



This submission to the World Commission on Dams
was presented at the Commission's
East / South-East Asia Regional Consultation

Hanoi, Vietnam
26-27 February 2000

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Watershed Management and Downstream Effects on Wetlands in Relation to Dam Construction

Abstract

A summary of wetlands benefits and the importance of integrated river basin management are discussed, particularly in view of the importance of mitigating impacts from dam construction. It is essential that an integrated planning and implementation approach be used from the very beginning of the dam construction planning. The approach takes into consideration ecosystem management, biodiversity maintenance, and protection of the benefits derived from the dam and its reservoir (e.g., water supply, hydroelectric power). Guidelines for watershed and downstream management are discussed, with emphasis on the recently endorsed Ramsar Convention Resolution VII.18, "Guidelines for integrating wetland conservation and wise use into river basin management." A case study from Japan, the Miyagase Dam, is presented as an example of environmental planning and implementation to help mitigate the serious impacts involved with construction of this very large dam located near Tokyo. Finally, the conclusions are presented from the International Symposium on Dams, Reservoirs and Nature Conservation, held in Tokyo, Japan, 20-21 January 2000. While much focus was on Japan, and exchange of information with other countries, the conclusions from the symposium are of relevance globally and not only for Japan.

Introduction

With growing populations, the need to provide more water and electricity will continue to expand. In many areas, it will be considered necessary on humanitarian grounds to supply these increased demands. Dams will continue to be built. Improved management of a dam's watershed, or catchment, is essential for the sustainability of the dam's functions. Proper watershed management not only protects the dam's functions but also the biodiversity within the immediate area of the dam. A clear linkage may be seen between protection of the watershed and the sustainability of the dam.

However, consideration of the downstream effects of dam construction is often neglected in practice. Construction of a dam alters the natural wetland areas, or hydrological systems, dramatically. The ecosystem functions of wetlands have supported biodiversity and human populations which depend on wetland resources. Both ecological and sociological considerations must be taken into account during the planning phase – and before any earthworks begin. The river basin that is subjected to alteration from dam construction is forever changed.

The definition of *wetlands* used here is that established by the Ramsar Convention on Wetlands of International Importance and also used by Wetlands International: "Areas of marsh, fen, peatland or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" and may include "riparian and coastal zones adjacent to the wetlands or islands or bodies of marine water deeper than six meters at low tide lying within."

A *watershed* may be defined as a topographically delineated area, or hydrological unit, drained by a stream or river system, i.e. the total land area above some point on a stream or river that drains past that point. The watershed is often used as a physical-biological and socio-political unit for planning and management of natural resources (Brooks *et al.* 1991). A *river basin* is similarly defined but is larger, and includes all lands that drain through a river and its tributaries into the ocean. *Watershed management* is the process of guiding and organising the use of the land and other resources on a watershed to provide desired goods and services without harming soil and water resources. The inter-relationships among land use, soil and water, and the linkages between uplands and downstream areas are recognised in this concept (Brooks *et al.* 1991).

Wetlands Benefits

The important functions, uses and attributes possessed by wetlands and the negative impacts on wetlands from often poorly conceived river basin developments are well known and documented (e.g., Maltby 1986, Davies and Claridge 1993, Giesen 1997, UNEP/Wetlands International-Asia Pacific 1997). A summary of wetlands benefits has been succinctly provided by Davies and Claridge (1993) where wetlands are described as highly productive ecosystems. Wetlands benefits, sometimes called “goods and services”, may be broadly grouped according to functions (e.g., groundwater recharge, flood control, maintenance of biodiversity), products or uses (e.g., agricultural produce, fish, building materials, fuelwood, wildlife products), and attributes (e.g., aesthetic values, cultural or religious significance). The maintenance of wetlands as functioning ecological systems often ensures that important contributions to development are maintained. Types of wetland benefits (Davies and Claridge 1993) are:

Water Supply

- Direct extraction of water by people
- Water supply to an aquifer (groundwater recharge)
- Water supply to another wetland (lower in catchment)

Flow Regulation (*primarily flood control*)

Prevention of Saline Water Intrusion

- Ground water
- Surface water

Protection from Natural Forces

- Shoreline protection and erosion control
- Windbreak

Sediment Retention

Nutrient Retention

Toxicant Removal

Source of Natural Products

- On-site (directly harvested from the site)
- Off-site (transported by natural processes to another site)

Energy Production (e.g., hydro-electric power, firewood, peat)

Water Transport

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- Commercial exploitation of products
- Maintenance of wildlife (flora and fauna) populations

Significance for Conservation

Significant habitat for the life cycle of important plant and animal species

Presence of rare species, habitats, communities, ecosystems, landscapes, processes or wetland types

Recreation and Tourism

Socio-cultural Significance

- Significant component of the landscape or aesthetic significance
- Association with religious and spiritual beliefs and activities

Presence of distinctive human activities (e.g., specialised fishing methods)

Historically important sites

Significance for Research and Education

Contribution to the Maintenance of Existing Processes and Natural Systems

- Ecological, geomorphological and geological processes and systems
- Global carbon sink
- Maintenance of microclimates
- Prevention of development of acid sulphate soils

Guidelines for Integrated River Basin Management

Doolete and Magrath (1990) have emphasised that "watersheds as hydrologic units provide appropriate units for conceptualising and implementing development investments." This is an important point, because forestry, biodiversity conservation, water resources and agricultural development projects can affect one another, and must therefore not be developed in isolation. This is the basis for any integrated conservation and development project (e.g., dam construction and wetlands conservation). Integrating conservation and development of forests, water resources and wetlands is critical to their management. Watershed management provides the framework for managing multiple resources through an integrated approach. "The ecological usefulness of forests is most readily observed in their beneficial effect on water catchment areas, where they have a regulatory effect on streamflows and where they protect soils from erosion and prevent silting of dams and canals" (World Bank 1978). Yet the entire river basin must be taken into consideration, both upstream and downstream from the dam.

Both economic and environmental perspectives are essential for sustainable development, and wetlands provide a resource or basis for both perspectives. A holistic or integrated approach to planning and management is increasingly discussed and endorsed by governments and the public. However, putting an effective integrated river basin management planning process in place is not a simple task. The number of stakeholders to be consulted and the potential environmental and social impacts resulting from dam construction can be staggering.

Guidelines for sound development and management of river basins or watersheds are of considerable importance for building the capacity of watershed managers and decision makers. Guidelines can identify short, medium and long-term priorities for ensuring an integrated approach to watershed management. Governments need to consider the multiple use of natural resources in uplands and downstream areas. The multiple resources and benefits of forested land as watersheds cannot be managed by individuals and agencies with conflicting agendas or competing use of the land. However, this is almost always the case – conflict of management for multiple uses. Local institutional mechanisms are needed to manage successful river basin or watershed projects.

Guidelines for wetlands and integrated river basin management, including those of relevance to mitigating the effects of dam construction on wetland systems and biodiversity have been prepared (e.g., Wetlands International / UNEP 1997). These guidelines have been further developed and adopted by the Ramsar Convention at the Convention's CoP7, held during May 1999 in San José, Costa Rica. Specifically, Resolution VII.18, "Guidelines for integrating wetland conservation and wise use into river basin management", is of relevance and is based on Ramsar's Operational Objective 2.2. of its Strategic Plan for 1997-2002, which urges all Contracting Parties to the Convention "to integrate conservation and wise use of wetlands . . . into national, provincial and local planning and decision making on land use, groundwater management, catchment/river basin and coastal zone planning, and all other environmental management." The Guidelines for the Contracting Parties are annexed to the Resolution; all are of relevance to dam and reservoir construction and management. The Guidelines are grouped into categories or sections:

Relating to Integrated River Basin Management

Development and Strengthening of Policy and Legislation for Integrated Water Resources Management
Establishment of River Basin Management Authorities and Strengthening of Institutional Capacity
Involvement of Stakeholders, Community Participation and Public Awareness (refers also to Resolutions VII.8 and VII.9)

Assessment and Enhancement of the Role of Wetlands for Water Management

Identification of Current and Future Supply and Demand for Water

Minimising the Impacts of Land Use and Development Projects on Wetlands and Their Biodiversity

Reducing the Impact of Water Development Projects on Wetlands

Maintenance of Natural Water Regimes to Maintain Wetlands

Protection and Restoration of Wetlands and Their Biodiversity

Management of Shared River Basins and Wetland Systems

Partnerships with Relevant Conventions, Organisations and Initiatives

Case Study from Japan: Miyagase Dam

An International Symposium on Dams, Reservoirs and Nature Conservation was held in Tokyo, Japan, 20-21 January 2000. The conclusions from the Symposium follow in the next section. One of the symposium case studies, presented by Shinichi Miyata, focused on the Miyagase Dam, Kanagawa Prefecture, Japan. With construction starting in 1991 by the Kanto Regional Construction Bureau of the Ministry of Construction, the recently completed dam at Miyagase is a large-scale gravity concrete dam, located about 50 km from Tokyo and about 40 Km from Yokohama and Kawasaki. The multi-purpose dam provides flood control, maintenance of river flow, urban water supply, and electric power generation. At a height of 155 meters and a length of about 400 meters, the dam has a total water storage capacity of about 200 million tons and provides 1.3 million m³ per day. Associated with the reservoir is a large area of marshland dominated by various reeds.

The development of the dam intended to minimise the extent of unavoidable impacts on the original mountain ecosystem, and a wetland restoration scheme was accomplished. Before, during and after dam construction, monitoring surveys were made of the ecosystem and impacts that were being made. The survey enabled the planners to design a zonation system, and restoration and maintenance of watershed and downstream effects comprise a major on-going activity. The goal of the planners is to “restore and develop” the natural system damaged by construction as much as possible. Prior to construction, a Natural Ecosystem Survey and Restoration Plan was prepared, including surveys of flora and fauna. For example, during the surveys 107 species in 36 families of birds were recorded, and the home ranges of some mammal species were determined by radio transmitters. Rare and valuable species of plants (e.g., dwarf azalea, hosobakon chrysanthemum, spring strawberry geranium) were collected and transplanted to avoid submersion. The intention of the surveys was to minimise impacts to the natural ecosystems surrounding the inundated area by adopting appropriate construction methods.

Control of development within the watershed of the reservoir is strict, and is seen as essential for maintaining the reservoir as well as the biodiversity of the area. After dam completion, a “Development of Biotypes” program was initiated. This is an activity involving restoration and creation of wildlife habitat in new areas where some species had not previously occurred. Populations of two species of butterfly, the Gifu and the Giant Purple, are decreasing in many parts of Japan. Part of the program is to improve the habitat for these species by planting appropriate plant food species required at different times of the life-cycle. To avoid down-stream impacts, the position of water intake, and therefore the quality of outflow to the river, is adjusted so as to maintain appropriate water temperature and minimise turbidity and silt load.

Concrete aggregate for dam construction was removed from the raw-stone mountain. To restore slope ecosystems and promote stability, plantation experiments were conducted to determine growth and planting requirements of various plant species. The aim is to recreate the natural state on the slopes as much as possible and to maintain the existing forest in its original state without further development. Mountain streams and swamps are being maintained for biodiversity conservation. Marsh plants (e.g., ditch reed, water oat) function to filter and purify water and provide spawning sites for fish and insects such as dragonflies. In the on-going development planning and implementation for the Miyagase lakeside, creation of marsh wetlands, reforestation and maintenance of existing forests are promoted.

It is unavoidable to not seriously alter the original system when constructing such a large dam. However, planners considered methods of construction and extraction techniques that tried to minimise the impacts. Rather than constructing hillside roads and creating additional damage, roads were confined to the riverbed of the Nakatsu River, submerged eventually by the reservoir. New methods for removing raw stone for concrete aggregate from the mountain were adopted. This involved dropping raw stone through three vertical, slanting pits into a tunnel dug from the riverbed road. Attempts were made to aesthetically landscape the area, including lakeside roads, and with extensive replanting along the slopes. Other methods used to minimise environmental impact during construction included incline ramps for truck loading, similar to a cable car; this conserved energy and reduced gas emissions. Also, devices for purifying muddy waste water were employed before the water was released down stream during construction.

Conclusions from the International Symposium on Dams, Reservoirs and Nature Conservation, Tokyo, Japan, 20-21 January 2000

The following conclusions were prepared by the symposium participants and presented in this format by Wetlands International-Japan (WI-Japan, in press). The conclusions are applicable globally and, although of great significance for wetlands conservation and dam development planning in the country, the conclusions are not specific to Japan.

1. The symposium was organised with the following purposes:

Dams and reservoirs constructed for the purpose of flood control and irrigation have provided numerous social and economic benefits such as generation of hydropower, navigation, and development of reservoirs for recreational use. However, it cannot be denied that these developments have also brought impacts on the environment. Thus far, remedial measures such as the construction of passage facilities for fish, restoration of vegetation on the banks of reservoirs, or improvements of water quality have been taken to reduce these environmental impacts.

Recently, there has been an increasing tendency to lay stress on the non-economic values of dams and reservoirs. Attempts to create “biotopes”, new reconstructed or enriched habitats, targeting birds, amphibians, or insects are also starting in some sites of dams and reservoirs.

The sites of dams and reservoirs construction, especially mountain riverside, are vital habitats for birds and mammals. Some attention is directed toward the environmental requirements of these species, but it is not yet sufficient.

Today, cases of dispute between some citizens and the agency in charge of a particular construction project occur at some sites of dams and reservoirs, particularly concerning the protection of rare species of raptors (hawks and eagles). However, it is a matter of great importance for conservation of biodiversity to consider the whole biological community on which these predators depend. We must therefore research and improve conservation measures for wildlife in the mountain riverside and other riverine habitats.

The symposium, aiming at a more sustainable co-existence of dams, reservoirs and wildlife, invited experts on dam mitigation from countries with many cases of advanced practice: Japan, Germany, the Netherlands, Norway, the United Kingdom and the United States, as well as a representative from the World Commission on Dams. The purpose of the symposium was to improve environmental conservation measures for wildlife habitats in the riverine areas through study trips for the participants. In this way, the experts were able to observe practices of environmental conservation in dams and reservoirs in Japan. Through presentations and discussions during the symposium on cases of dam development in Europe and the United States, Japanese experts were able to share this knowledge.

2. The symposium was conducted as follows:

The International Symposium on Dams, Reservoirs and Nature Conservation was organised by Wetlands International – Japan. It was supported by the Ministry of Construction, Ministry of International Trade and Industry, Ministry of Agriculture, Forestry and Fisheries and Environment Agency of Japan. The symposium was additionally sponsored by the Foundation of River and Watershed Environment Management, the Japan Fund for Global Environment, the Federation of Electric Power Companies, and the Japan Electrical Safety and Environment Technology Laboratories.

The symposium, with over 200 participants, included keynote lectures on environmental mitigation during and after dam construction. Presentations of case studies were made to compare various methods to improve the natural functions and values of rivers in Japan, Germany, the Netherlands, Norway, the United Kingdom and the United States. Following the presentations, discussions were held among the participants. The keynote and case study papers presented during the symposium, as well as an

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overview of the workshop sessions, will be published in a full proceedings (Wetlands International – Japan, in press).

3. To attain a more sustainable coexistence of dams, reservoirs and wildlife, the participants of the symposium encouraged consideration of the following conclusions or recommended conservation measures, as feasible within the existing possibilities of technical and economical resources:

Development of river basin management plans, encompassing the full catchment and affected coastal zone, which define environmental as well as economic and social objectives.

Rehabilitation of mountain riverside and other downstream riverine and estuarine habitats, which are vital to wildlife, by allocation and management of appropriate land and water resources to meet environmental objectives.

Habitat enhancement in reservoirs including

creation of habitat corridors to enable wildlife to cross reservoirs

creation of floating islands or subsidiary dams to provide a transition area between water and land and to create new landscape features more suitable as wildlife habitats

creation of artificial nesting sites to attract raptors, bats and other species.

Review current knowledge and define priorities for further research and demonstration management projects on the impacts of dams and reservoirs on riverine ecosystems, habitats and species, particularly the ecological requirements of aquatic and wetland communities for particular water flow and water quality regimes.

Further exchange of information through forums and symposia to obtain improved understanding of conservation measures to reduce the impacts of dams and reservoirs.

Involve non-governmental organisations (NGOs) in appropriate aspects of river basin planning and management.

Implement a communication strategy to improve public awareness of the true values of total riverine ecosystems and the complex challenges in achieving their sustainable management.

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