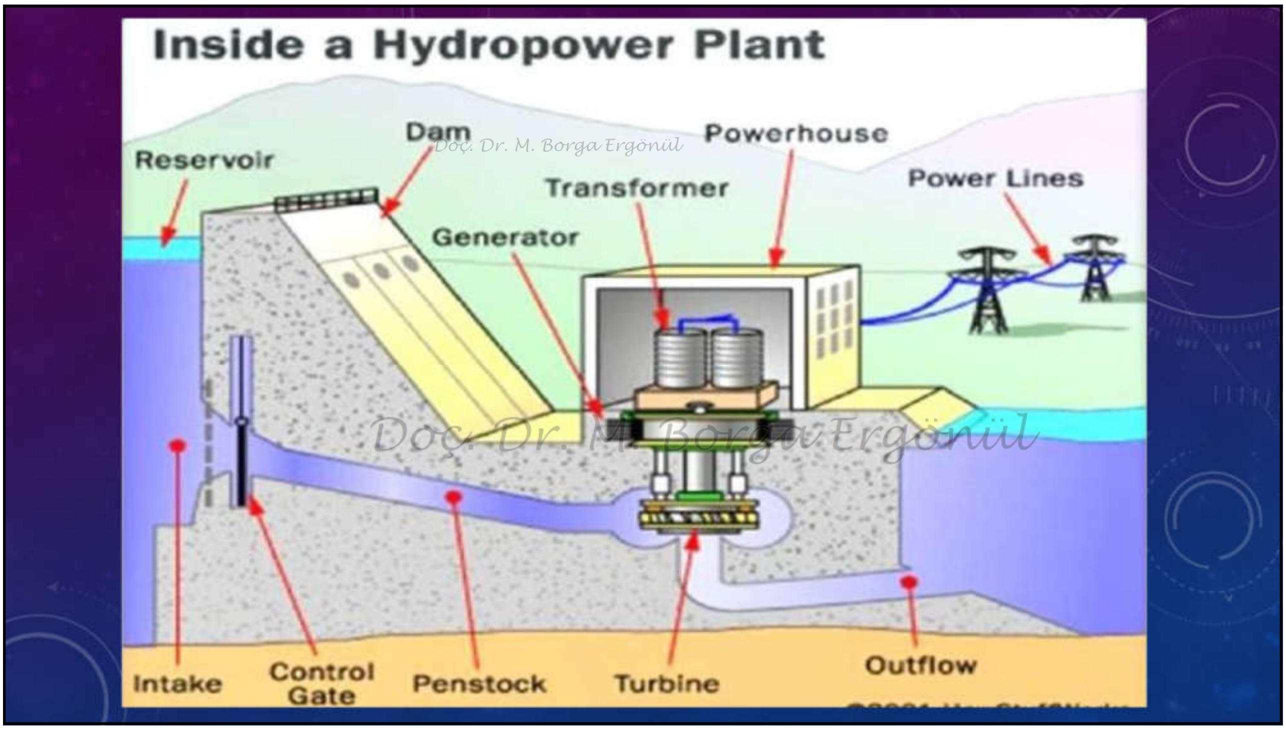
MANMADE WATER SOURCES

Man-made sources of water are reservoirs (or dams) and canals (either for irrigation or for transport).

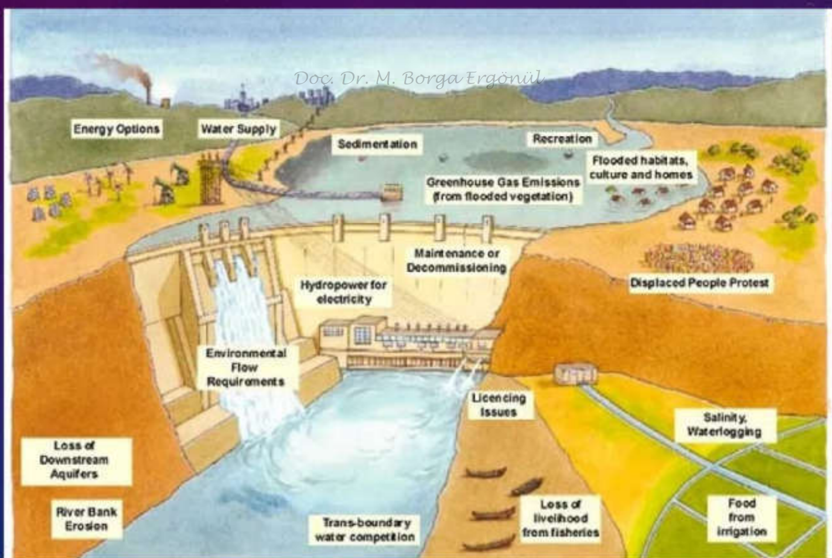
Man-made reservoirs, sometimes called artificial lakes (or dam lakes), are important water sources in many countries. Reservoirs are usually formed by constructing a dam across a river or by diverting a part of the river flow and storing the water in a reservoir. Upon completion of the dam, the river pools behind the dam and fills the artificially created basin. Seasonal changes of runoff and precipitation feed the reservoir. The stored water can be used for irrigation, drinking water after purification or to produce energy (hydroelectrical power plant).

Three Gorges Dam (Yangtze River, Hubei, China)

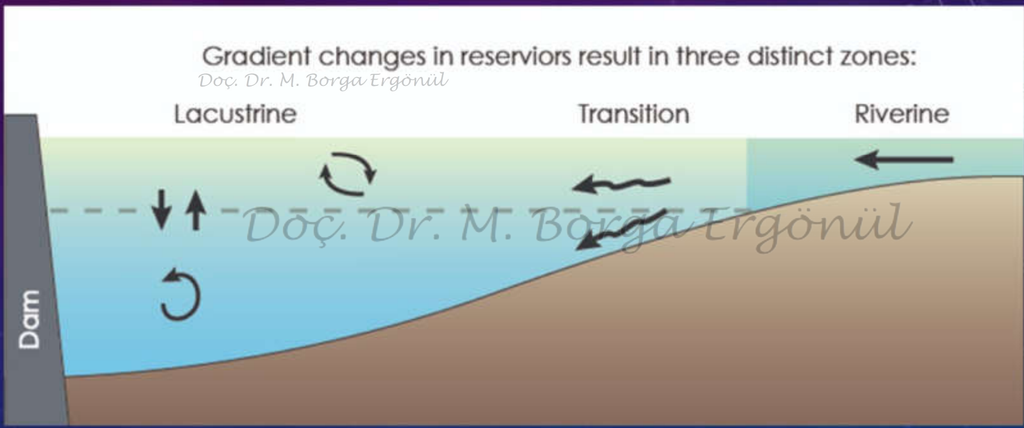
Yusufeli Dam (Çoruh River, Artvin, Turkey)



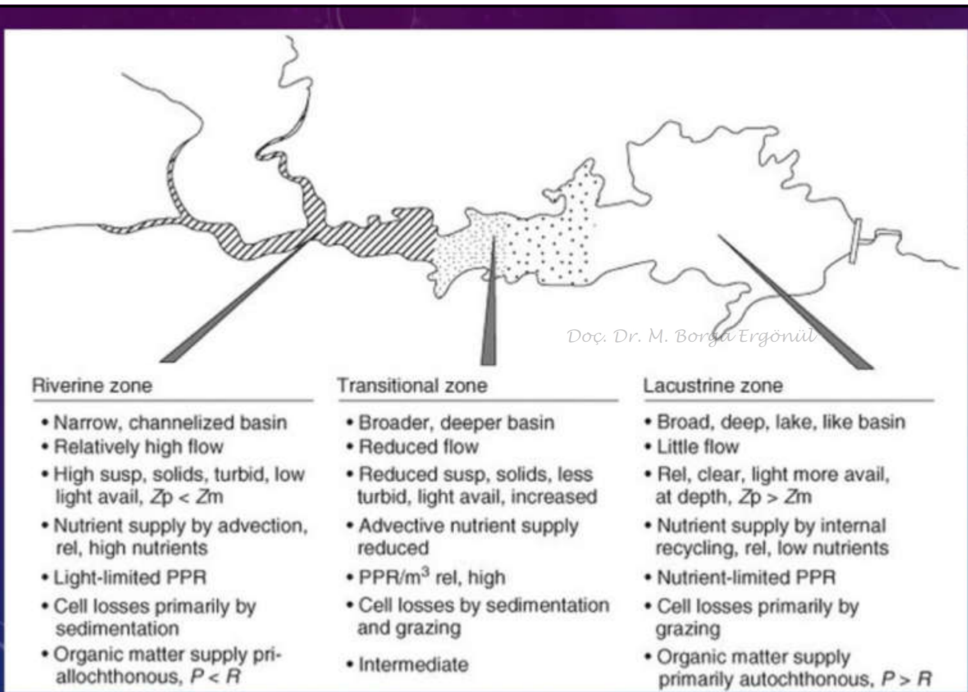
Reservoirs have several effects on the physical, chemical and biological features of the water bodies; both downstream and upstream direction.



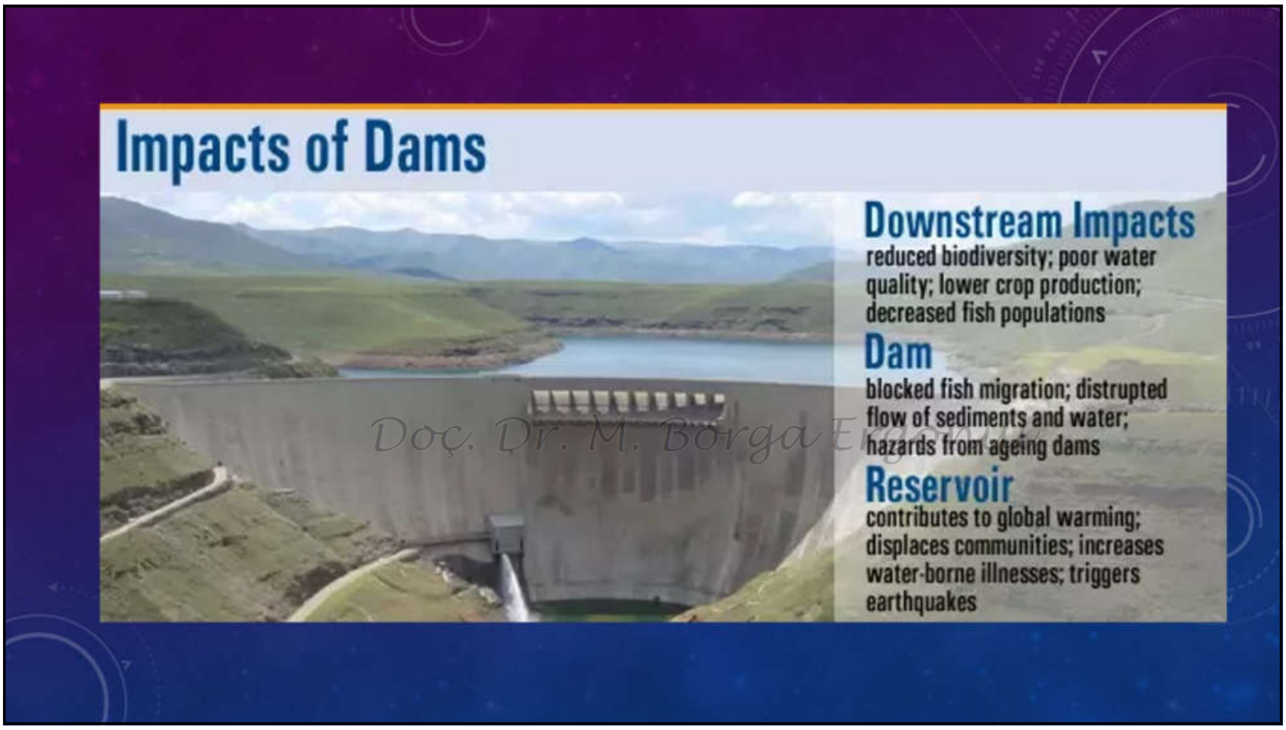
First, we should briefly explain the zones observed in a reservoir to get an idea on what might be affected in or around a dam lake. There are 3 longitudunal zones in a reservoir starting from the riverine, transition and lacustrine zone. There is a gradual difference between those zones mainly based on river flow velocity and depth.



*downstream (mansap) – upstream (memba) *



Zp – Photic depth; Zm – Mean depth; P – Production; R – Respiration; PPR – Primary production]



A review of the integrated **effects** of changing **climate**, land use, and **dams** on Mekong river hydrology

Y Pokhrel, M Burbano, J Roush, H Kang, V Sridhar ... - Water, 2018 - mdpi.com

The ongoing and proposed construction of large-scale hydropower **dams** in the Mekong river basin is a subject of intense debate and growing international concern due to the unprecedented and potentially irreversible impacts these **dams** are likely to have on the ...

☆ 99 Cited by 83 Related articles All 10 versions Web of Science: 50

A method to consider whether **dams** mitigate **climate** change **effects** on stream temperatures

SE Null, ST Ligare, JH Viers - JAWRA Journal of the American ..., 2013 - Wiley Online Library

This article provides a method for examining mesoscale water quality objectives downstream of **dams** with anticipated **climate** change using a multimodel approach. Coldwater habitat for species such as trout and salmon has been reduced by water ...

☆ 99 Cited by 37 Related articles All 7 versions Web of Science: 30

Modeling of **climate** change **effects** on stream temperatures and fish habitats below **dams** and near groundwater inputs

BA Sinokrot, HG Stefan, JH McCormick, JG Eaton - Climatic Change, 1995 - Springer

A deterministic heat transport model was developed to calculate stream water temperatures downstream of reservoir outlets (tailwaters) and groundwater sources. The model calculates heat exchange between the atmosphere, the water and the sediments and is driven by ...

☆ 99 Cited by 125 Related articles All 7 versions Web of Science: 69

Hydrological **effects** of **dams** and water diversions on rivers of Mediterranean-**climate** regions: examples from California

GM Kondolf, RJ Batalla - Developments in Earth surface processes, 2005 - Elsevier

Rivers in Mediterranean-**climate** and other semi-arid regions tend to be more heavily impounded and thus their hydrology more strongly affected than rivers in humid climates because demand for water is greater (to supply irrigated agriculture) and runoff is out-of ...

☆ 99 Cited by 74 Related articles All 6 versions

GEOPHYSICAL RESEARCH LETTERS, VOL. 38, L04405, doi:10.1029/2010GL046482, 2011

The influence of large dams on surrounding climate and precipitation patterns

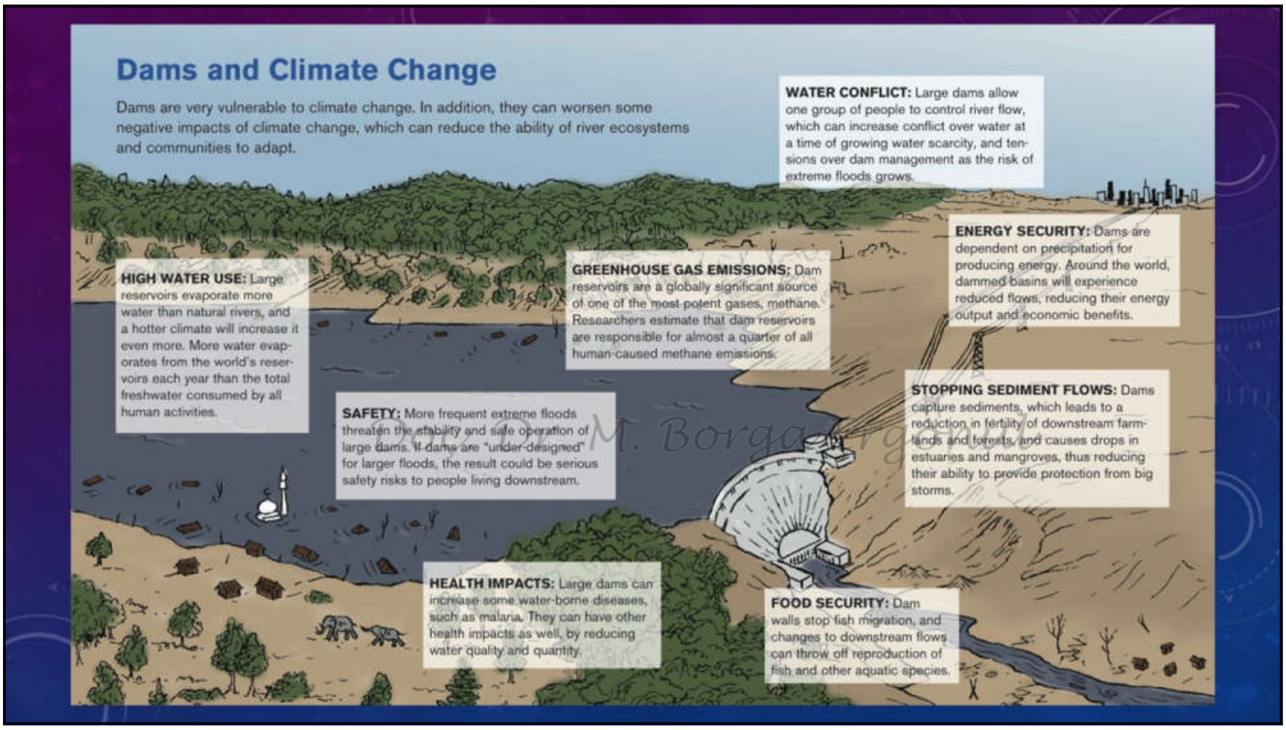
Ahmed Mohamed Degu,[1] Faisal Hossain,[1] Dev Niyogi,[2] Roger Pielke Sr.,[3] J. Marshall Shepherd,[4] Nathalie Voisin,[5] and Themis Chronis[6]

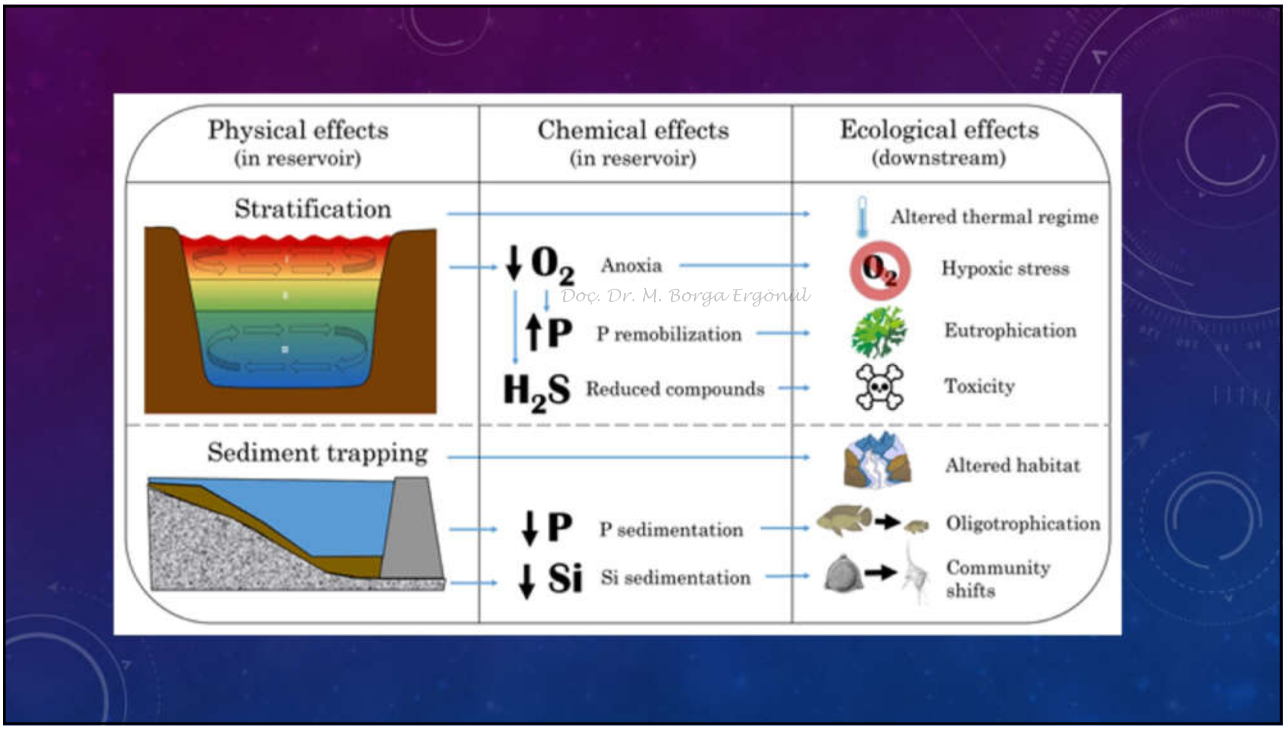
Received 12 December 2010; revised 12 January 2011; accepted 26 January 2011; published 24 February 2011.

[1] Understanding the forcings exerted by large dams on local climate is key to establishing if artificial reservoirs inadvertently modify precipitation patterns in impounded river basins. Using a 30 year record of reanalysis data, the spatial gradients of atmospheric variables related to precipitation formation are identified around the reservoir shoreline for 92 large dams of North America. Our study reports that large dams influence local climate most in Mediterranean, and semi-arid climates, while for humid climates the influence is least apparent. Clear spatial gradients of convective available potential energy, specific humidity and surface evaporation are also observed around the fringes between the reservoir shoreline and farther from these dams. Because of the increasing correlation observed between CAPE and extreme precipitation percentiles, our findings point to the possibility of storm intensification in impounded basins of the Mediterranean and arid climates of the United States. **Citation:** Degu, A. M., F. Hossain, D. Niyogi, R. Pielke Sr., J. M. Shepherd, N. Voisin, and T. Chronis (2011), The influence of large dams on surrounding climate and precipitation patterns, *Geophys. Res. Lett.*, *38*, L04405, doi:10.1029/2010GL046482.

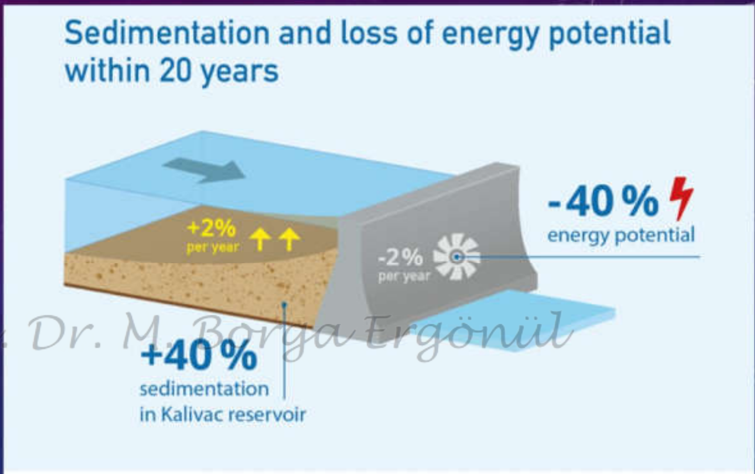
... *and Yasunari*, 2009]. Herein, we refer to mesoscale as essentially "local" and between the ranges of 10–100 km. One such local effects of LULC change can be a modification of rainfall [*Avissar and Liu*, 1996; *Cotton and Pielke*, 2007; *Pielke et al.*, 2009]. Thus, if dams are regarded as a catalyst for systematic change in LULC, then it is physically plausible to expect a gradual change in the local climate and rainfall patterns in the impounded river basin attributed directly to the multiple land use development that reservoirs produce.

[3] While the impact of climate variability and change on artificial reservoirs has been studied at local/regional scales for some time [see, e.g., *Hamlet and Lettenmaier*, 1999; *Christensen et al.*, 2004], the converse (impact of reservoirs on local/regional climate) has not been explored as much. It has been recently argued that very little is known on how artificial reservoirs (hereafter interchanged with "dam") modify storms under certain atmospheric conditions and the consequential implication on hydrology and dam safety [*Hossain et al.*, 2010; *Hossain*, 2010]. Dam design in engineering assumes as "stationary" the design parameters of extreme rainfall during its service span, a practice that is


Dams and Climate Change
Dams are very vulnerable to climate change. In addition, they can worsen some negative impacts of climate change, which can reduce the ability of river ecosystems and communities to adapt.
WATER CONFLICT: Large dams allow one group of people to control river flow, which can increase conflict over water at a time of growing water scarcity, and tensions over dam management as the risk of extreme floods grows.
ENERGY SECURITY: Dams are dependent on precipitation for producing energy. Around the world, dammed basins will experience reduced flows, reducing their energy output and economic benefits.
HIGH WATER USE: Large reservoirs evaporate more water than natural rivers, and a hotter climate will increase it even more. More water evaporates from the world's reservoirs each year than the total freshwater consumed by all human activities.
GREENHOUSE GAS EMISSIONS: Dam reservoirs are a globally significant source of one of the most potent gases, methane. Researchers estimate that dam reservoirs are responsible for almost a quarter of all human-caused methane emissions.
SAFETY: More frequent extreme floods threaten the stability and safe operation of large dams. If dams are "under-designed" for larger floods, the result could be serious safety risks to people living downstream.
STOPPING SEDIMENT FLOWS: Dams capture sediments, which leads to a reduction in fertility of downstream farmlands and forests, and causes drops in estuaries and mangroves, thus reducing their ability to provide protection from big storms.
HEALTH IMPACTS: Large dams can increase some water-borne diseases, such as malaria. They can have other health impacts as well, by reducing water quality and quantity.
FOOD SECURITY: Dam walls stop fish migration, and changes to downstream flows can throw off reproduction of fish and other aquatic species.


Physical effects
(in reservoir)
Chemical effects
(in reservoir)
Ecological effects
(downstream)
Stratification
Altered thermal regime
↓O2
Anoxia
Hypoxic stress
↑P
P remobilization
Eutrophication
H2S
Reduced compounds
Toxicity
Sediment trapping
Altered habitat
↓P
P sedimentation
Oligotrophication
↓Si
Si sedimentation
Community shifts
Doç. Dr. M. Borga Ergönül

Dams are built to store water but they also store the sediment that all rivers carry. This sediment builds and steadily decreases the storage capacity of the reservoir. Ultimately all dams fill with sediment and might be destroyed by natural floods.



More sediments, less energy: The Kalivaç reservoir would constantly fill up with sediments, leading to a 2% loss of energy potential each year. After 20 years, the power plant would lack 40% of its original capacity.

DOLNA ARDA CASCADE

PROJECT	HPP				DAM				RESERVOIR	
	N /MW/	E /GWh/	Q /m³/s/	TURBINE	TYPE	H /m/	L /m/	V /Mm³/	Vt /Mm³/	Vl /Mm³/
KARDAJALI	106.4	110.6	180.8	FRANCIS UNITS	ARCH	103.5	384	370	532.90	415.80
STUDEN KLADENETS	60.0	170.6	128.8	FRANCIS UNITS	CONCRETE	67.5	338	300	489.00	339.00
IVAILOVGRAD	103.5	157.9	280.5	FRANCIS UNITS	CONCRETE	72.0	250	278	188.00	109.00
Total	269.9	439.1								

GORNA ARDA CASCADE

PROJECT	HPP								DAM				RESERVOIR	
	N /MW/		E /GWh/		Q /m³/s/		TURBINE		TYPE	H /m/	L /m/	V /Mm³/	Vt /Mm³/	Vl /Mm³/
	HPP	SHPP	HPP	SHPP	HPP	SHPP	HPP	SHPP						
MADAN	46.0	1.0	99.4	1.0	62.0	1.4	2 units	1 units	ROCKFILL	92.4	457	1930	141.10	72.10
ARDINO	56.6	1.4	139.4	1.4	68.0	1.7	2 units	1 units	ROCKFILL	101.1	273	1640	93.40	74.60
SARNITZA	67.9	1.3	174.5	1.3	80.0	1.9	2 units	1 units	ROC - GRAVITY	97.4	340	667	92.30	71.20
Total	174.2		444.5											

Such effects are multiplied in consecutive dams

One of the main impacts of dams is blocking fish migration. To overcome this problem fish gates or fishways (also called fish ladder) should be constructed on dams.

Fish migrations involve completing a cycle of upstream and downstream movementsin lakes and/or rivers which depends on the fish species, fish's life stage, and the type of migration. Generally, downstream migration is a feature of early life stages, while upstream migration is a feature of adult life. Fish migrate to spawn, to feed, and to seek refuge from predators or harmful environmental conditions, such as the complete freeze-up of a stream or lake. Fish are often able to cross natural (e.g. a waterfall) barriers. But man-made (e.g. a dam, weir, or culvert) obstructions block the stream leading to slowdown or totally stop fish migration.

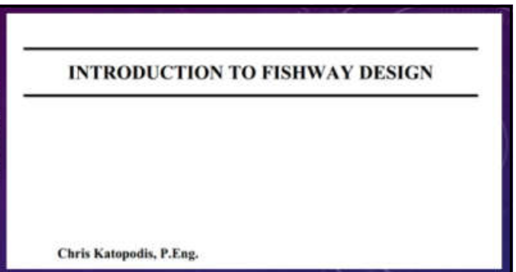
A fishway is a waterway designed to allow the passage of a single species or a number of different species of fish to past a particular obstruction. While in most cases fishways are built for adult spawners in some cases migrating juveniles are the target species. Delays are critical particulalry to adult fish spawning migrations for reproductive success.

Fish passage over dams and weirs or through culverts is an important issue to maintain healthy fish populations. Thus, well designed and constructed fishways is crucial for fish to continue migrating. Biological requirements such as fish behaviour, preferences, migration timing and swimming ability determinant for design and construction of fishways.

Weir

Culvert

There are several fishway designs available mostly involve a lower slope to enable fish to swim up, a flow of water (based on species requirements; fish has a natural instinct to swim towards water splash) and corridors that can be used to take a rest while this energy consuming travel.


INTRODUCTION TO FISHWAY DESIGN

Chris Katopodis, P.Eng.

A paranthesis here: shade balls

These floating balls are initially created to prevent birds landing on waterbodies (which include toxic wastes). But in 2008 they were used in USA to prevent the sunlight to reach water. The main objectives of dumping the shade balls into reservoirs is preventing the formation of a carcinogenic chemical, bromate, which forms when naturally occurring bromine reacts with chlorine (used for disinfection) in the presence of sunlight. Other environmental benefits include slow evaporation, prevent algae growth. Although, the main purpose was different, these balls also reduce the evaporation of the reservoir by 85 to 90 percent during warmer seasons. However, shade balls can not used in all reservoirs due to their affect on aquatic life.

Inland waterways or dredged canals to interconnect seas are defined as navigable water bodies. Inland waterways are usually used for irrigation or naviagiton of small ships.

Waterways in India