Chapter 7

Environmental Flows : The South Asian Experience

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INTRODUCTION

The rivers of South Asia have received considerable attention from researchers, water resource managers, politicians and various stakeholders. Their hydrology and geomorphology have been investigated for more than a century. Their flows have also been diverted for irrigation for many centuries. Their biodiversity, water quality and ecology have been also investigated for over a century (see Gopal and Zutshi 1998, Gopal 2000). Political developments during the past few decades have also raised disputes over sharing of water resources between neighbouring countries and even among neighbouring states. River flows have been regulated at increasingly rapid pace with the construction of dams, barrages and embankments. Domestic and industrial wastes were discharged with no or little treatment. The problem of rapid degradation in water quality has attracted engineering solutions with total disregard to the ecology of river systems, In India, the Water (Prevention and Control of Pollution) Act was enacted in 1974. The Ganga Action Plan was launched in 1985 to focus on the problem of water pollution by concentrating on interception, diversion and treatment of domestic sewage in major towns along the river Ganga. The issues concerning the flow in relation to any of the ecological or biological features or water quality were totally ignored. The effects of dams on the migration of fish were pointed out by the fishery scientists but no attention was paid to the requirement and design of fish passages. Until recently, there had been practically no interaction between the water resource managers and fishery

scientists or river ecologists. Neither the rivers were treated as ecosystems nor were their flow-ecology relationships discussed until the end of 20th century. The term 'Environmental Flows' did not appear in the scientific literature from this region and was not discussed at any other forum.

The beginning of the 21st century witnessed major developments in understanding environmental flows, assessing their requirements, and also on issues related to policy and implementation. Several organisations have actively promoted the concept, assessment and application of environmental flows in the region. Vladimir Smakhtin of the International Water Management Institute (IWMI) based in Colombo (Sri Lanka) has led several studies whereas the IUCN through its Asia-Pacific office and various country offices have promoted the concept through training workshops and the WWF-India has directly undertaken a detailed study. These developments are summarised below based on personal knowledge, many published and unpublished reports, and various websites.

INDIA

The issue of providing some flow in the river was raised for the first time in the context of extreme degradation of water quality in River Yamuna along its 22-km stretch through Delhi that received no freshwater but all of the mostly-untreated domestic wastewater. In May 1999, the Supreme Court of India directed the government to ensure a 'minimum flow' of 10 cumec ($m^3 s^{-1}$, 1 cumec = 35.31 cusec) in the river to improve its water quality. The value was suggested by the Central Water Commission in an ad-hoc manner without any scientific basis.

The issue of flow requirement of the rivers for their conservation was discussed for the first time at a National Workshop on the Conservation of Rivers and Floodplains in India (New Delhi, 23-24 November 2001), organised by the Ministry of Environment and Forests, Government of India. The resolution adopted at the Workshop recognised the need to ensure adequate flow in rivers for maintaining their ecological integrity, water quality and biodiversity, and called for regulating abstraction of water for various uses in consonance with the hydrological conditions of the river basin to the extent that 'under no circumstance4s the abstraction exceeds a maximum prescribed proportion of the total flow".

In May 2003, the Water Quality Assessment Authority (WQAA) – a joint body of the Ministry of Environment and Forests and the Ministry of Water Resources - decided to constitute a Working Group to advise it on "minimum flows in rivers to conserve the ecosystem". The Working Group was notified only in September 2003. The Working Group held 4 meetings and submitted its report in July 2007. It is noteworthy that despite the use of the phrase "minimum flow", the focus of the WQAA was on the conservation of the "ecosystem". However, except for including extracts from various international publications, the Report did not look into any ecological aspect of the ecosystem. Based on statistical analysis of hydrological data of a few Himalayan and Peninsular rivers by the National Institute of Hydrology (NIH), Roorkee, and the Central Water Commission, Hyderabad, the Working Group recommended the following:

Himalayan Rivers

- Minimum flow to be not less than 2.5% of 75% dependable Annual Flow expressed in cubic meters per second.
- One flushing flow during monsoon with a peak not less than 250% of 75% dependable Annual Flow expressed in cubic meters per second.

Other Rivers

- Minimum flow in any ten daily period to be not less than observed ten daily flow with 99% exceedence. Where ten daily flow data is not available this may be taken as 0.5% of 75% dependable Annual Flow expressed in cubic meters per second.
- One flushing flow during monsoon with a peak not less than 600% of 75% dependable annual Flow expressed in cubic meters per second.

The recommendations were neither unanimous (personal information as a Member of the group) nor accepted by the WQAA. The WQAA asked the Working Group "to include the water quality aspects in the study for fixing minimum flows of the rivers in India". A smaller subgroup was constituted which reported that enough freshwater is not available for dilution of even the treated wastewaters which are generated in huge amounts and none of the available economically viable treatment technologies can remove all pollutants. The Group made several recommendations for the maintenance of water quality. The WQAA for the third time in 2009, constituted a Committee on "Assessment of Environmental Flows in Rivers of India" which did not finalise any report. In October 2010, the WQAA again constituted a subcommittee to review the report of the Working Group on Minimum Flows. The Sub-Committee submitted the following recommendations in November 2011:

- An allocation of 10 to 20 percent of MAR temporally distributed as per natural FDC (based on run-off data up to 1990) may be reserved for environmental needs of Himalayan rivers broadly which may maintain the river ecosystems in a reasonable state. The environmental flow in peninsular rivers/non-Himalayan rivers can be taken as flow in any ten daily period to be not less than observed ten daily flow with 99% exceedence (considering pre-1990 data). Where ten daily flow data is not available this may be taken as 0.5% of MAR uniformly distributed throughout the year.
- Flushing flow provides cue to fish and other species to start spawning /regeneration in the immediate downstream of flow control structures. The biota growth may get disrupted due to probability of absence of adequate flow. Sub-Committee observed that provision of flushing flows may not be necessary unless major storage dams exist with substantial high flows release facilities. The environment management should therefore focus on low flows, while the assumption can be made that high flow will occur naturally and may not be controlled subject to final analysis downstream of control structure, flushing flow should be provided particularly in Non Himalayan Rivers in case there is a major storage. One flushing flow during monsoon with a peak not less than Q_{10} to Q_{20} (10-20% exceedence value of FDC) expressed in cubic meters per second should be provided.
- For specific purposes, such as Varanasi Bathing Ghats, Kumbh Mela etc, minimum flow to maintain a bathing depth may be provided for limited duration.

The WQAA has not yet taken any final view on the subject as the issue of environmental flows is being discussed at other levels in the Government.

While the Working Group on Minimum Flows was engaged with its discussions, the National Institute of Ecology (NIE), jointly with the IWMI (New Delhi, March 2005) organised a workshop on environmental flows, with participants representing Ministry of Water Resources, Ministry of Environment and Forests, Indian Council of Agricultural Research, NGOs and research institutions and several international experts such as V. Smakhtin, R. Tharme and W.J. Junk (Chauhan 2005). The WQAA Working Group appended the recommendations of the workshop to its Report but did not take any point into account.

After the Workshop, IWMI got interested in undertaking environmental flow assessments in India using hydrological desktop methods. Smakhtin and Anputhas (2006) formulated a rapid assessment method for 13 major Indian rivers, taking into account the limitations of available hydrological and ecological data, to compute environmental water requirement (EWR). The monthly flow time series data were used to compute flow duration curves for several environmental management classes (EMCs). The required environmental flow volume (expressed as % of natural Mean Annual Runoff) and elements of flow variability were set to progressively reduce with the decreasing level of ecosystem protection (FDC shifting method). The final environmental water demand was presented as a flow duration curve and a monthly flow time series. The study concluded that the estimated EWR were .lower with increasing flow variability of a river, and the Rivers Brahmaputra and Ganga, which have lowest variability in flow regimes, had the highest EWR.

Later, using the same method, Smakhtin et al. (2007a) calculated the environmental flow requirements, for two environmental management classes, for the donor and receiver points on the proposed Polavaram-Vijayawada link between Godavari and Krishna rivers.

In another study, Smakhtin et al. (2007b) developed a prototype scoring system for the ecological status of rivers in India, as a part of the desktop environmental flow assessment. The scoring system is based on several indicators such as the presence of rare and unique aquatic biota; diversity of aquatic habitats; presence of protected areas; sensitivity of aquatic ecosystems to flow reduction; percentage of a watershed and floodplain remaining under natural vegetation cover types; percentage of exotic aquatic biota; overall richness of aquatic species; degree of flow regulation and fragmentation; human population density in a river basin; and the overall quality of water. Estimates of each indicator, based on available data and expert knowledge, were converted to a score on 1-5 scale. The sum of scores, expressed as a percentage of the maximum achievable score, reflects the degree of deviation of a basin from its natural condition and, therefore, the most probable 'environmental management class'. The latter, in turn, was related to the environmental flows. The approach was illustrated using several peninsular river basins and a part of Ganga.

The National Institute of Hydrology (NIH), which had conducted some analysis for the WQAA's Working Group on Minimum Flows, also initiated studies on EF assessments using hydrological methods. Jha (2008) examined the daily discharge data for several stations on Brahmani and Baitarani River Systems to develop flow duration curves from

daily, 7-day mean and 30-day mean values. The FDCs were used to evaluate the severity of high, ordinary, and low flow regimes and Q95 value was suggested to be most suitable "environmental design flow" that was less than 5% of Mean Annual Runoff (MAR) at different stations.

A report by Lenin Babu and Harish Kumar (2009) and Harish Kumar et al. (2010) compared annual discharges from the Bhadra reservoir against the data on average monthly inflows into it for the period 1967-2006 and simply observed that the releases during ten different years did not meet the Tennant's recommendation of 30% minimum flow. The reports do not qualify to be an environmental flows study.

The only detailed study of environmental flows so far has been conducted by the WWF-India for the upper reaches of river Ganga, in partnership with UNESCO-IHE, IWMI, IIT-Kanpur and other institutions and researchers (O'Keefe et al. 2012). The study applied the Building Block Methodology (BBM) and considered biodiversity, socio-economic and cultural components for the assessment of their flow requirements. The study is summarised in a separate chapter in this book (Suresh Babu and Kaushal 2013). Also the assessment of flow requirements for benthic organisms and fish are presented in greater detail in another chapter. A follow up study of Environmental Flows assessment for the entire Ganga river basin has been initiated by a consortium of Indian Institutes of Technology under the National Ganga River Basin Environmental Management Plan (Tare 2011). Earlier this year, a study on the water requirement in river Ganga at Allahabad on the occasion of Kumbh (marked by mass bathing of millions of devotees) was also treated as part of environmental flows (WWF-India 2013).

A definitive policy on environmental flow requirements in various water resources development project has yet to be finalised (see details later) and an appropriate methodology for the assessment of environmental flows, for different rivers or their reaches, has yet to be developed to suit Indian conditions. However, some consideration is being given by the Environmental Appraisal Committee for River Valley Projects to the need for flows downstream of the projects which are in the planning phase and require necessary environmental clearances. The civil society has also protested against several hydropower projects in different stages of construction in the Himalayan region and demanded provision of environmental flows. Therefore, several consultants and institutions have prepared reports on the environmental flows required to be released from the HEP projects into the river. All of these reports are based on inadequate and inappropriate hydrological and ecological data, and short-term field visits, without applying any standard methodology. Various percentages of some flow estimates are recommended primarily to obtain approval for the project. A recent report for a hydropower project in Arunachal Pradesh needs to be mentioned here because it was prepared by the fishery scientists of the Central Inland Fisheries Research Institute (CIFRI 2011). The study relied on Tennant's method and small inflows downstream of the project site in its recommendations based on only water depth and velocity requirements for fish movement, ignoring all other ecological considerations.

Another issue that has drawn some attention is that of cumulative impacts of the numerous HEP projects which are being developed in cascades on the same river and also

on their tributaries, often very close to each other. Following a Supreme Court directive in 2009, the Forest Advisory Committee of the Ministry of Environment and Forests decided to undertake cumulative impacts studies of HEP projects. The Ministry assigned the studies on the cumulative impacts of the HEP projects in Alaknanda and Bhagirathi river basins (headwater reaches of River Ganga) to the Alternate Hydro Energy Centre (AHEC) of the Indian Institute of Technology (IIT), Roorkee, and the Wildlife Institute of India, Dehradun. The AHEC report (AHEC 2011) considered, inter alia, the issue of river ecology and its flow requirements. The EMC-FDC method was followed, using 10-daily mean discharge data, to arrive at its recommendations for environmental flows. A detailed critique of the report was made by Thakkar and Dandekar (2011) and various flows related issues were examined by Theophilus (2011). The WII team used the same flow data, made detailed field studies on wildlife and fisheries (Rajvanshi et al. 2012). They also followed the shifting FDC method (Smakhtin and Anputhas 2006) with a mean seasonal flow approach to assess the Environmental Flow requirements with a focus of mahaseer and snow trout. The major conclusions and recommendations of the two reports regarding environmental flows and other ecological impacts, are, however, at great variance from each other. A final decision has not been taken as yet.

This chapter is not intended to analyse or evaluate the studies and reports. It is important to note that considerable interest has been generated and the term EF has been gradually accepted. Several NGOs and other organisations are getting involved in communication and advocacy. For example, a National Workshop on Eflows (Bangalore, 3-4 January 2009), organised jointly by SVRAJ, SANDRP and River Research Centre, stressed upon the need for interpreting the concept of eflows in the context of India's specific socio-ecological and cultural setting, developing methodologies suitable for Indian rivers, analysing the aspect of trade offs that will occur while reallocating the resource. It also emphasised the need to maintain the few remaining biodiversity-rich and least-modified rivers in their natural state as baseline for future reference. An International Conference on 'Environment Flow Requirements of Himalayan Rivers' was organized jointly by SWaRA and WWF – India at Lucknow on 21and 22 July 2009, adopted a number of general recommendations regarding E-Flows principles, planning, policies, methodologies and practice. The River Research Centre in Kerala and South Asia Network on Dams, Rivers and People, Pune, have brought out a primer on environmental flows (Anantha and Dandekar 2012) targeted at river basin communities and river activists.

There is a sudden upsurge of interest in environmental flows among environmentalists and there are signs of various interest groups pulling the subject in different directions depending upon single specific objectives. The situation of the Indian rivers is so complex that no method or approach developed outside the region can be adopted without adapting and modifying it to meet the specific biophysical, hydrological, social, cultural and economic realities of different parts of the country. Interdisciplinary scientific studies are needed together with the convergence of views on various issues and consensus on approaches.

BANGLADESH

In Bangladesh, studies on of instream flow requirements of rivers were initiated in 2003 under the ENFRAIM project within the framework of a capacity building programme between the Dutch Delft Cluster (a co-operation platform of five Dutch institutes including WL/Delft Hydraulics, Alterra, Delft University of Technology and UNESCO-IHE) and the Bangladesh University of Engineering and Technology (BUET) (Bari and Marchand 2003a). Other organisations and institutions involved in these studies included Water Resources Planning Organization, Bangladesh Water Development Board, Centre for Environmental and Geographic Information Services, Institute of Water Modelling and the Joint River Commission. The studies focused on the selection of suitable methods for assessment of environmental flows along with the consideration of socio-economic aspects (Marchand 2003, Bari and Marchand 2003b, 2006). Three rivers considered in the study were the Surma-Kushiyara, the Teesta and the Gorai. The ENFRAIM project tested the applicability of Flow Duration Curve and RVA methods (Meijer et al. 2004), developed and applied the river ecotope system, mapped the geomorphology and land use using Remote Sensing images, and used hydrological data to compute environmental flow requirements in a wide range of river settings, providing a representative picture for different geographical, environmental and social situations (Marchand 2003).

Mullick et al. (2010) analyzed the flow characteristic of the Teesta River in Bangladesh based on 40 years historic flow data and estimated the environmental flow requirements for the river following the Tennant, Flow Duration Curve and Range of Variability (RVA) methods. Similar hydrological methods were employed in another study of Dudhkumar river - an unregulated river (Hossain and Hossain 2011). A recent study by Akter and Ali (2012) assessed the environmental flow requirements in the Halda River by using the building block method. The study examined the the expected extreme and satisfactory flows for fish habitat at Panchpukuria station.

NEPAL

The subject of environmental flows was introduced in Nepal by the IWMI, to "promote the need for planning environmental water allocation in river basin development and to streamline the inclusion of environmental water demand assessments into relevant national policies". A case study of East Rapti River basin was undertaken to demonstrate the available methodologies and processes to be followed. East Rapti River basin includes the Royal Chitwan National Park (RCNP). The 122 km tributary of Narayani has a total catchment 3084 sq. km. There are no major water regulating structures in the basin. Daily flow time series data were generated using a spatial interpolation technique as reliable discharge data were available for only one site. Boating in the RCNP was the important consideration foe determining the flow requirement. The Tennant method (30% of average annual flow, with the maintenance of elements of natural flow variability) and the Range of Variability Approach (RVA) with 16 flow variables including daily and 30-day minimum and maximum flows) were used. Later, Smakhtin et al. (2006) extended the study to examine the applicability of a more advanced hydrology-based method, the South African

Desktop Reserve model (DRM). The study concluded that the methods like DRM, which are developed for a specific country/region, need to be tested and re-calibrated for additional physiographic and climatic environments (such as the monsoon and ice melt-driven flow regimes of Nepal) before they can be reliably applied.

SRI LANKA

In Sri Lanka, IWMI initiated steps to create awareness about EF among responsible authorities through a case study of Walawe river basin that illustrated also the applicability of available methods (Smakhtin and Weragala 2003). In the Walawe River basin, in a semi-arid zone of southern Sri Lanka, two major reservoirs in the upstream and middle reaches of the river have altered significantly the hydrology of the river. The hydrological reference condition was simulated using a non-linear spatial interpolation technique based on observed rainfall and flow records. Then, environmental flow regime was approximated by a modified RVA method (using mean flow for each of the 12 months, and one-day minimum and maximum flows) based on simulated, unregulated daily flow time series and their flow duration curves. No further study has been undertaken.

REGIONAL INITIATIVES OF IUCN

The IUCN has promoted EF in South and Southeast Asia region under its Water and Nature Initiative (WANI), largely through experience sharing and learning on environmental flows amongst key regional stakeholders. It supports an Asian eFlows Network whose website *(https://sites.google.com/site/asianeflownet/home)* serves as the knowledge base and hosts a collection of resources and links to other experiences and materials on environmental flows.

During recent years, the IUCN organised regional workshops in Kathmandu, Nepal (August 2011) and Khao Lak, Thailand (November 2011) with the objectives of (a) understanding the links between river flow regimes and economic, social and ecological impacts, (b) introducing methods for flow assessment and options for modifying flows, (c) reviewing requirements for enabling implementation of environmental flows, and (d) synthesising components into practical designs for application of environmental flows.

Environmental flows is also a major component of the IUCN's project, 'Ecosystems for Life – a Bangladesh-India Initiative' which aims at promoting integrated management of trans-boundary water regimes with a view to enhance food, livelihood and water security in the South Asian Region. A joint team of researchers from India and Bangladesh is developing a common methodology for environmental flows assessments (personal communication).

LAWS, POLICY AND INSTITUTIONS

All South Asian countries have formulated several policies which are related to different water uses (agriculture, fisheries, domestic water supplies, navigation, sanitation and health, energy, etc.). In most countries there is also a national water policy which mentions the need

for integrated water resources management and addressing the environmental concerns. All countries of the region are a party to the Ramsar Convention on Wetlands and the Convention on Biological Diversity which stress upon the conservation of biodiversty and ecosystem services of aquatic ecosystems. None of the countries, however, has a well defined policy for providing flows for maintaining the ecological integrity of rivers and associated aquatic ecosystems. The absence of an appropriate policy related to the protection and conservation of aquatic ecosystems is as much due to the pressures of economic development as due to the lack of scientific data and understanding of these systems. In India, some initiatives have been taken that may lead to a policy on environmental flows with legal backing at the national level.

Bangladesh

Bangladesh faces the twin problem of flooding during the monsoon season and water scarcity during the dry season. Because of its deltaic location and topography, increasing salinity is another problem. Its large network of rivers is used for navigation but siltation is a major problem. The National Water Policy of Bangladesh Ministry of Water Resources (1999) declares that minimum stream-flows will be maintained in designated rivers and streams for navigation, after diversion of water for drinking and municipal purposes (Rasul and Chowdhury 2010). The objectives listed in the relatively recent National Water Management Plan (WARPO 2004) include "quality, size and connectivity of water bodies adequate for the restoration and preservation of the aquatic biomes". The Plan also seeks to maintain freshwater flow for the Sundarban mangroves for increasing productivity and reducing salinity.

Nepal

Numerous major tributaries of River Ganga arise in Nepal and yet, Nepal also faces water scarcity during the dry season. The National Water Plan of Nepal considers mitigation measures for the reduction of downstream water flow during dry season. It recognises "compulsory downstream water requirement as a water right" and requires that 10% of the lean season flow should be released or compensation should be paid to downstream water users. However, the Environmental Action Plan (2003-08) states "establish minimum in-stream and outflow in important aquatic ecosystems".

Sri Lanka

People in Sri lanka have historically managed the seasonal water scarcity in the dry zone by building thousands of storage tanks and trans-basin diversions in traditional manner. However, the country embarked upon the development of a donor-driven national policy and water management plan which has been mired in controversies because of its top-down approach, lack of transparency, lack of historical and cultural perspectives, and inadequate attention to environmental issues (Gunatilake and Gopalakrishnan 2002). Although the Government approved a policy document in 2000, a final official policy is not yet in place (Ariyabandu 2008, Nanayakkara 2010).

Pakistan

The National Water Policy of Pakistan recognises the need for developing and managing the national water-resources in a holistic, determined, and sustained manner" (http://cms.waterinfo.net.pk/pdf/NationalWaterPolicy.PDF). It devotes a section to Wetlands, Ecology and Recreation which states that "the protection and restoration of the natural environment and its biodiversity including wetlands, mangroves, national parks and river ecosystems should be a part of all future development and management strategies". A relevant policy statement identified the need to:

> "Minimize downstream as well as upstream environmental impacts, and embody appropriate measures as a part of the design of reservoirs and other development works" and
>
> "Ensure that sufficient fresh water is flowing through the rivers to the sea to maintain a sound environment for the conservation of the coastal ecosystem and for the fresh and brackish coastal fisheries. Environmental needs must be addressed while framing "release rules" from the major storage dams for hydropower and irrigation, to ensure sustainability of such areas as the Indus Delta".

India

India adopted a National Water Policy (NWP) as early as 1987 which was revised in April 2002 and again in December 2012. The NWP 2002 listed the priorities for allocation of water resources and placed 'ecology' after drinking water, irrigation and hydropower, without elaborating upon the term. It also stated, under the section on water quality, that "minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations". The NWP 2012 makes several references to environment, ecology and ecosystems but sticks to the word 'minimum'. It does not prioritize the allocations very clearly but states that "*Water is essential for sustenance of eco-system, and therefore, minimum ecological needs should be given due consideration*". Further, the section on Uses of Water states:

> Ecological needs of the river should be determined, through scientific study, recognizing that the natural river flows are characterized by low or no flows, small floods (freshets), large floods, etc., and should accommodate developmental needs. A portion of river flows should be kept aside to meet ecological needs ensuring that the low and high flow releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water use.

Another section specifically devoted to "Conservation of River Corridors, Water Bodies and Infrastructure" reiterates that "*Environmental needs of aquatic eco-system, wet lands and embanked flood plains need to be recognized and taken into consideration while planning*".

However, till date, there is no definitive policy or legal requirement for the environmental flow requirements. As early as 1992, the Central Water Commission had prepared 'Guidelines for Sustainable Water Resources Development and Management'

which required that "the minimum flow in the river should not be less than the average of 10 days minimum flow of the river in its natural state". These guidelines were ignored by the WQAA appointed Working Group in formulating its recommendations as described earlier in this chapter.

Hydropower Policy of the Government of Himachal Pradesh

A major policy decision was taken by the Government of Himachal Pradesh even before the WQAA Working Group finalised its Report. The Government decided that in case of all Hydro-Electric Power projects (HEPs), *"The company shall ensure minimum flow of water immediately downstream of the weir/ barrage/dam for downstream requirements as directed by the Government/ State Pollution Control Board."* Based on some studies by a Committee on Biological parameters (Saprobity Index and Diversity Index), Dilution/ dispersion capacity of the river to assimilate the pollution load and Desilting criteria in Satluj and Baspa river stretches, the Government introduced, in July 2005, a provision of 10% minimum discharge downstream for all existing and upcoming HEPs but soon thereafter, based on some studies revised the provision to 15% vide notification of September 2005. The provision of 15% water discharge was incorporated in the Hydro Power Policy of 2006 which stated,

"The Company, if ROR Project, shall ensure minimum flow of 15% water immediately downstream of the diversion structure of the Project all the times including lean seasons from November to March, keeping in mind the serious concerns of the State Government on account of its fragile ecology & environment and also to address issues concerning riparian rights, drinking water, health, aquatic life, wild life, fisheries, silt and even to honour the sensitive religious issues like cremation and other religious rites etc. on the river banks. However, the companies are at liberty to install mini hydel Projects to harness such water for their captive use, for their utilities, systems and colonies."

The government further amended the minimum lean season flow requirement, in March 2009, to include average discharge in the lean months i.e. from December to February.

The Government's notification was challenged in the High Court of the State of Himachal Pradesh by the National Hydropower Corporation (NHPC) in respect of three Projects namely Chamera-I & II and Baira Siul in District Chamba and the Panjab State Electricity Board (PSEB) for their Shanan Project. Hon'ble High Court granted stay on the application of the provision in case of these projects and constituted a committee chaired by the Chief Secretary to the Government of H.P. to look into the issues. The Committee in report in March 2010 observed,

1) "Although there is variance of perception of Experts in their reports on the amount of water to be released, both the Experts are agreed on the need of availability of certain amount water in the rivers.

2) These views of the Experts are also shared by other members including the representatives of the NHPC and PSEB subject to their specific observations mentioned hereinabove for their existing operational projects.

3) There is general agreement that data needs to be collected systematically for various parameters which have bearing on determination of amount of water to be released and that this should be project specific and based on long term studies".

In the absence of a clear policy or settled legal provision for the environmental flow requirements, the Environmental Appraisal Committee for River Valley Projects in the Ministry of Environment and Forests has been recommending different quanta of flows to be released downstream of the HEPs at the time of granting necessary environmental clearances. As mentioned earlier, various consultants estimate the environmental flow requirements without collecting reliable and adequate data. The project developers are unable to realise that the environmental flows requirements cannot be the same fixed percentage of a particular value (such as mean annual flow) for all kinds of rivers in all climatic zones.

Recommendations of Inter-Ministerial Group

As described earlier, the cumulative impact assessments of HEPs in the Himalayan reaches of river Ganga by two prominent institutions failed to resolve the issues regarding the desirability of numerous projects and the environmental flow requirements. The Government constituted, in June 2012, an Inter-Ministerial Group (IMG) whose terms of reference included, "To suggest environmental flow requirement that could be prescribed for various stretches of Bhagirathi, Alaknanda and other tributaries of river Ganga". The IMG submitted its Report in March 2013 (IMG 2013) which immediately attracted severe criticism from the civil society (Thakkar 2013). The IMG recognised the importance of e-flows regime that mimicks the river flows close to the natural flows but still stressed that the e-flow policy regime has to be effectively implementable by different hydropower projects and hence the e-flow norms have to be simplified with minimum variations during the year. Having found 'big and large manipulation of data' by the IIT-R, the IMG agreed in principle with the recommendations of the WII but modified them in terms of percentages of daily uninterrupted inflows. It also recommended up to 50% of the daily discharge during winter months in rivers where the natural flow is drastically reduced so that the societal needs can be met. The IMG also recommended the adoption of a policy to make ecological flow mandatory in all stretches of the River Ganga, and that it will be mandated at 50% of the mean season flow and 30% for other seasons.

Environmental Flows in the International Court of Arbitration (The Hague)

The issue of minimum flow in a river reached the International Court of Arbitration (The Hague) for the first time in the case of a dispute between India and Pakistan. India had sought diversion of the water of River Kishanganga for the 330MW Kishanganga hydroelectric project in Jammu & Kashmir. In May 2010, Pakistan instituted arbitration proceedings under the Indus Waters Treaty 1960 and approached the International Court of Arbitration (ICA) which granted a stay. In February 2013, the International Court of Arbitration allowed India to divert a part of the water from Neelum/Kishanganga Rivers until it determined

the minimum flow required downstream. Interestingly, DRIFT methodology and decision support system were discussed for determining the environmental flows requirements (Brown et al. 2013).

Currently in the absence of a clear policy and legal requirement for the provision of environmental flows, there is no institutional support for any aspect of environmental flows in any of the South Asian countries. There is hardly any support for research on environmental flows that is further greatly constrained by the inaccessibility to long-term hydrological data. In India, the subject has been hijacked by the consultants for river valley projects, and as mentioned earlier, arbitrary recommendations are made without any understanding the concerned riverine ecosystem and with the sole objective of getting a project clearance. There has been no effort to undertake studies for comparing various methods and adapt an existing method or develop a new method to suit the condition in the region. Thus there is an urgent need for adequate institutional arrangements for promoting research directed at the development of appropriate methodology, assessments of Environmental Flows for various rivers by examining thresholds for abstraction of water, and for implementation and monitoring.

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