(Planning for) Dam Decommissioning as an Environmental Priority

Dams are not forever!

"I'll be honest with you, we made mistakes." US secretary of state Hillary Clinton told a gathering of Mekong region leaders in July 2012. A country which once believed that every stream should be used for human benefit has built 79000 dams to date. If the US was on a dam building spree in the 20th century, starting in 1960s, dam building ran out of steam. A raft of federal legislation, such as the Wild and Scenic River Act of 1968 and the National Environmental Policy Act of 1969, forced developers to take rivers' ecological benefits into account. "We've ended up with a lot of dams that aren't serving economic needs anymore but nobody's really responsible for them," said Jane C. Marks, a professor at Northern Arizona University who helped rehabilitate Arizona's once-dammed Fossil Creek. The US has decommissioned at least 1000 large and small dams to date for the sake of reviving the fisheries and damaged ecology of their rivers[1].

The above is not to enter into a comparison of India with the US. It is just to invite the attention to the fact that the world's largest dam builder is rethinking its decisions and embarking upon a repair of damaged ecology through dam decommissioning. Their more than a century old experience in dam building has revealed that dams have a lifespan, poor designs can reduce the lifespan, dams can underperform, they can silt up, dam safety can pose threat to lives and dams can lead to the death of rivers and wipe out fisheries.

Dams are critical infrastructures built with massive investments with diverse projected uses, like power generation, irrigation, flood control, drainage, drinking water supply etc. India is the third largest dam builder in the world with more than 5100 large dams built to date. Some of the oldest dams in the world exist in India. Demands for decommissioning have been already raised for the Mullaperiyar dam (117 years old), Dumbur dam over the Gumti river in Tripura and Jaikawadi Dam in Maharashtra in different contexts. Estimates reveal that around 100 large dams are more than 100 years old and more than 400 large dams between 50 – 100 years old. The collapse of the 118 year old Jaswant Sagar dam in Luni river basin in Jodhpur district of Rajasthan a few years back stands before us as a living example of the massive scale of downstream destruction caused by dam break. The failure of the Machuu dam (28 m high masonry work) in Gujarat back in 1979 had resulted in the death of more than 2000 people. In fact the Standing Committee under the Chairman, Central Water Commission (CWC) constituted by the Government of India in 1982 had recommended unified dam safety procedures for all dams in India and the necessary legislation on dam safety. However, dam safety issues under the Dam Safety Bill 2010 mainly deals with the proper surveillance, inspection, operation and maintenance of dams with respect to certain parameters to ensure their safe functioning and thereby to protect the persons and property against risks associated with dam failure. **The equally if not more serious performance related and environmental surveillance**

---

[1] www.chinadialogue.net/article/show/single/en/5505-Don-t-repeat-our-mistakes-on-dam-building-US-urges-Asia

related aspects are yet to be considered seriously within the environmental governance framework.

The table below illustrates a few notable dam failures in India

Sl No	Name of the Dam	Height (metres)	Year of completion	Year of failure
1	Kaddam	22.5	1957	1958
2	Panshet	53.0	1961	1961
3	Khadakwasala	20.0	1875	1961
4	Chikkhole	36.7	1968	1972
5	Machuu II	24.1	1975	1979

Source: Report on Dam safety procedures. MoWR, CWC, Dam Safety Organisation, 1986

We seem to believe that dams once built will be there forever. Unlike buildings, dams are constructed across '***living rivers'*** and it is impossible to rebuild them in the same manner or in the same location if they are damaged. The Governments and technocrats always view and justify more and more dams, mostly from an engineering perspective, of physically taming the river flows and fulfilment of political agenda. The Ministry of Water Resources (MoWR) and Ministry of Power (MoP) enjoy the prerogative of taking decisions to regulate river flows from a purely hydrological and technocratic point of view. The forest and environmental clearance remain as mere formal hurdles to be crossed with ease with some compliance conditions which remain largely on paper.

Rivers are foremost ecological entities and their hydrological potential is inextricably linked to the ecological well being of the flowing river and its catchment. We are facing the reality of rivers unable to perform their ecological functions, failing to reach the seas during summer and collapse of inland fisheries across the country, with direct pointers towards dam induced environmental problems (explained later). A study by the International Water Management Institute (IWMI) shows that Krishna and Kaveri have reached full or partial closure. Another IWMI study shows that in the Krishna river basin, the storage capacity of major and medium reservoirs has reached total water yield, with virtually no water reaching the sea in low rainfall years[2]. The scenario is so serious that governments cannot afford to ignore the need for putting in place strategies for assessing the actual performance and environmental impacts of the thousands of dams already operating in the country and have measures for repairing damaged ecosystems and river dependent livelihoods. ***It is here that the Ministry of Environment and Forests (MoEF) has a pivotal role to perform in deciding upon the viable options including dam decommissioning for the long term ecological survival of rivers.***

While India continues to clear more and more dam projects, often citing USA as the example, there is absolutely no mechanism in place to assess the viable lifespan and performance of dams and projects which has a direct bearing upon the consideration for dam decommissioning from an environmental perspective.

Serious issues in Performance, Dam safety and Environmental impacts

[2] http://www.indiawaterportal.org/sites/indiawaterportal.org/files/vol_1_1.pdf

In the case of large dams built with huge construction costs, environmental uncertainties represent considerable financial risks for the dam-builders and governments. The profitability from such dams depends upon how long they continue to provide the services they have been built for after completion at the cost of the massive environmental damage wrought by them. The performance assessment scenario of dams in India is plagued by many such serious problems;

1. Environmental clearance once granted to a hydro electric / irrigation project is in perpetuity. There is no mechanism for periodic assessment of the performance of the dam or the project including dam safety aspects, siltation studies, *post facto* impact assessment on downstream ecology, fisheries and related livelihoods and seismicity. A mechanism for assessing and including the cost of dam decommissioning and ecological reparation when the construction costs of the dam are assessed and placed before the various committees for clearance is yet to materialise.

2. India is yet to have clearly defined, legally binding accountability mechanisms in case of dam failures. Civil society groups and movements working for protecting rivers have been consistently pointing out the need for the same.

3. Studies reveal an alarming increase in the rate of siltation of reservoirs in India leading to heavy loss to the public exchequer. Impacts of siltation of reservoirs include increased evaporation losses, increased backwater flooding and also could damage the power house turbines. The Report of the Government of India's National Commission of Integrated Water Resources Development implies that we are losing about 1.3 BCM of storage capacity each year. Even this can be an underestimate. In fact, the power generation from the upgraded 15 MW installed capacity at the Gumti Dam in Tripura is so low that even the World Bank strategy paper for the North East (dated June 28, 2006) recommended exploration of decommissioning of the dam. As per 2006 estimates we have already lost a quarter of the live storage capacities of 23 reservoirs due to siltation. SANDRP estimates reveal that on an average, each day we are losing Rs. 40 million worth of storage capacity through siltation[3]. ***Meanwhile there is a lack of proper official estimate of the cost of loss of reservoir storage capacity for all the operating reservoirs in the country.***

4. Catchment area treatment plans for most of the projects remain on paper. These if implemented properly have a significant role in improving life span of the project. The 1500 MW Nathpa Jhakri Hydropower Project in Himachal Pradesh commissioned in 2003 had to be stopped due to high silt in the river for 25 days since April 2006[4]. The controversial Tehri dam is showing signs of quick silting up. The dam was completed in 2006 despite the catchment being a seismic zone,

[3] Himanshu Thakkar and Swaroop Bhattacharya Wake Up Call on reservoir siltation nationwide. http://www.indiatogether.org/2006/oct/env-siltation.htm
[4] ibid

rapid erosion of steep hillsides, the threat of rapid siltation and potential impact on fisheries and other fauna and flora repeatedly pointed out be experts and movements protesting the project. The expected life span of the dam is predicted to be much lower than the projected 100 years.

5. There is no legally enforceable mechanism by which environmental flows should be allowed below already dammed rivers. Hence most dammed rivers have either curtailed and regulated flows or diverted flows in the downstream. As for completely diverted rivers as in the case of Mullaperiyar where the ecological death of the river is evidently visible to the layman's eye, even minimum flows have not been allowed into the river for the last 117 years !

6. As per the Dam Safety Bill proposed in August 2010, "dam failure" shall mean such failures in the structures or operation of a dam which may lead to uncontrolled release of impounded water resulting in downstream flooding affecting the life and property of the people. The Bill does not contain any norms relating dam safety with environmental impacts. While dam safety remains the domain of MoWR it does not touch upon the environmental impacts, both upstream and downstream, in case of faulty performances, lack of proper sediment flush outs, sudden flooding of downstream due to uncontrolled releases of impounded water, dam failure etc. ***In other words, MoEF which grants environmental and forest clearance to dam projects does not have a role when it comes to dam safety related issues impinging upon the river ecology or livelihoods dependent upon rivers.***

7. Even for those dams where the safety alarm has been sounded, there is a lack of proper assessment of potential impacts on ecology and downstream livelihoods. In 1979, leaks were detected in Mullaperiyar, one of the oldest dams in service in the world located within the Periyar Tiger Reserve in the Western Ghats. The Central Water Commission (CWC) appointed a Committee to look into the matter. The CWC ordered lowering of the height of the reservoir level to 136 ft from 152 ft including leak proofing as precautionary measure against possible dam failure. Many more leaks have been detected in the structure and the people living downstream are constantly under fear of dam failure. There is not much happening on the ground related to precautionary measures related to dam failure from the government. ***To date there has been no attempt by the MoEF to commission an appraisal of the type or extent of impacts of dam failure on the people's lives or ecology downstream.***

8. In the cost benefit analysis (CBA) associated with dams, socio - economic costs of loss of riparian forests and islands, flood plain habitats, fish habitats and fisheries, aquatic ecosystems etc. have been either unaccounted or under rated or just dismissed as externalities to make the dam project look benign. Such an analysis can reveal the reparation costs associated with future decommissioning.

9. Majority of irrigation and hydro power dams do not have proper fish passages. The few fish passes built in India are on the Mahanadi barrage, Nartaj barrage in river Mahanadi, the Hathnikund barrage on river Jamuna and Farraka barrage on Ganga. Most of these structures have drawbacks. Presently fish passages are recommended in environmental clearances. Experiences in the US which is the reveal that inspite of fish ladders or structural improvement, fisheries have declined.

10. Like a river which is ever changing and dynamic in nature, changes can also occur in the catchments over time. Human interventions like mining, infrastructure development, deforestation, soil eroding agriculture take place within the dam catchment over years which can lead to silt build up in reservoirs leading to reduction of capacity and performance of the project. There is no mechanism for accounting such changes into the performance analysis.

Recently 'dam decommissioning' has become a highly debated topic, after it was recommended in the Ministry of Environment and Forests (MoEF) constituted Western Ghats Ecology Expert Panel Report as one of the important recommendations relating to water sector. Dam decommissioning is a completely unexplored arena for India. Hence, it has raised lot of dissent within the different arms of the government as well as from the Western Ghats states. In this context, it is important to clarify and discuss why it is time India starts seriously planning for dam decommissioning as a strategy to ensure the much needed balance between ***'development of rivers for human needs and revival of rivers for its own survival and well being'***.

Internationally, dam decommissioning for restoring riverine fisheries and fish migration, restoring river flows and river ecology is already a reality and in different stages of planning, designing and implementation. In 1998, two small dams on tributaries of the Upper Loire River in France were demolished to help protect the Loire Salmon. In Thailand, decommissioning campaigns were initiated as a result of social and ecological disruptions to the downstream fishing and rice farming communities by the Pak Mun Dam constructed on the Mun River in 1994, the largest tributary of the Great Mekong. In 2001 the Thai government relented to international pressure and ordered the dam's gates to be opened for a one year study of its impact on fisheries and communities.

An Ontario Hydro study of data from several hundred North American dams shows that on average hydro dam operating costs rise dramatically after around 25-35 years of operation due to the increasing need for repairs. When the cost of maintaining an old dam exceeds the receipts from power sales, its owners must decide either to invest in rehabilitating the dam, or, if the cost of repairs would be prohibitive, to disconnect the dam from the grid and cease producing power[5].

Dam decommissioning - Interpretation

[5] http://www.internationalrivers.org/dam-decommissioning

Dam decommissioning is nothing radical or new – in fact in the US dams have been designed to be decommissioned at the end of their useful lives. In the US, most dams are licensed by the Federal Energy Regulatory Commission (FERC) or its state equivalent, usually on a 30-50 year cycle. At the end of that license cycle they have to be re-evaluated and can then be retired. There are also emergency procedures for de-licensing dams in the event of safety concerns (such as earthquake damage, etc.). Through the relicensing process, FERC has mandated new operating conditions to meet environmental concerns, including increased minimum flows, added or improved fish ladders, periodic high flows, and protection measures for riparian land[6].

Dam decommissioning offers a range of alternatives from full removal of the structure to partial removal to changes in management. In cases in which full or partial dam removal is not considered a viable option, there are opportunities to change dam operation and to implement new water use planning without significantly limiting or abolishing the social and economic benefits of the dam and/or hydroelectric power plant operation[7]. There could be many reasons for decommissioning a dam. These concerns need to be weighed properly based on relevant assessments before taking a decision whether to decommission a dam or not. The important reasons usually considered across the world include:

1. Economic reasons including inefficient power production or irrigation efficiency, high operation and maintenance costs, obsolescence etc.
2. Dam safety and Security issues – related to faulty design or wearing out of materials used for construction
3. Silt build up – eventually all reservoirs will get filled up
4. Legal and financial liability
5. Ecosystem restoration – for restoration of fisheries, riparian habitats, flood plains and other riverine ecosystems
6. Site restoration – heritage value or for the sake of the habitat

The environmental context for dam decommissioning in India

'Flow' is the master variable for a river. The physical and biological characteristics of a river are decided by its flow regime and vice verse; these characters in turn preserve and nurture the flow characters like water quality, flow velocity, magnitude of flows etc. A river's flow regime refers to the range in magnitude, regularity and frequency of water transport down a river channel and over a set period (that is, seasonal, year-round, life-time) ranging from highest flood flows to lowest flows in high summer. These flow regimes are indispensable for sustaining the morphological and ecological character of the river and for supporting the millions of livelihoods both directly and indirectly dependent upon a river up to the coast. The rich and diverse aquatic life sustained by the

---

[6] Auer, N. A. 1996. Response of spawning lake sturgeons to change in hydroelectric facility operation. *Transactions of the American Fisheries Society* 125:66 –77. In Bednarek. T, Angela. 2001. Undamming Rivers: A review of ecological impacts of dam removal. Environmental Management Vol. 27, No. 6, pp. 803–814

[7] http://www.internationalrivers.org/en/node/3149

flow regimes at different altitudes is in turn indispensible for maintaining the fresh water quality for human use. Moreover, flows are required from the source to the sea for maintaining lateral and longitudinal connectivity of river and flood plain ecosystems and completion of life cycles of aquatic organisms especially fish and for preventing saline ingress deep into the river. Flow regimes are also essential for enabling sediment and nutrient transport and deposit all along the journey of the river. ***The rivers in India are losing these irreplaceable ecological functions which maintain the life in and around the rivers*. *Various researches conducted so far reveal that the diversity of hydrological pattern, or in other words the flow regime, is central to the maintenance of habitat heterogeneity and species diversity*** This is the most critical environmental aspect which is completely disturbed by dams.

While a single large dam could create substantial impacts, more the number of dams built across a river and its tributaries, more accentuated would be the impacts. The most significant environmental impacts due to dams are:

1. Dams change the magnitude, frequency, timing and velocity of natural flows downstream in turn impacting the life cycles of thousands of aquatic species which are tuned to the natural high and low flows in the river.

2. The flowing river is transformed into series of lakes with heavily altered flows or no flows in between creating '*serial discontinuity'* which is highly detrimental to species adapted to flowing rivers. This in turn changes the river temperature within and outside the reservoirs creating thermal blocks that adversely affect fish migration and breeding. Apart from blocking the migration of fishes, dams severely affect species which swim upstream to breed (for example *Anguilla bicolor*). The reservoirs or semi-lacustrine conditions created by dams are highly disliked by hill stream fishes adapted to rapid flowing water (species of the genus *Glyptothorax*)[8].

3. Dams lead to loss and fragmentation of stream habitat especially riparian habitat. More the number of dams in a river more is the extent of fragmentation and isolation of riparian habitats. Riparian habitats are niche specific and are vital for maintaining the longitudinal and lateral connectivity of the river, regulation and maintenance of biodiversity in the landscape and for providing food and breeding niches for aquatic species.

4. Fishes being the direct indicators of river health, if the severe decline of inland fish diversity and fisheries are any indication then dams are definitely the main culprits along with pollution and over fishing. Estimates reveal that though 10.9 million people in India depend upon riverine and related wetland biodiversity for their needs and livelihoods, current riverine fishery is below subsistence level

[8] Dahanukar. et.al. 2011. The status and distribution of freshwater fishes of Western Ghats. In. Molur, S., Smith, K.G., Daniel, B.A. and Darwall, W.R.T.(Compilers). 2011. *The Status and Distribution of Freshwater Biodiversity in the Western Ghats, India.* Cambridge, UK and Gland, Switzerland: IUCN, and Coimbatore, India: Zoo Outreach Organisation

with an average yield of 0.3 million tonnes, which is about 15 per cent of their actual potential, a clear indication of declining fish wealth[9].

5. A report by IUCN on the Western Ghats freshwater diversity (2011) states: dams are identified as a major ongoing threat to all the groups, impacting 13% of fishes (19% of threatened fishes), 8% of molluscs (71% of threatened molluscs), 4% of odonates (25% of threatened odonates) and 3% of plants (22% of threatened plants).

6. All dams trap sediment, alter the flood peaks and seasonal distribution of flows, thereby profoundly changing the character and functioning of rivers. Dams disrupt the longitudinal continuity of the river system and interrupt the action of the conveyor belt of sediment transport. The *sediment starved* water released from the dam is very high in energy and thus called *hungry water* since it lacks sediments and erodes the channel bed deeper and scours the stream bank changing the channel morphology[10].

7. Rivers transport much of the sediments that create coastal habitats. Impounding rivers and their sediments can exacerbate the loss of shoreline habitats that depend on continued sediment transport[11]. This in turn has affected the livelihoods of coastal communities which depend upon coastal ecosystems like mangroves, backwaters, estuaries and ocean.

8. As the dam gets older, the sediments raise the stream bed, often settling closer to the reservoir, slowly filling up the reservoir that often limits hydro power operations, reduces performance, reduces water storage and flood control[12]. Presently, most of the projects are touted as run of the river with sediment flushing out mechanisms built in. Even for the run of the river projects there is no information forthcoming on the actual working and impacts of sediment flushing out mechanism from reservoirs. However, past experience with dam maintenance does not offer much hope either.

Evidences of impacts on river ecology and livelihoods

There are mounting evidences to prove that the rivers of India are losing out as ecosystems due to dams. The ability of a river to outlive any human intervention depends upon the ecological well being of the river. And restoring the flows at least closest to the natural flow regime is the only option for the long term survival of the river and dependent lives.

[9] sandrp.in/dams/Impacts_of_Dams_on_Riverine_Fisheries_in_India_ParineetaDandekar_Sept2012.pdf
[10] Kondolf, G.M. 1997. Hungry Water: Effects of Dams and Gravel Mining on River Channels. *Environmental Management* 21(4): 533-551
[11] American Rivers. 2002. The Ecology of Dam Removal. A Summary of Benefits of Dam Removal. Washington DC.
[12] Petts, G.E. 1984. Impounded Rivers: Perspectives for Ecological Management. John Wiley and Sons. Chichester, England, 322 pp.

Ecosystem impacts are effectively costs to society, and need to be included into accounting structures and applied at the project appraisal stage of dam planning. If this does not happen, the dam development may have spatial and temporal impacts which create a situation of both *intra generational* and *intergenerational* inequity. There are several studies emerging on the impacts of damming on river ecology in India. A few are illustrated here.

1. Prior to the coming up of the large number of hydraulic structures the overall physical and biological structure and function of the Mahanadi River system was conducive to the maintaining of the ecological integrity of the river. The transport of water sediment and nutrients downstream was adequate. The floodplains were connected providing vital lateral connectivity to the cyprinids (fish species) for breeding and recruitment. This provided great variety of ecological habitats, for harbouring rich ichthyofaunal diversity. However, in recent years the fragmentation of the river basin by series of dams (15 in number) have converted river sections from lotic to lentic systems and disconnected the main channel from their flood plain wetland reducing fish habitat availability potential[13].

2. In Ganga a recent study[14] reveals that the main eco hydrological alterations have been caused by construction of dams and barrages on the river, loss of wetlands and flood plain habitat and water diversion. The upper catchment of Ganga has a series of dams and barrages commissioned from Rishikesh to Narora. Reports reveal that Tehri dam constructed in Uttarakhand has considerably reduced the water flow and have shown detrimental effects on physical attributes and destruction of feeding, spawning, and migration routes of mahseer. Along with mahseer (*Tor putitora, T. tor)* the other migratory species like dwarf goonch (*Bagarius bagarius*), yellowtail catfish (*Pangasius pangasius*), pangas catfish (*Silonia silondia*), hilsa (*Tenualosa ilisha*) and long whiskered catfish (*Sperata aor*) from the middle and upper stretch is under severe threat.

3. In Krishna river, studies by CIFRI (2009) show that during summer the upper zone of the estuary was dry due to negligible discharge from the river resulting in higher salinity in the estuary downstream of Prakasam Barrage. The river valley modifications like Upper-Krishna Projects in Maharashtra, Karnataka and Andhra Pradesh has been found to be the main reason for dwindling freshwater discharge into the estuary. This has lead to near disappearance of oligohaline and freshwater species of carps, catfishes, murrels, feather backs, etc. Low run off from the catchments, seawater intrusions due to absence of fresh water, increased salinity (20-35 ppt) and drying up of one third of the estuary in non monsoon months leading to inadequate nutrient supply and sub normal

---

[13] Das. M.K. Malay Naskar., Mohammad. L Mondal. , Pankaj.K. Srivastava., Sumanta Dey and Anirban Rej. 2012. Influence of ecological factors on the patterns of fish species richness in Indian Tropical Rivers. Acta Ichthyologica Et Piscatoria (2012) 42 (1) : 42- 58

[14] Sarkar U. K., A. K. Pathak, R. K. Sinha , K. Sivakumar , A. K. Pandian , A. Pandey ,V. K. Dubey and W. S. Lakra. 2012. Freshwater fish biodiversity in the River Ganga (India): changing pattern, Threats and conservation perspectives. Rev Fish Biol Fisheries (2012) 22:251–272

productivity of fisheries**.** The ecology and productivity of Krishna estuary may be improved by discharging at least 1300-1500 TMC of freshwater from Prakasam Barrage every year on regular monthly instalments[15].

4. The lack of downstream flows due to upstream regulations and diversions in turn aggravates other related problems. For instance the lack of adequate environmental flows in the Krishna River has significantly aggravated water pollution problems from cities, since domestic and industrial effluents can no longer be sufficiently diluted by flowing water[16].

5. The Himalayas are comparatively young mountains with high rates of erosion. Their upper catchments have little vegetation to bind soil. Deforestation has aggravated the problem. Rivers descending from the Himalayas tend, therefore, to have high sediment loads. A 1986 study[17] found that 40 per cent of hydro-dams built in Tibet in the 1940s had become unusable due to siltation of reservoirs. Studies by engineering geologists with the Geological Survey of India record many cases of power turbines becoming dysfunctional following massive siltation in run-of-the-river schemes. Climate change is making predictability of river flows extremely uncertain. This will rise exponentially as more and more dams are built in the region. Diverting rivers will also create large dry regions with adverse impact on local livelihoods (fisheries and agriculture)[17].

6. According to Valdiya, the neo-tectonism of the Brahmaputra valley and its surrounding highlands in the eastern Himalayas means that modifying topography by excavation or creating water and sediment loads in river impoundments can be dangerous. Quake-induced changes in the river system can adversely impact the viability of dams as several basic parameters of the regime of rivers and the morphology and behaviour of channels may change[18].

7. In the west flowing short and monsoon fed Western Ghats rivers, saline ingress and decrease in summer flows is already evident due to dams and flow regulations upstream. In fact the pumping of drinking water schemes had to be stopped across the river Periyar at Alwaye consequent to salinity intrusion in November 2012 ([1]The Times of India. December 2 2012. Fluctuating salinity shorts water supply) long before the setting in of summer. The Power Minister of Kerala was forced to increase power generation from Edamalayar Hydro Power Project upstream to release more water into the river. Periyar is a highly dammed and diverted river with 16 dams including one inter-basin diversion at Idukki HEP and one inter state diversion at Mullaperiyar.

---

[15] Shrivastava. N. P, B.C.Jha., D. Nath and H.C. Karmakar. 2009. Krishna Estuary: Ecology and Fisheries, CIFRI, 2009

[16] R. Ackerman (2011): New Directions for Water Management in Indian Agriculture. In 12th Five Year Plan Document Volume 1, Planning Commission. Government of India

[17] K. Pomeranz (2009): 'The Great Himalayan Watershed: Agrarian Crisis, Mega-Dams and the Environment', New Left Review, No. 58, July–August 2009. In 12th Five year Plan Document Volume 1, Planning Commission. Government of India

[18] K. S. Valdiya. 1999: 'A Geodynamic Perspective of Arunachal Pradesh', Keynote Address at Workshop organised by the GB Pant Institute of Himalayan Environment and Development

8. Fish species diversity pattern in rivers is dependent on the complex interaction of the different ecological variables of the river, namely, size, surface area of the drainage basin, mean annual river discharge, temperature, depth, flow velocity, channel morphology, substrate, and climate[19]. Dams topple this complex organic interaction. Mahseer, once an abundant game and food fish in India is now on the list of endangered species. It has been virtually wiped out from all Indian rivers due to dams and barrages and upcoming dams in North East and Himalayas will compound this problem.

The repercussions and ultimate failure of unsafe dams may result in: (1) the loss of life; (2) the destruction of property; (3) harm to the downstream environment; (4) the release of toxic sediments; (5) risk to the river users; (6) the loss of critical services to the community such as water supply or flood control (American Rivers 2003). With the number of aging dams that require more frequent repair increasing every year, dam decommissioning is often an economically viable solution[20].

Ecological Benefits of Dam Decommissioning

Some of the ecological benefits widely experienced through dam decommissioning alone are elucidated here.

1. Re-establishment of the natural flow regime and connectivity between river, its various ecosystems to the sea ***Most heavily dammed rivers have lost their organic connectivity with the sea defying the traditional sea farers and fisher folk wisdom that 'Sea begins in the Mountains'.*** In those rivers which have some flow releases in place, they are often timed to meet just the human demands of irrigation, drinking water and navigation and not tuned for re-establishing the lost connectivity with the riparian or flood ecosystems and sea and the coastal ecosystems like backwaters/ mangroves/ estuary etc. Many dams prevent ocean tidal surges and sea-run fish from moving upstream; most migratory fish rely on these same tidal surges to transport themselves from estuaries and coastal regions into upstream spawning habitat. For example, the removal of the Edwards Dam on the Kennebec River in Maine provided coastal fish populations access to previously impounded upstream habitats. After dam removal, regional fish populations of striped bass, Atlantic and short nosed sturgeon, smelt, American shad, and blue back herring have increased, in some cases significantly, due to the re-establishment of the natural interaction between the river and the sea[21].

2. Restoration of Aquatic Biodiversity: As the river gradually returns to a free flowing state the pattern of flows and sediment transport changes making it more conducive for aquatic species to return. Experiences from the US reveal that dam decommissioning benefits riverine fish by:

---

[19] Postel. S and Richter. B. 2003. Rivers for Life. Managing water for people and nature. Island Press. Washington DC. USA.
[20] http://www.michigan.gov/dnr/0,4570,7-153-10364_52259_27415-80303--,00.html
[21] Dadswell, M.J. 1996. The Removal of Edwards Dam, Kennebec River, Maine: Its Effects on the Restoration of Anadromous Fishes. Draft Environmental Impact Statement, Kennebec River, Maine, Appendices 1-3, 92 pp.

(1) Removing obstructions to upstream and downstream migration;
(2) Restoring natural riverine habitat;
(3) Restoring natural seasonal flow variations;
(4) Eliminating siltation of spawning and feeding habitat above the dam;
(5) Allowing debris, small rocks and nutrients to pass below the dam, creating healthy habitat;
(6) Eliminating unnatural temperature variations below the dam; and
(7) Removing turbines that kill fish

Decommissioning also helps the return of native fish species into the river. Following the removal of the Woolen Mills Dam in Wisconsin, high densities of non-native common carp declined, while populations of native species such as smallmouth bass increased[22].

Experience from Penobscot River, USA

Though the methodology followed for the Penobscot River restoration may not be applicable in India, the benefits outlined in the river restoration plan through dam decommissioning arrived at based on studies and assessments are very relevant

- Provides unobstructed access to 100% of historic habitat for "lower river" species such as Atlantic and Short nose sturgeon and striped bass (fish species).
- Significantly improves access to nearly 1,000 miles of historic river habitat for endangered Atlantic salmon and other "upper river" species of native sea-run fish.
- Maintains hydropower generation;
- Restores critical ecological functions that will benefit native plant and animal communities in the river, estuary, and Gulf of Maine.
- Leads to a cleaner, healthier, more resilient river.
- Revitalizes the Penobscot Indian Nation's culture and traditions.
- Offers new opportunities for economic and community development in riverside communities.
- Enhances outdoor recreation such as fishing, paddling, and wildlife watching.
- Resolves a number of longstanding issues and avoids future uncertainties over the regulation of the river while remaining committed to the local community and economy.[23]

4. Redistributes Sediments improving the ecology and habitats Experiences in the US reveal that when a dam is removed, fine sediment is mobilized from the slow moving reservoir and redistributed, exposing gravel, cobble, and boulders within formerly impounded areas. For example, following the removal of the Woolen Mills Dam on the Milwaukee River in Wisconsin, the percentage of rocky substrate in the previously impounded area of the river increased by nearly two times. Fish, such as the native smallmouth bass, increased in number following the dam removal. The restoration of fine sediment to the coastal regions by dam decommissioning is expected to return native biota, including economically valuable species such as hard shell clams (DOI 1995) when the removal of Elwha and Glines Canyon dams on Elwha river is completed[24].

---

[22] Staggs, M., J. Lyons, and K. Visser. 1995. Habitat Restoration Following Dam Removal on the Milwaukee River at West Bend. Pages 202-203 in *Wisconsin's Biodiversity as a Management Issue: A Report to Department of Natural Resources Managers*. Wisconsin Department of Natural Resources.
[23] http://www.conservationgateway.org/Files/Pages/penobscot-river-restoration.aspx
[24] Bednarek. T, Angela. 2001. Undamming Rivers: A review of ecological impacts of dam removal. Environmental Management Vol. 27, No. 6, pp. 803–814

Dam decommissioning needs careful planning

While planning for dam decommissioning some impacts on the riverine ecosystem are likely which has been used to a totally regulated system and lake like reservoir conditions for many years. Sudden release of sediments for instance can impair feeding and spawning grounds of aquatic species. Riparian roots and stems can get buried below the sediments and damaged by abrasions. If there are pollution sources in the catchment of the reservoir, contaminated sediments can pose a health hazard. Hence, dam decommissioning options and strategies need to be planned based upon long term studies of the character of the river, its geology, ecology, climate and other related aspects. It would also entail economic analysis of the process.

Meanwhile decommissioning decisions need to consider alternatives to the services that were performed by the dams. For instance the decommissioning options for Mullaperiyar dam should be complemented by a participatory developed plan for augmenting and restoring the surface and tank irrigation systems, improving water use efficiency, SRI techniques in farming in the ayacut, applying watershed principles in land use, replacing with renewable energy sources for the power lost, to name a few. These can be worked out on a case by case basis.

Recommendations

The move to restore flow regimes that mimic natural flow variability should mark the evolution of a new paradigm in river basin management[25]. Such a river basin management approach should have dam decommissioning options as a part of its long term strategies.

Against all the above, it is high time the MoEF considers dam decommissioning as a viable option for restoring the ecology of rivers and creating more free flowing rivers. A few recommendations to carry forward the strategy are discussed briefly.

1. MoEF should formulate a comprehensive law for protection of rivers. This law should make river restoration mandatory for highly degraded rivers and enable more free flowing rivers. If dams are found to be the most significant reason for the degradation of a river, it should be made mandatory to assess the benefits of dam decommissioning to the river ecology, aquatic wealth and dependent livelihoods. Based on the assessment, the best option should be worked out towards decommissioning.

2. Dam decommissioning should be included in policy and decision making process that governs all dam projects, namely, Amendment to EIA Notification 2006, CWC norms of MoWR and the Dam Safety Bill under consideration of the MoWR Standing Committee on Water Resources. Infact Chapter II point 2.2 of

[25] Postel.S and Richter.B. Rivers of Life. *Managing water for people and nature.* Island Press, Washington. USA.

the Seventh Report on Dam Safety Bill 2010 of the Standing Committee on Water Resources has noted that 'safety of aquatic life and natural resources which would be adversely affected by dams has not found a place' in the proposed Bill.

3. EIA assessment for new projects should include the life cycle analysis of the dam project. The Government of India and concerned ministries should make it legally mandatory to assess and include the process of performance assessment, alternate management plans to mitigate downstream impacts, cost of dam removal or decommissioning and ecological reparation when the construction costs of the dam are assessed and placed before the various committees for clearance. Once commissioned, the performance of the project should be reviewed periodically through dam safety assessments, siltation studies, *post facto* impact assessment on downstream ecology, fisheries and related livelihoods and seismicity.

4. For already functioning dams that have crossed 30 - 50 years / alleged to be unsafe / reported loss of fisheries and impacts on downstream ecology, carry out a social and environmental impact assessment. Based on the same decisions can be arrived at if retaining the dam with its present operation pattern as such is more viable when compared to planning for appropriate decommissioning process.

5. Dam decommissioning should be part of a basin level assessment and carrying capacity study of the river basin. In other words, those dams that have been proven to create ecological damage to the river ecosystem and fisheries, damaging impacts on downstream basic and livelihood needs can be listed for decommissioning based on basin level assessment of their impacts. As a first step take river basins in different ecological region (Western Ghats, Himalayas, Central India) with dams that have crossed viable life span as sample case. A set of criteria based on dams in Indian conditions can be evolved by the MoEF, validated by experts, opened for public debate and consultation and then finalized. Some of the important environmental criteria that are obligatory to include are:

- ✓ The extent of flow fragmentation created
- ✓ The extent of degradation and fragmentation of riparian forests
- ✓ The minimum flow existing below the dam
- ✓ The extent of siltation in the reservoir
- ✓ The alteration in the sediment flow and transport in the river system
- ✓ The rate of extinction of important fish species, habitats
- ✓ The fall in fisheries and fishing community livelihoods over years since damming
- ✓ The loss in local economy and livelihoods due to the dam

Dr. Latha Anantha, River Research Centre, Kerala latha.anantha9@gmail.com

January 2013