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# A fair share: sharing the waters of multipurpose reservoirs

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*The multipurpose functions of reservoirs can create competition and conflict, prompting an increasing need for wise stewardship of global water resources. Sharing the water uses of multipurpose hydropower reservoirs is now the focal point of a framework recently produced by Electricite de France and the World Water Council. Suzanne Pritchard reports.*

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In order to achieve proposed Sustainable Development Goals (SDGs), the 2014 World Water Development Report stated that by 2030 we will need to find 35% more food, 40% more water and 50% more energy. Ultimately with the SDGs striving towards food security and access to water and energy for all, there will be greater demands for water for many different uses by many different users. As water scarce nations try to navigate this path towards sustainable growth and development, water scarcity and water quality issues will become increasingly important and complex issues across many parts of the world.

"Hydropower is at the cross road of two basic human needs - energy and water supply," Emmanuel Branche, senior economist engineer with Electricite de France (EDF), explains. "Hydropower is at the heart of the water-energy nexus," he adds. "It has a special role to play in economic development, social justice and environment caution which represent the basic pillars of sustainable development."

Branche describes previous approaches to managing water and energy resources as being ad hoc or laissez faire. He says that even though the two resources are inextricably linked, they have often been planned for and managed separately at the expense of the environment. An integrated and interconnected approach is needed for future management to ensure that these needs complement rather than compete against each other.

Alongside electricity generation, hydropower reservoirs often lead to the development of other uses such as water supply, flood control, irrigation, and environmental and recreational services. According to ICOLD, as of March 2015, 26% of 38,452 large dams with described purposes are multipurpose large dam reservoirs.

Sharing water amongst competing uses is acknowledged as being a major challenge for these multipurpose facilities. Although often complementary, such a multitude of functions can often create conflict. It was with this in mind that EDF and the World Water Council (WWC) agreed to work together in 2012. Their purpose, to compile a framework for the multipurpose water uses of hydropower reservoirs, was to address the following issues:

- Minimise contradictions and competition among multipurpose hydropower reservoirs.
- Set an appropriate governance structure to allow coordinated/integrated water use management for strategy, planning, decision making and operation.

The initiative is linked with the ICOLD Committee on Multipurpose Water Storage Dams and the IEA Hydro Annex on Hydropower Services. Other contributing organisations included the International Hydropower Association, the World Bank and WWF. The 2015 World Water Forum in Korea was chosen as the venue to unveil the completed framework.

## Sharing

There is universal agreement that the positive aspects from the multipurpose water use of hydropower reservoirs need to be maximised, while negative impacts are avoided, minimised, mitigated or compensated. The EDF-WWC

framework admits that, although there are no one fits all solutions, there are principles that can be shared and adapted. It states that the following values can help achieve sustainable water management in the development and operation of multipurpose hydropower reservoirs:

- Shared vision.
- Shared resource
- Shared responsibility.
- Shared rights and risks.
- Shared costs and benefits.

The framework brings together the considerations around multipurpose projects in one document and identifies the issues and principles which can guide decision making. All projects are case specific and should be adapted to local contexts. Furthermore the sustainability of multipurpose hydropower reservoirs is categorised into five value propositions known as the SHARE concept:

- Sustainability approach for all users - The degree to which multipurpose hydropower reservoirs can advance sustainable development objectives depends on careful planning, construction, operation, management and governance.
- Higher efficiency and equity among all sectors - Economic data and innovative financial mechanisms are crucial for equitable and efficient management.
- Adaptability for all solutions - It is essential to provide greater flexibility and adaptability in the way water is allocated among users during the entire lifetime of the reservoir.
- River basin perspectives for all - An integrated approach is essential to reach a holistic view of the river basin.
- Engaging all stakeholders - Stakeholder engagement is critical for success in multipurpose reservoir management in terms of sustainability and efficiency.

EDF and WWC urge that future investments in and operation of hydropower projects should embrace the SHARE concept and take a multipurpose approach where appropriate together with co-financing to make it work. The framework calls for a "sustained and steady focus" in utilising multipurpose opportunities for investment and operation over the coming decades.

### **Drivers of sustainable development**

Multipurpose hydropower reservoirs are often described as being drivers of sustainable development. The Director of the United Nations University Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES), Reze Ardakanian, re-iterates that a nexus approach is required to achieve this. "Successfully managing hydropower reservoirs to drive sustainable development will require new or linked models able to consider water uses in an equitable way across sectors, promoting synergies and minimising trade-offs," he said.

Professor Benedito Braga is President of the World Water Council and believes that water infrastructure, with hydropower as an integral part, is central to delivering water security. Water infrastructure of the future, he says, must be multipurpose.

"I do not believe that we can afford to pursue individual sectoral solutions around water any longer," he added.

However a key challenge in delivering water security through resilient multipurpose water infrastructure is investment. On a global scale Braga says that we are not investing enough to bridge the gap between supply and demand. He wants to see new financing solutions as well as new ways of engaging all users in genuine shared responsibility for our precious water resources.

### **Economic analysis**

The EDF-WWC framework concludes that the SHARE concept should now be shared with all multipurpose reservoir stakeholders. It should be implemented by multipurpose reservoir planners, developers, operators, decision makers and

other stakeholders to foster sustainable water management of such reservoirs. Continued collaboration is also encouraged with research initiatives that focus on economic value, new financial mechanisms and adaptive design. It would be beneficial if such research, methodologies and modelling approaches were connected to policy making.

Gathered at the 2015 World Water Week, UN-FLORES, the IHA and United Nations Development Programme convened a session to discuss the possibilities and limitations of utilising multipurpose reservoirs for integrated water management and sustainable development. An important conclusion of the discussion was the need for more research into the economics of multipurpose dams.

"There is research on the ecosystems services, on the social benefits and challenges, on the financial returns, the flood protection and the navigation, but the ability to start pulling these together is what will enable societies and governments to work out what the real trade-offs are," argued William Rex, Global Lead for Hydropower and Dams at the World Bank. "We need a science of the economics of trade-offs".

In September 2015 Oak Ridge National Laboratory published research into the economic benefits of multipurpose reservoirs in the US federal hydropower fleet. As the report explains: "While multipurpose reservoirs account for billions of dollars in contributions to National Economic Development every year, no attempt has been made to evaluate their benefits on a national scale. This study is an on-going work conducted by Oak Ridge National Laboratory in an effort to estimate the economic benefits of multipurpose hydropower reservoirs in the United States."

The research's initial focus is on US federal hydropower. Together the Tennessee Valley Authority (TVA), US Army Corps of Engineers (USACE) and US Bureau of Reclamation (USBR) own and operate 157 powered dams which account for almost 50% of the country's total installed hydropower capacity. More than 80% of these dams and associated reservoirs are authorised for more than one purpose in addition to hydropower generation.

In the report TVA and USACE reservoirs show a similar benefits structure, with recreation comprising the largest overall benefit at nearly 40% of total economic benefit. Recreation opportunities on surface waters and surrounding land attract millions of visitors annually. In contrast navigation provides the smallest benefit. Power generation provides between 25% and 15% of the total benefit, ranking as the second and third largest benefit for TVA and USACE, respectively.

USBR reservoirs are the primary supplier of water for irrigated crops, farmland and livestock in the Western US. Irrigation is an authorised use for nearly all of these reservoirs and as such 60% of economic benefit in USBR dams is tied to this function.

Federal US hydropower dams generate over 276,000GWh of power annually. However as Oak Ridge National Laboratory's benefits analysis revealed: "while a critical component of many multipurpose projects, power generation does not contribute the largest National Economic Development benefit in most cases." Instead recreation and irrigation provided the largest economic benefit. Influential factors towards this include recreation visitors and spending, and the value of irrigated crops.

The report goes on to state: "As hydropower installed capacity at a reservoir is increased, the benefit of hydropower is significant when only one or two additional purposes are present. For true multipurpose projects with four to five quantifiable uses, hydropower benefits represent a disproportionately smaller percentage of the total economic benefit. Large projects often benefit many stakeholders, and the most valuable multipurpose use is a function of many competing inputs, including location, mode of operation, and authorised use."

Each of a multipurpose reservoir's functions often have significant and quantifiable economic benefits, the authors conclude. The magnitude of the

benefits depend on reservoir volume, geography, allocated storage and installed capacity among other factors.

Oak Ridge National Laboratory says its ultimate objective is to engage publicly owned and private sector hydropower dam owners and complete a national estimate of multipurpose benefits.

## References

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## Sharing case studies

The EDF-WWC Framework provides details of 12 indepth case studies from Latin America, North America, Europe, Africa, Asia and Oceania. They represent a diverse range in terms of geography, size and purpose, and give an important insight into lessons which have been learnt.

### AFRICA:

The multipurpose Kandadji dam is a 26m high embankment dam impounding a 1.6Mm<sup>3</sup> reservoir in Niger, Africa. It is located on the main Niger River downstream from the Mali border. Designed to produce 629GWh annually it will irrigate an area of 45,000ha and guarantee a minimum release of 120m<sup>3</sup>/sec for water supply and ecological restoration in this vulnerable and insecure part of the Sahel region.

Kandadji has been studied since 1976 with an initial focus on hydropower. However by the mid-1990s the consequences of repeated drought and low river flows highlighted the need for improved water supplies, and optimising project benefits from a regional perspective. The Niger Basin Authority was established as an intergovernmental organisation to foster cooperation in managing water resources for its member countries: Benin, Burkina Faso, Cameroon, Chad, Cote D'Ivoire, Guinea, Mali, Niger and Nigeria.

Dam construction started in 2012 but was stalled due to poor performance. It is due to resume in 2016 and expected to be completed by 2020.

One of the major challenges with this multipurpose scheme is that many of the benefits (including irrigation) are not attractive to the private sector; failing to provide sufficiently attractive economic and financial rates of return to ensure repayment of commercial loans.

Promoting this project as a public scheme, with broad political will to include irrigation and flow control for livelihood improvements, has helped to improve the situation but did not change the economic internal rate of return. The World Bank is financing 25% of the total programme with remaining costs financed by co-financing from ten different partners and counterpart financing from the Government of Niger. Managing a large number of financiers has been described as adding an extra layer of complexity to an already challenging project.

The importance of adequate coordination among all riparian countries is stressed as being a critical component for success in such complex, multi-sector projects in transboundary river basins. Other difficulties encountered with the Kandadji project were that decisions on the design and financing of different parts of the scheme (irrigation, power plant and dam flow control) were made on different occasions.

#### **OCEANIA:**

Bronte Lagoon in Australia was created by Hydro Tasmania in the 1950s for the single purpose of hydro storage but has evolved into multipurpose infrastructure over its lifetime. As there was no conscious decision to change from a single to a multipurpose storage there hasn't been any specific economic analysis of the costs and benefits of changing rules to enable and enhance multiple uses.

Factors behind this drive for change include:

- Economic development associated with tourism around recreational trout fishing and canoeing at state and local levels.
- Evolved societal expectations and values, relating to an increase in the ability to pursue recreational activities, the appreciation of outdoor and natural resource-based recreational pursuits, and an interest in local food sources and self-sourcing.

Difficulties that Hydro Tasmania has faced relate to balancing recreation requirements and land and water use, eg managing conflicts between competing recreational groups, how to manage illegal camping, waste, boat traffic, safety, signage etc. As Hydro Tasmania's primary business is electricity generation, and not the management of local and multiple use pressures, it has developed Recreational Principles to guide interaction with external stakeholders.

Bronte lagoon is described as being a very good example of multipurpose water use of reservoirs in Tasmania. Accommodating recreational purposes has little consequence for electricity generation, but provides business value in the way of good stakeholder and community relations and a positive view of the company.

#### **LATIN AMERICA:**

Lake Arenal and Sangregado dam are administered by Costa Rica's National Electric Power Company. The 157MW hydropower plant has been of great importance to the country and initially generated 70% of all power after construction in 1978.

The project was intended for hydropower and irrigation and benefits 1125 families who produce sugarcane, fodder, rice and fish - creating an income for the region of approximately US\$163.7M. Excellent recreational opportunities have also been provided and are becoming of increasing importance. New activities such as windsurfing and fresh water fishing have developed around the 1750m<sup>3</sup> reservoir which is becoming an important tourist destination.

Arenal Lake has enabled Costa Rica to harness water, generate power and irrigate agricultural land with a large social pay off. Increasing tourist activity has also given the lake a new purpose. Furthermore the government is promoting sustainable development and encouraging protected areas. It was classified as a Ramsar site in 2000 (an intergovernmental treaty for the conservation and wise use of wetlands and their resources).

**The full case studies were compiled by Emmanuel Branche from EDF and can be found in the EDF-WWC framework documents.**