Going with the flow?

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Environmental and social issues related to hydropower

Technical aspects of hydropower plants

Humans have been using the gravitational force of falling or flowing water to create electrical or mechanical energy for centuries. Today, hydro energy is a major source of renewable energy and provides 16% of the global electricity demand. However, only a fifth of the total global hydropower potential has been developed yet. Canada, Brazil and China are the largest producers of hydropower energy. In Sweden, hydropower provides more than half of the country's electric energy and is the main energy source besides nuclear power. As an operating hydropower plant creates little to no CO_2 emissions, hydroelectricity is often regarded as one of the cleanest sources of energy. Due to its high storage capacity and fast response ability, hydropower can cover sudden fluctuations in the electricity grid and buffer more fluctuated sources of renewable energy. Moreover, hydropower development can help to regulate water supply and control floods and droughts. Hydroelectric power uses the kinetic and/or the potential energy of water. Kinetic energy is classified as the energy that an object (water) has relative to its surroundings, whereas potential energy is the energy stored in a system by its position in a force field or in a system. In the case of water, potential energy is stored by raising water to a certain height. The resulting hydraulic pressure and the flow rate of water that is released from its reservoir describe the function of hydraulic power.

Ecological issues associated with hydropower

Hydropower plants that stores water in reservoirs often changes the natural flow of the water. This has consequences for the river as a habitat. We need the most electricity during the winter, but the highest flows in a natural river in Sweden occur during spring when the snow melts. Sometimes parts of the river can be left almost or completely dry and then suddenly get a flush of water. This can have severe consequences for the ecosystem, since one of the most important functions of a river ecosystem is the water flow. The water transports sediments, nutrients and provides food for a number of organisms. The effects go beyond the actual water ecosystem. Occasional flooding gives the riparian zone (the border between land and the water body) a nutrient input and some plants growing alongside the river use the water to spread seeds. One important organism group that is highly affected by hydropower is fish.

Many fish migrate within the river, to a lake or out to the ocean and therefore need a free passage. They can get stressed, injured or even killed when they come in contact with the turbines and their habitats get fragmented (the natural home is divided into smaller parts) by the constructions. This can be prevented by building fish ladders or by creating alternative routes. However, it is not always an easy task to make the fish understand which way to go, neither when they are travelling upstream nor downstream. Fish usually go for the dominant flow, so the passage needs to have a sufficient amount of water. This can be problematic, since the hydropower companies want as much water as possible to go through the turbines in order to maximize the electricity output.

Societal and economic consequences of hydropower projects

Social and (indirect) economic aspects of hydropower are often overlooked. In cases where inhabited areas are flooded, people are forced to move and find a new home. This can lead to severe violations of human rights. The displaced people may lose more than just their houses. Social community ties, their identity as well as bases for their livelihoods can be destroyed. Farmers have to find agricultural land elsewhere, trade routes like roads, railway lines or shipping routes are relocated, touristic infrastructure like hotels and restaurants may have to move or adapt. The focus of fishermen will also change from flowing water and migratory fish species to those living in standing water. At the same time, new economic opportunities can develop around the reservoir. Through aquaculture, tourism or logistics, a dam can also create new jobs. While adequate compensation can help in some economic cases, cultural and natural values are far less possible to fix. Further, natural beauty and uniqueness are main drivers of tourism and might be lost, so are fish species for sports fishing or certain plants that only can live on the natural river banks. Religious and spiritual communities furthermore often have close contact to natural elements. If sacred sites like rocks, forests, paths or buildings are lost, traditional knowledge and local identity get destroyed. The changing flow of water also leads to standing water freezing at higher temperatures and evaporating easily, which brings along health risks like pests or pollution of drinking water. However, the risk of flooding can widely be eliminated for inhabitants downstream, at the price of potential salinization (enrichment with salt) of soils and decreasing input of fertile sludge. Balancing these double-sided reasons, building dams has decreased since the 1960s and 70s, and has become very rare throughout Europe. In countries of the Global South, however, additional dams are still under construction.

Selected open source links for further information

Älvräddarna
http://www.alvraddarna.se
Calles, O., Gustafsson, S. & Osterling, M. Naturlika fiskvagar i dag och i morgon.
http://www.nrrv.se/wp-content/uploads/2012/11/CG%C3%96-2012.pdf
Environmental Science Activities for the 21st Century
http://esa21.kennesaw.edu/activities/hydroelectric/hydroactivity.pdf
Foundation for Water and Energy Education (FWEE)
http://fwee.org/environment/how-a-hydroelectric-project-can-affect-a-river/
International Energy Agency
http://www.iea.org/publications/freepublications/publication/hydropower_essentials.pdf and
http://www.iea.org/topics/renewables/subtopics/hydropower/
International Hydropower Association
http://www.hydropower.org/types-technology-0
National Hydropower Association (USA)
http://www.hydro.org/
US Environmental Protection Agency
http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html

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