

## Give and Take: The Toll on Ecosystems

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Increasing attention has been paid in recent years to conflicts among multiple uses of water and general policy statements have been prepared to suggest responses to the developing water crisis. Gleick (1998) suggests seven sustainability criteria to guide water planning. Among these are the following: “A basic water requirement will be guaranteed to all humans to maintain human health; A basic water requirement will be guaranteed to restore and maintain the health of ecosystems; Human actions will not impair the long-term renewability of freshwater stocks and ecosystems and flows, Water planning will be democratic, ensuring representation of all affected parties....” Similarly the United Nations Millennium Declaration (U.N., 2000) seeks to achieve a number of goals including eradicating extreme poverty and hunger while ensuring environmental sustainability. Under article IV, Protecting the Common Environment, several objectives are listed including reduction of greenhouse gas emissions, stopping the unsustainable exploitation of water resources, and pressing for implementation of the Convention on Biological Diversity. In many situations, these various desired outcomes present conflicts, testing creativity in devising equitable solutions, especially when current political structures do not explicitly consider all needs.

An example of potential conflicts is presented by current proposals to develop hydroelectric projects in the Patagonia area of Chile. The context is a response to an “energy crisis” brought on by strong economic growth in Chile over the last twenty years with a growth in energy demand of about 7.5 percent per year (Iglesias, 2008) coupled with the increasing unreliability of natural gas supplies from neighboring Argentina. One response to this dilemma has been the proposal for five hydropower projects on the Baker and Pascua rivers in Region XI of Chile with a combined generating potential of 2750 MW, about 30 percent of the current usage in the major power grid in Chile. It can be argued that these projects are ideal solutions to Chile’s energy supply problem: the projects utilize available national resources, promoting energy security while hydropower results in low greenhouse gas emissions. On the other hand, the Patagonian area of Chile represents a world-renowned pristine environment, similar in many ways to the Arctic National Wildlife refuge in the U.S. which is also currently subject to considerable controversy related to energy development of a different type. Due to its unique geographical circumstances, Chile has several endemic fish species and contains significant biodiversity that has been poorly characterized due to limited scientific study. There are also issues of social equity since the produced power would be exported out of a region that is the least populated area of Chile (0.4 inhabitants per km<sup>2</sup>) also with the lowest per capita income; concerns have expressed for the loss of the local way of life due to the proposed development. Studies have also indicated that project development is projected to lead to a decrease in tourism (Santiago Times, 2008), a major source of income for the region.

The World Commission on Dams has prepared a synthesis on the effect of large dams (WCD, 2000). Key findings suggest mostly negative impacts on rivers, watersheds and aquatic ecosystems and that efforts to counter these negative impacts have met with limited success. In many cases, the outcome has been an irreversible loss of species and ecosystems, much of which was not anticipated in the planning process. The difficulty of accounting for adverse environmental and social costs makes the true profitability of projects elusive. A prime example is the 1972 completion of the Libby Dam on the Kootenai River in Montana, USA. The Kootenai white sturgeon population which was already in decline was severely impacted and was listed as endangered in 1994. A 1997 population census indicated approximately 1500 fish, nearly all of which were over 25 years of age while a 2005 count showed a further population reduction to 450. Investigations indicated that sturgeon require river flows in excess of about 1200 m<sup>3</sup>/s and water temperature within a range of 8.6-12.9°C during the months of May and June for successfully spawning (Paragamian et al, 2005). Reservoir management operations had reduced both discharges and temperatures during the spawning period, resulting in essentially no population recruitment since the dam was commissioned.

Presuming that they can be identified, adverse environmental impacts can be alleviated to some extent by proper reservoir management. However, anticipating the range of those impacts has proven elusive in the past and will probably continue to be the case for future projects. Hydrological conditions such as low flows, high flow pulses, small floods and extreme floods can all influence different key ecosystem processes (Bunn and Arthington, 2002) and a reasonable conclusion is that operation schemes that minimally impact the natural hydrological regime will be preferred. Negative effects on water quality and fish passage may be reduced by incorporating multiple outlets and 'fishways' into dam designs. Both the Baker and Pascua rivers are subject to relatively low flow variability due to the fact that large lakes are the sources of both rivers and it may be possible to minimize the flow disturbances in these rivers, but there will probably be other unanticipated outcomes if the projects proceed. In addition, these projects represent only about a third of the hydropower development considered for the Patagonia region and other projects that would inevitably follow will be less suited to mitigation of adverse impacts related to river discharge.

Chile is a country with an economy that is based on a strong free market system and has often been cited as a positive example for market-based economics. However, the relative lack of government involvement in water resources management, for example, works against the long term planning that is required for sustainability concerns to be properly considered in decision making processes. The country is also relatively new to environmental regulation with a national environmental law in effect only since 1994. Although the law requires an environmental impact assessment, the process can best be described as evolving. Comments presented in response to the environmental impact assessment process come too late for concerns to be addressed during the project development phase.

In order for sustainability concerns to be adequately addressed in project implementation, there is a need for a combination of long term energy and water resources planning and a greater level of stakeholder participation earlier in the planning process. This example in Chile is not unique and more comprehensive planning

approaches must become an integral part of water resource decision making if repeating the mistakes of the past is to be avoided.

## **References**

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