to be followed in dam and reservoir projects, such as those on involuntary resettlement, tribal peoples, wildlands (biodiversity), cultural property, international riparian rights, dam safety and the general guidelines on environmental policy.

Governments need to have environmentally and economically sound macroeconomic and sector policies on matters which affect dam and reservoir projects. In the context of individual investment projects, the Bank should review these policies and seek to improve them where necessary.

Adverse environmental impacts should be avoided, minimized or compensated for wherever possible during project design (e.g. by modification of dam location or height), and by measures implemented as part of the project, bearing in mind the need to balance environmental, economic, social and other concerns. Opportunities to increase benefits should be sought in the design of the project, such as by using reservoirs for waterfowl, tourism and fisheries. Cost-benefit analyses should explicitly include estimates for all necessary mitigatory measures, as well as for quantifiable environmental losses and enhancements due to the project.

Design of investment programmes for supplying water or energy should consider demand management as well as supply options such as conservation of water and energy, efficiency improvements, system integration, cogeneration and fuel substitution. Environmental analysis is essential in decisions about the need for a project, its type (eg. thermal vs. hydro), size, location and area of influence. Where viable alternatives exist, careful dam siting is critical to minimize the inundation of forest or other wildland areas, and the dislocation of people. The creation and/or protection of compensatory forest or other wildland areas should be promoted. The feasibility of preparing the reservoir area prior to inundation should be



© Andrew Couldridge / Oxfam

Integrating power generation and irrigation with rural development increases the benefits of a dam or reservoir project.

Dr. Robert Goodland is Chief, Environment, Latin American Section, World Bank, Washington, DC 20433 USA.

Figure 1 Typical environmental effects of dams and reservoirs

LAND LOSSES Large tracts of agricultural lands, forests or other wildlands may be inundated. Careful siting can minimize such losses (e.g. by selecting reservoirs with high Kwh-generated/ha land area inundated). The value of lost timber and other resources, and foregone use of inundated land should be estimated in the economic analysis.

HEALTH Some water-related diseases (e.g. schistosomiasis, malaria, onchocerciasis and Japanese B encephalitis) may increase unless precautions or mitigatory measures are implemented. Vector control, environmental modifications, and education of residents may need to be incorporated into the project.

PLANT AND ANIMAL LIFE Biotic surveys are normally essential; plant and animal extinction can be prevented or minimized by careful project siting. Loss of wildlife may be mitigated by including elsewhere in the country a wildlands management area equivalent to the inundated tract, as provided for by the Bank's Wildlands policy. Animal rescue, replenishment and relocation can be useful. Canal and other crossing facilities are often essential.

FISH AND OTHER AQUATIC LIFE Fish migrations (if any) will be impaired even with passage facilities. Fish propagation may mitigate losses and produce more fish protein than before the project. Spawning areas, aquaculture, improved fishing methods and marketing may need special attention. A reduced supply of nutrients downstream and to estuaries can impair fishery productivity. Interbasin transfers may threaten aquatic species by introducing new predators or competitors. A socio-economic survey can determine the importance of fish to the society.

WATER WEEDS Proliferation of floating weeds (e.g. water hyacinth [*Eichornia*] and water lettuce [*Pistia*], can impair water quality and increase disease vectors and water loss (through evapo-transpiration). Clogging impairs navigation, recreation, fisheries and irrigation. The potential to use weeds for compost, biogas or fodder should be investigated.

WATER QUALITY Suitability of water quality for drinking, irrigation, fisheries or other uses, both within reservoirs and downstream, should be addressed. Issues include saline intrusions, water retention time (i.e. flow/volume), loss of flushing, increased nutrients in reservoir, pollution (e.g. agricultural leachates, pathogens, industrial effluents), raising or contamination of water table, and salinization.

ANAEROBIC DECOMPOSITION Inundated vegetation on the bottom of reservoirs decomposes, consuming large amounts of oxygen. If thermal stratification occurs, mixing of surface and bottom water is impeded, and the bottom water may become anaerobic. Anaerobic decomposition of organic material produces noxious gases toxic to aquatic life and harmful to machinery. If discharged by the dam, downstream fish could be killed. Multiple-level outlets in the dam can avoid the discharge of anaerobic water. Inexpensive models are available to predict thermal stratification. Conversion of forest to timber before reservoir filling reduces project contribution to greenhouse gases.

EROSION Erosion upstream in the catchment area leads to sedimentation or land slides which can impair storage; catchment area management should be encouraged where appropriate. Increased erosivity of the water (the so-called 'hungry waters' effect), on the river-bed and structures below the dam, including deltaic and coastal changes, should be considered during preparation. Trap efficiency, the capacity of the reservoir to store sediments should be estimated. Many dams have low trap efficiency and do not store much sediment, hence do not increase erosivity downstream.

DOWNSTREAM HYDROLOGY Changes in downstream hydrology can impair ecosystems dependent on seasonal flooding, including areas that may be important for fisheries (e.g. floodplains, lagoons, marshes, mangroves) or for traditional flood-recession agriculture. Sometimes management of downstream water-releases can minimize such damage by partially replicating natural flooding regimes.

INTACT RIVERS Hydroelectric and other developments should preferably be concentrated on the same rivers if hydrological risks and other circumstances permit, in order to preserve elsewhere a representative sample of rivers in the natural state. This should be considered part of the trade-off.

MULTIPLE USE Multiple use should be addressed through tourism, irrigation, fisheries, bird and other biotic sanctuaries, and recreation. Water-flow regulation can convert seasonal rivers into perennial waterways, reduce flooding, and improve drinking-water and irrigation. Communal access should be perpetuated.

[Note that involuntary resettlement, tribal people, cultural property and dam safety are not discussed here as they are covered by other Bank policies.]

determined. Removal of vegetation will improve the water quality of the reservoir and reduce growing conditions for aquatic weeds, while selective removal of timber and other obstacles will improve the possibility for net fishing and enhance water circulation, important for oxygen distribution.

Benefits from dam and reservoir projects increase when they become regional development projects which integrate, for instance, power generation, irrigation and municipal water-supply, with catchment area management and rural development. Designing water projects in the context of overall river-basin and regional development plans normally reduces the potential for unanticipated cumulative adverse environmental effects and intersectoral problems. The need for catchment area management and improved land use, for example discouraging settlement in flood-prone areas, should also be systematically considered.

The lands inundated by a dam are typically more productive than neighbouring uplands, and are therefore more densely populated by people and livestock. Displacement of the lowland population to the uplands often endangers the environment, as more people and livestock have to survive on a reduced resource base. Demand for arable land, fuel, fodder, potable water, building materials and other resources may increase dramatically, and the carrying capacity of the uplands may be quickly exceeded unless development assistance increases the productivity of the remaining resource base. The Bank's resettlement policy emphasizes maintenance, the prompt restoration of and then the improvement of the social and economic production systems and income levels of *both* the displaced population and the host population among whom they are relocated. The key is the policy of *replacement* of assets in kind (rarely in cash), rather than compensation of assets at market or other value.

Project cycle

During project identification, an environmental reconnaissance by independent, recognized experts or firms, selected by the borrower and approved by the Bank, is essential to:

- ensure that potential environmental effects are identified;
- ascertain the scope of further environmental studies and actions needed;

© Elizabeth Hoddy

This small dam in the Rangpur district is used for irrigation, bathing and washing clothes.

- assess the ability of the borrower to undertake them; and
- advise on the need for an environmental panel.

Information collected is to be documented and provided to the Bank and government agencies concerned, to ensure that environmental factors are fully considered in project design, including determination of the final dam site and height, and should comprise part of the baseline data against which subsequent changes can be measured.

The Bank's 1989 policy on Environmental Assessment should be followed. During preparation, the Bank should review the draft Terms of Reference (TOR) for the environmental assessment part of the feasibility study, the short list of consultants, and their technical proposals. The environmental assessment should be consistent with country legislation on procedures and requirements. Broad intersectoral co-operation should be ensured between agricultural, fisheries, forestry, health, wildlife, tourism, municipal and industrial agencies, both at policy and field levels. Biotic, cadastral, social and cultural property surveys should be started early.

The appraisal mission should include environmental specialists to assess the environmental analysis, the design of measures to minimize or mitigate adverse environmental impacts, and the capacity of the borrower's staff to implement them. The environmental panel should be convened during project appraisal. The Appraisal Report should describe the environmental issues and their resolution, as well as the institutional arrangements.

Sector investment operations (as distinguished from specific investment projects) in sectors that include major dam and reservoir projects should proceed only when the environmental capabilities of the sector are adequate, or provisions to establish adequate environmental protection measures have been agreed upon during appraisal.

Bidding documents and contracts should incorporate appropriate measures to protect the environment. The environmental monitoring system, dam construction contractors' performance, adequacy of the environmental measures, institutional arrangements, training and performance of the in-house environment unit, and reports of the environmental panel should be reviewed with the borrower during supervision, and any necessary corrective actions identified and agreed upon.

Completion reports should review environmental problems and progress. In addition, as some environmental effects become apparent only after a decade or more of operation, the Bank should encourage the borrower to contract an independent environmental post-audit a decade or so after impoundment.

Institutional aspects

Major dam and reservoir projects should be used to help build environmental capacity (analytical, regulatory and enforcement) in institutions at the national and sectoral levels, through training, consultancy

and policy dialogue, and to foster coverage of dams and reservoirs by environmental legislation.

Environmental benefits can be maximized and costs reduced by improved intersectoral planning. Potential environmental implications are often better anticipated by involving the agencies responsible for environment, health, tourism, social affairs, municipal and industrial water-supply, agriculture, livestock, fisheries, and navigation, plus state and provincial authorities. Environmental agencies should be consulted in project planning and preparation, to ensure that relevant line ministries and other decision-makers are made aware of potential environmental impacts and recommended mitigatory measures.

An environmental unit

Each project involving large dams (height above 10m or reservoir volume above 2.5 million cubic metres, or with significant environmental implications) requires an in-house environmental unit with adequate budget and professional staffing strong in expertise relevant to the project, usually physical and biological science and sociology. It should normally be established within the implementing ministry or agency (such as that for irrigation or energy) or in a river-basin authority. The project's environmental unit should be located or well-represented at the project site, and work in conjunction with existing central agencies. Strengthening an existing agency-wide unit may be better than creating a new one. The unit should be established as early as possible to help ensure that pre-project baseline data are collected and environmental problems anticipated at an early stage. It should exist during project implementation plus an additional period to be agreed with the Bank. The unit should ensure that monitoring and evaluation anticipate environmental problems, and that mitigatory measures are implemented. Early and extensive training of unit staff is a priority.

For projects involving large dams, or having major environmental implications, the borrower should normally engage an advisory panel of independent, internationally recognized environmental specialists, the composition of which should be determined by the environmental reconnaissance. In certain cases, however, the reconnaissance study may advise, based on the significance of the environmental issues and the borrower's (including consultants') capacity to deal with them, that the panel is not needed. The costs of the panel could be financed from the loan or credit. Its TOR, and the short lists of individual experts from which the panel is to be selected, should be acceptable to the Bank. The panel should advise the borrower periodically on environmental aspects of the project, including:

- analysis of the findings of the environmental reconnaissance;
- the TOR and findings of the environmental assessment;
- environmental plans, procedures, budgets and progress throughout the life of the project; and
- the in-house environmental unit's staff, training, functions and relations with the Ministry of Environment.

Depending on circumstances, panel reviews would normally be held once or twice a year during preparation and implementation, or when the in-house environmental unit requests one. The advisory panel should continue to function after completion of the project for a few years (as agreed with the Bank), and could be convened on an ad-hoc basis thereafter.

Community organizations, research centres, environmental advocates and other NGOs can often provide valuable perspectives on improving both project design and implementation, as specified by other Bank policies. To tap these perspectives, the Bank encourages consultations by project authorities (including consultants preparing the project) with appropriate NGOs, particularly local NGOs. Various mechanisms for consultation may be appropriate, including sponsored public hearings or national workshops. Bank staff, too, should consult with NGOS as appropriate, bearing in mind the capacity of NGOs to offer important perspectives on project design, and the need to protect the confidentiality of information shared between the Bank and borrower. In addition, the Bank encourages consultation between project executing agencies and the population affected by the project, as part of the project design process. This includes tribal people, the focus of a separate Bank policy. The Appraisal Report should describe and assess the consultations which took place. ■