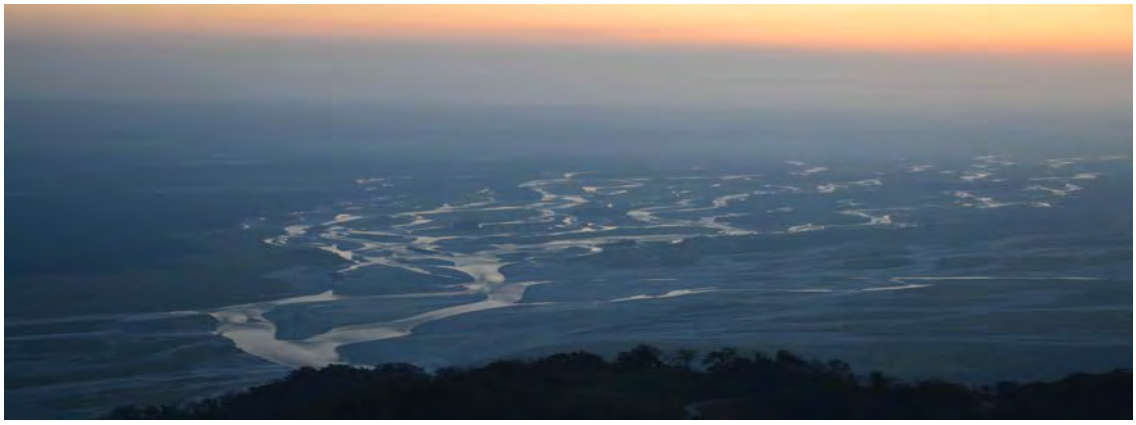


Towards Restoring Flows into the Earth's Arteries

A PRIMER ON ENVIRONMENTAL FLOWS

Latha Anantha & Parineeta Dandekar

Towards Restoring Flows into the Earth's Arteries

A PRIMER ON ENVIRONMENTAL FLOWS

Latha Anantha
River Research Centre, Kerala
&
Parineeta Dandekar
South Asia Network on Dams Rivers and People
Pune

Supported by
Global Green Grants Facility (GGF)

May 2012

Preface

Let us face it….
We have been taking all the flows from our rivers
Dams have regulated and fragmented the flows – often irreplaceably
More and more dams are still being planned to block the last flow and extract it for human use alone!
Our rivers are inching towards ecological and hydrological death.
Before it is too late, we need to put our act together…to save our lifelines

To put it very simply, rivers need their flow back…
To live and to ensure the survival of all other beings including we humans
These flows which are the right of the river are called the environmental flows or the flows required by the river as an ecosystem and its connecting ecosystems to perform their evolutionary and ecological functions….
To ensure the continuity of life for generations to come
It is time we started making efforts to prevent further blocking of flows and put back the flows into the earth's arteries…
World over, efforts are on to revive the lost flows…
This Primer is a small effort towards making communities, river and dam activists and all others concerned about rivers aware of the need for e flows and demystifying the subject using a simple idiom.

Global Greengrants Fund was kind enough to fund this endeavor
Keystone Foundation in the Nilgiris was willing to provide back office support
Samir Mehta, South Asia Program Director, International Rivers, identified that e-flows can be taken to the river and dam activists and civil society groups in South Asia through us and encouraged us
Many have helped us in this effort with their ideas and encouragement
Our families and colleagues deserve a special mention. Thanks to Deepak, Nachi, Himanshu and Unni for their support.
And because of all the above the Primer is before you…
We take the responsibility for any error that has crept into the Primer
We wish this Primer will serve the purpose for which it has been written

Latha Anantha and Parineeta Dandekar

The authors can be contacted at
Dr. Latha Anantha – Director, River Research Centre, Kerala
Tel - +91 (487) 2353021 / +91 98472 83120 email: latha.anantha9@gmail.com
Parineeta Dandekar – Associate Co-ordinator, South Asia Network on Dams, Rivers and People, Pune
Tel : 09860030742 email: parineeta.dandekar@gmail.com

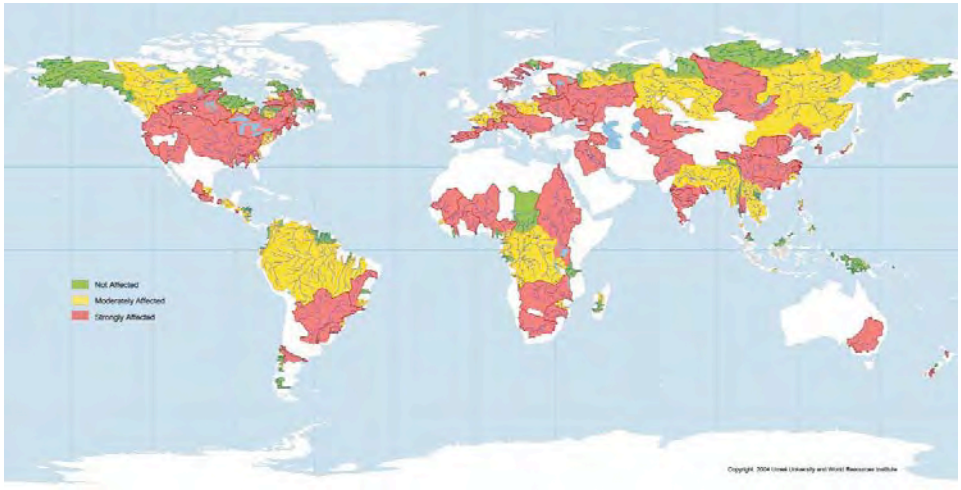
Stream 1

Why a Primer on E - flows?

'A river's flow is its heartbeat'

Without doubt, rivers are the one of the most important source of freshwater. They are also the refuge to diverse organisms and sub – ecosystems. Out of all the natural endowment used by human beings rivers have been the most used and abused on this planet. According to the Millennium Ecosystem Assessment, freshwater biodiversity is facing more threats as compared to all other ecosystems. Centuries of over extraction, damming, diversion and pollution have reduced most of our rivers to mere ghosts of their natural self. We are faced with the grim reality that many of our rivers are in a very bad shape and a few of them already on the road to death. Rivers like the Indus, the Ganga and the Brahmaputra which is the life line of millions in Asia are already struggling to reach the seas throughout the year. The outfalls into the sea from Krishna and Cauvery, the rivers that drain the Central Indian Peninsula are already so low that they hardly reach the seas in summer. The rivers are also a victim of the unpredictable changes in climate.

Fig 1: River Fragmentation and Flows Regulation in World's Rivers. Highly fragmented and regulated rivers (shown in red), include those with less than one quarter of their main channel left without dams, where the largest tributary has at least one dam, and where the reservoirs retain a considerable portion of a year's flow (Neilsson, 2005)



'Water is flowing waste to the sea and hence every drop has to be utilised for the benefit of mankind!' This is the popular view shared by our governments and bureaucrats when it comes to taking decisions on our water resources like rivers. This notion has been the driving force behind building more and more dams and diversions across rivers and extracting more water from our rivers. In this worldview, a river is dissected into

compartments and is apportioned between different uses and users. What happens to the river, its natural flows, to the downstream livelihood needs, to the ecology and aquatic biodiversity is rarely the concern of any bureaucrat or the government. Accounting for these impacts never enters into any decision making process either.

The construction of dams has been going on at a frenetic pace all over South Asia. Till very recently, the projects were cleared singularly based on project level environmental impact assessments. With more number of dams being planned in a river, cumulative impact assessment (CIA) of cascade of dams has gained prominence in India. This has been largely triggered by the mounting opposition to the series of dams being planned on the tributaries of the Brahmaputra in North East India rather than the stringency of the clearance mechanism.

Presently 41 % of the world's population lives in rivers basins under stress (CBD, 2005). The national and regional governments in the South Asian countries are slowly coming to terms with the reality that even the long term economic and social well being of the people is inextricably linked with flowing rivers. Many International Conventions, policies and legal instruments have included the value of water for nature and or environment in their framework. The Ramsar Convention (1971), The Helsinki Convention on Transboundary Water Courses and International Lakes (1992), The National Water Act (1998) of South Africa, Convention on Biodiversity (2001), are few among these.

River basin communities and river activists have been opposing destructive dams all over South Asia for the last many decades. The struggles still continue. Perhaps, the Narmada Bachao Andolan was one of the earliest movements to raise the issue of cumulative impacts of dams on a single river. Most of the movements have been challenging dam projects singularly. The decision to build cascade of dams in hitherto undammed pristine rivers especially in the North East and the Western Himalayas has made it necessary to pitch the issue at a river basin level. Rivers would flow through tunnels instead of their natural channels if all these dams are approved and constructed. Many groups have taken the legal recourse to challenge the clearances granted to such projects. Downstream communities are concerned about the impacts of high daily flow fluctuations that can ensue once the projects are operational. The impacts on river ecology, aquatic species, flood plains, farming, fisheries, drinking and irrigation water needs both downstream and between the dams due to the severe regulation of flows are anybody's guess.

Over years, the changing world view on our rivers has led to the realisation that a river is much more than just water flowing waste to the sea. A river is an ecosystem in itself and needs to flow if it has to perform its evolutionary and ecological functions that in turn enable it to continue providing the various services to human kind and to nature. The recognition of the need for environmental flows has stemmed from this impending scenario.

Environmental flows (henceforth termed as e-flows) in itself is not a new concept. E-flows are interpreted in different ways by scientists, technical experts and policy makers. From a purely natural principle based 'who are we to assign e-flows' to a pragmatic concept of 'flows need to be allocated' a wide range of interpretations have emerged over the years.

Flows required for ecosystem functions have been accepted as one of the most important factors deciding the longevity of a river.

E-flows is at various stages of planning, assessment, designing and implementation in several countries like Australia, US, Europe, Africa etc. Countries like South Africa and Australia have framed laws and guiding principles for enabling e-flows. The Cumulative Impact Assessments (CIAs) being carried out in India have recently introduced environmental flows estimation. CIAs of Lohit, Alaknanda – Bhagirathi and Bichom sub basins have carried out environmental flow assessments. However, these have been arrived at out without heeding to community needs or keeping ecological and livelihood needs as a priority. The assessment of e-flows does not capture the actual social and ecological impacts of flow fluctuations on the river either. The CIAs are often based on adding up the impacts of individual dam projects rather than cumulative impacts on flows and on the downstream. Over 200 methodologies have been tried out in e-flows assessment across the world. The Ministry of Environment and Forests (MoEF) has meanwhile decided to accept the Building Block Methodology (BBM) for its e-flows assessments.

The river dependent communities like tribes, fishing and boating communities are familiar with the natural highs and low flows in their river. Their livelihoods depend upon the flow – ecology linkages of the river. Their innate knowledge and experience with the river is different from that of a dam engineer or a river expert. The present estimations of e-flows has failed to capture the ecological – livelihood linkages of flows. The river basin communities are seldom consulted on the flows required for various livelihood and ecological functions in a decision making process related to dams or other human interventions in a river.

Realisation and recognition alone does not suffice. What kind of actions and policy changes are required from grass roots upwards for effective e-flows implementation and bringing it within the environment governance framework is an equally important challenge. All over the world, significant and widespread progress has been made in developing policies and laws to recognize environmental flow needs**.** However**,** an understanding of environmental flows as a public policy imperative remains a comparatively recent development. Who all should be involved in the e-flows implementation process is another important question. What all obstacles including political buy-in would have to be addressed is yet to be experienced.

E-flows largely remains a purely technical exercise of assigning quantitative values based on Mean Annual Run off or average of the seasonal flows. Directly river dependent communities understand the river and its flows in a totally different way. The technical approach would alienate the river communities from understanding or involving in the e-flows assessment and monitoring process. The purely technical approach may not always address the very dynamic and equally fragile flow changes in a river system or the accounting of the land use changes within the river basin. Hence while heeding to science, there is a need to demystify the technical approach to e-flows and take the discourse to all relevant stakeholders who depend on river flows for various needs. Meanwhile, the role of good science and policy and enabling institutional framework cannot be avoided either.

It is extremely important to place e-flows within its proper perspective before river basin communities and NGOs engaged in working towards conserving rivers or on different aspects of water resources management. There is a need to create discussions on what and how of e-flows, the right mix of science and community approach needed to assess e-flows and pitch it on a broader platform within a decision making framework. Lots of literature is already published on e-flows. However, we have not come across any material that tries to make the concept easy to comprehend for river basin communities and movements involved in saving rivers from destructive development projects, that places the need for e-flows within a river basin framework, helps communities and river activists to campaign for e-flows and to enable them to take the right choices with respect to setting the objectives.

Hence this primer is attempted. The chapterisation of the primer has followed a pattern towards taking forward the stream of thought that rivers have a 'right to flow' and we can abstract only as much water which will ensure there is minimum deviation from the natural flow regime. Or in other words, those flows that are required to meet the ecosystem and livelihood needs should be ensured. From the need for the primer, the next chapters move into why rivers should flow into the sea and how communities have adapted themselves to live with the flows. Perhaps the most significant section is what are the objectives of setting e-flows? Setting objectives and deciding on the flow regime required is easier when compared to the socio – political challenges in implementation and monitoring of e-flows which forms the main content of the next two chapters. Any such strategy should be backed by enabling policy and legal instruments which forms the core of the penultimate chapter. The last section of the primer tries to place environmental flows within the context of a larger river basin planning framework.

At the same time, we would like to take this opportunity for a word of caution. Unfortunately, till now we have seen that in South Asia, and also in many other countries, measures like Environment Impact Assessments, Environment Management Plans, Compensatory afforestation, fisheries management plans, etc., have succeeded only marginally in achieving their original objectives. More often than not, these tools simply became an opportunity to green wash destructive projects with huge social and ecological impacts. We hope that the same does not happen with the concept of e-flows. For this, involvement of local communities and orgnisations in the process from planning, implementing to monoitoring is imperative. At the same time, eflows are only a compromise. There is an urgent need to protect the rare and disappearing free flowing rivers of the world, which provide numerous services to communities. E-flows need to be looked at in their proper context as one of the means to achieve good river health in already dammed rivers, it should not be an excuse to dam free flowing rivers.

Stream 2

Do rivers need to flow to the sea?

A river is much more than water flowing and wasted into the sea!

Human communities through centuries have learned to prosper with the journey of the flowing river, adapting themselves to the natural rhythms, meeting their various needs from the different river related ecosystems. Traditionally rivers have been the main source of food, water and primary livelihoods like fishing, flood plain farming, etc. Later, rivers came to be used for navigation, power generation, canal irrigation, industries, tourism, etc. increasing the diversity and complexity of river use over the years. Rivers have also been the cultural and religious meeting places for South Asians. Flows are the most important connecting link in all the different uses and ecosystem services provided by rivers to humanity.

Dams are the direct modifiers of flows

Out of all different human interventions, dams have been the direct and often irreversible modifiers of river flows. WCD (World Commission on Dams) estimated that around 47,000 dams of more than 15 m height were built all over the world by the year 2000. About half of the world's large dams were built primarily for irrigation. Large dams are estimated to contribute directly to 12–16 per cent of global food production and 19 per cent of electricity requirements. However, of all the human interventions on river systems, dams have been the most significant, often irreversible and direct modifiers of river flows, at the cost of the ecological health and ecosystem services of such river systems. Globally, over half of the 292 large river systems are affected by dams. Presently the number of dams blocking our rivers has crossed 50,000. India, the third largest dam builder in the world has more than 5,000 dams to date. Cascades of dams are being planned and commissioned across many of the tributaries of the transboundary Ganga, Brahmaputra and the Indus, which were flowing free till recent times.

Among all the environmental changes wrought by dam construction and operation, the alteration of natural flow regimes has the most pervasive and damaging effects on river ecosystems. Dams can heavily modify the amount of water flowing through the river. Once dammed, the river is at the mercy of the dam operator and the river loses it natural flow pattern. The operation of a hydropower dam can be peaking or base load and can fluctuate between the two on a daily basis, the operation pattern of the power station henceforth decides the timing, frequency and duration of high and low flows, and alters the natural rates at which rivers rise and fall during runoff events. Dams and diversion of water are capable of affecting several kilometres of downstream ecosystems, depending on the size and design of the structure, and the dynamism of the river, thus fragmenting rivers into static reservoirs and channels. Infact, the very high flow fluctuation to be created by the dams planned over the tributaries of the Brahmaputra River, especially the Lower Demwe

Hydro Electric Project, are feared to impact the *chapories* (the river islands) and the Dibru Saikhowa National Park atleast 100 km downstream

Fig 2. Map showing the dams proposed in the state of Arunachal Pradesh

The important ecological impacts associated with flow alteration can be summed up as below:

(1) Altering flows can lead to severely modified channel and floodplain habitats, because river flow shapes physical habitats such as riffles, pools, and bars in rivers and floodplains, and thereby determines biotic composition;

(2) Aquatic species have evolved life history strategies such as their timing of reproduction in direct response to natural flow regimes, which can be de-synchronised through flow alteration;

(3) Many species are highly dependent upon hydraulic connectivity, both lateral and longitudinal, which can be broken through flow alteration; and

(4) The invasion of exotic and introduced species in river systems can be facilitated by flow alteration (Richter and Thomas: 2007).

Hydropower dams, which are mainly preferred for their peaking power hold back water for an extended period in a day (20-22 hrs) and release it during the peak demand hours. This causes the river bed to go dry for extended periods, playing havoc with riverine and riparian ecosystems and communities along the river bank and depending on the river.

Our rivers have been managed under the engineering assumption that there is no limit to the yield of a river and its flows can be controlled or channelized or regulated to any extent and every single drop is for human use alone! This basic assumption is the root cause behind the

indiscriminate damming of rivers. Rivers are treated like pipes which can be run through tunnels, twisted and bent to suit our unlimited needs. The cascades of dams planned across the Lohit, Dibang, Alaknanda Rivers, would end up in the river flowing more through tunnels and pen stocks rather than the river channel. Another important assumption is that water can be transferred from 'surplus' to 'deficit' river basins without any harm to the surplus river basin. This has resulted in the complete diversion of the river to another river without allowing any downstream flows. The famous Mullaperiyar Project is an apt example of complete diversion of a tributary of the west flowing Periyar River to the east flowing Vaigai river basin. Such diversions have not respected the riparian rights of downstream communities and are often the source of conflict between the donor and the recipient state.

Since the WCD, fundamental questions are being raised by movements and river groups on the long term impacts of dam building across rivers. There is realisation all over the world that rivers are not able to complete their natural hydrological cycle. Dams are cited as the major reason for this as described above. Rivers are not able to perform many of their ecological and evolutionary functions. This has led to the need for understanding rivers and flows from a scientific and ecological perspective. There is an urge to relook at the functions of rivers and to move away from the very narrow hydro – techno centric world view of rivers.

Why should a river flow?

A flowing river is indeed one of the most important and beautiful natural entities on earth. A river is the only ecosystem that connects other ecosystems, carries water, transports dissolved minerals, sediments and nutrients to maximum places before emptying into its natural outlet. How much water would flow through a river channel and the sediment and nutrient load carried by a river is decided by the nature of the catchment and the rainfall or snow fall pattern. Flowing rivers connect different ecosystems like glaciers, forests, riparian zones, flood plains, mangroves, etc. on their way. Flowing rivers also create flood plains, sand deposits, deltas, etc. Rivers while draining the land carry out groundwater recharge by percolating into deeper aquifers. All rivers do not necessarily flow directly to the seas or open oceans. Some like the Amur Darya and Syr Darya flow into the Aral Sea which is land locked. Some of the Western Ghats west flowing rivers drain into the backwaters.

High flows of different frequency are important for channel maintenance, bird breeding, algae control, wetland flooding and maintenance of riparian vegetation. Moderate flows may be critical for cycling of organic matter from river banks and for fish migration, while low flows of different magnitudes are necessary for fish spawning, water quality maintenance, the use of the river by local people, etc.

Riparian vegetation in a Western Ghats river is needed for breeding and feeding habitats of birds and fishes
Photo : Latha Anantha

A flowing river alone can perform the above functions. In this context, flow means minimum deviation from natural flows and flow also means the river has to complete it natural hydrological cycle and carry out various ecological processes through its flow. This alone would enable river communities and other users to avail of the different social services and ecosystem values the river provides.

Take the case of the Indus River basin. Originating from the Himalayas, Indus flows 2,900 km through four countries (China, India, Afghanistan and Pakistan) before it drains into the Arabian Sea. The Indus River is critical for Pakistan's 160 million people and irrigates 80% of its 21.5 million ha of agricultural land. The Himalayan glaciers provide the Indus with 70-80% of its water, the highest proportion of any river in Asia.

The Indus Delta covers an area of some 5,000 km^2, of which 2,000 km^2 is a protected area. The fan-shaped Delta is the sixth largest in the world and supports a population of over 1, 30,000 people, whose livelihoods are directly or indirectly dependent on the Indus River. The delta is rich in mangroves which provide habitat for fish and shrimp and, together with the tidal mudflats, support a rich variety of flora and fauna and are particularly important as resting and feeding grounds for migratory birds. From a biodiversity perspective also the Delta is important, with ten species of mammals, 143 species of birds, 22 species of reptiles, over 200 species of fishes, many invertebrate species, including 15 species of shrimp. The Indus River is also home to one of the few species of freshwater dolphin, *Platanista minor* and to the fishing cat (IUCN).

Atleast 84% of people living in the delta comprise of fishing communities who used to catch an estimated 2, 47,000 million tonnes of fish per annum. Due to heavy abstraction and diversions, the amount of water in the Indus River has decreased dramatically from around 1, 85,000 million m^3 per annum in 1892 to 12,300 million m^3 per annum in the 1990s. Little freshwater now reaches the lower Indus. As a result of the reduced flow into the fertile Indus delta, the extent of mangrove forest and biodiversity has declined, shrimp and

fisheries reproduction has been reduced due to change in seasonal water availability and modified water quality, and agricultural chemicals have accumulated in the soil. Increased salinisation of the lower Indus has resulted in a decline of fish species which are sensitive to changes in temperature and salinity. Also, saline water has intruded 64 km inland, because of which 1.2 million acres of farmland has been lost. The loss of delta has led to a decline in the potential of fisheries by 70 per cent (IUCN).

More dams are proposed by Pakistan and India on the Indus. Climate change also if factored into the problems will worsen the state of the river.

In another case, some indigenous ichthyofauna (e.g., the anadromous fish, *Tenualosa ilisha,* or *Puntius* species, which used to constitute 28% of the landings in 1943–1944) have completely disappeared from the Kaveri River after the construction of the Mettur Dam. There is documented evidence that the outfalls into the Krishna River are falling over the years from 57 BCM (Billion Cubic Metres) before 1960s to almost nil in 2004 impacting the coastal ecosystems. (Smakthin: 2007).

There are no freshwater flows in the Yamuna downstream of Tajewala upto Etawah, where Chambal River meets Yamuna, at least during the lean months. Central Pollution Control Board Report (CPCB) itself claims: 'From Wazirabad barrage no water is allowed to flow down particularly during summer, as the available water in the river is not adequate to fulfill the water supply demand of Delhi." (Water Quality Status of Yamuna 1999-2005, CPCB). The same report notes that 70% of the total cattle population in the Yamuna basin uses flowing water of river and canals for bathing and watering purposes directly, highlighting the multifaceted dependence on freshwater flows in rivers in South Asian countries.

Evidences are already emerging on the deleterious impacts of not allowing rivers to flow and reach their destination. It is hence imperative to understand the inextricable linkages between flowing rivers and dependencies of communities, which is at the core of the 'environmental flows' concept.

References

Richter, B.D., and Thomas, G.A., 2007, 'Restoring environmental flows by modifying dam operations', *Ecology and Society* **12**(1): 12, http://www.ecologyandsociety.org/vol12/iss1/art12/

IUCN, 'The Lower Indus River: Balancing Development and Maintenance of Wetland Ecosystems and Dependent Livelihoods', cmsdata.**iucn**.org/downloads/**indus**.pdf

Smakthin, V. et al, 2007, 'Developing procedures for assessing ecological status of Indian river basins in the context of environmental water requirements', Research Report no. 114, IWMI.

Stream 3

Living with the flows

Humankind has been adapted to river flows directly or indirectly for millennia, right from the Nile valley civilisation. Neither the term e-flows has been used to describe it nor has complicated technical expertise been used to assess or arrive at it. Irrespective of faith, caste or creed and livelihoods, communities ranging from direct flow dependent tribals, farmers and fishers to water extracting industries and expanding cities depend on flows in one way or the other to meet their diverse needs. Innumerable instances of such dependencies reinstate the need to understand e-flows.

The social and agricultural calendar of riparian communities is in close harmony with the river flows. For example, in the state of Bihar in India, floods are welcomed with songs, poems and boat rides across flooded rivers in the nights.

In coastal rivers of Maharashtra, cropping pattern along the shores depends on the salinity of estuarine waters which in turn depends on riverine flows, while in Karnataka, mussel collection from the river mouth begins from November-December, when the water levels start dropping. Riverine fisher folk communities are aware of nearly all the fish species in the river, their periods of breeding and spawning and the part of river where the majority will be found. For example, in a small river of Central India, the traditional fishing community has distinct names for all the 63 fish species found in the river and are experts on their lifecycles. These are in turn, closely related with the hydrology of the river, or flows. In the Himalayan State of Himachal Pradesh, in addition to small irrigation channels or *kuhls* which use the riverine flows for small scale irrigation, indigenous flour mills or 'Gharats' operate on the flow of river water.

Gharats, or small scale flour mills in Himachal Pradesh, using flowing water.

Photo Courtesv: Himachal News

Communities across South Asia from various tribes, clans and religions have had a strong bond with flowing rivers. Rivers with natural flows are an integral part of the cultural identity of this region and find mention in folklores, songs, epics and stories. Every river has multiple names and is deified in myriad ways. Integral part of this deification and worship is the 'flow' associated with rivers. River Ganga, the mother, according to Hindu scriptures had to be contained in Lord Shiva's tresses to tame her wild flow, as she descended from the heavens. Even today, one of the main driving forces behind e-flows

allocation for Ganga is the immense cultural significance of 'Aviral Dhara' (uninterrupted flow) of the river. The word 'Ganga' itself comes from a Sanskrit verb 'Gam Gacchti' which literally means 'to flow'![1]

Many rivers, streams and waters sources in South Asia have been protected at the source through a network of Sacred Groves. These groves can be found from Nepal Himalayas to Sri Lanka to Kerala and have been maintained by numerous faiths. Nearly every hydrological junction of the river, its origin, confluence and estuary is venerated across South Asia. The entire valley of the River Teesta is considered holy by the Lepchas of Sikkim, who think that damming the Queen Goddess Teesta will bring a calamity.

In tribal areas of India, riparian forests are protected through community conservation methods. The river is divided in various sections, and deeper pools in the river, which act as major congregation sites for fish are protected as *Dev Doh* (Sacred pools) where fishing and exploitation is banned.

Nearly all major rivers in India have temple fish sanctuaries on their banks, where traditionally, fishing and exploitation has been banned. Across South and South East Asia, Buddhist Monks, tribals and temples are still maintaining hundreds of fish sanctuaries, which protect endangered fish like Tor species, as well as the pristine character of certain rivers.

Left: A sacred grove in biodiversity hotspot of Western Ghats, protecting and worshiping seven streams which emanate from the seven chambers

Photo: Parineeta Dandekar

In most tribal belts and rural areas of India, temporary earthen or wooden check dams are constructed across rivers for fishing or irrigation. However, after the season, these dams are dismantled and way is made for the river to flow.

Historically, in Indian states like Assam, Bihar, West Bengal and lower riparian countries like Bangladesh, moderate floods have been welcomed with open arms, as they bring nurturing alluvium and water and help fishing and agriculture.

[1] Personal communication with Dr. Ravi Chopra, Peoples Science Institute, Dehradun

Chippalgudde Temple Fish sanctuary, protecting the Mahseer Fish on the banks of River Tunga
Photo: Parineeta Dandekar

Netherlands is a flood prone country.Realising the ecological significance of floods, the guiding principle in water management in the Netherlands has changed from '*controlling floods and rivers'* to *'living with floods and giving room to water'*. The e – flows concept emphasises the societal need to understand the dynamics of flow and how to live with it rather than just controlling it and regulating it.

References

1. Dinesh Kumar Mishra, personal communication

2. Parineeta Dandekar, 2011, *India's community fish sanctuaries protect wild fish and rivers*, World Rivers Review (http://www.internationalrivers.org/resources/india's-community-fish-sanctuaries-protect-wild-fish-and-rivers-16410

Stream 4

Setting Objectives for Environmental Flows

The damage to the rivers cannot be undone. Without doubt, the toughest challenge before the governments in the coming years will be how to revive the lost flows in our rivers. However, when it comes to actually assessing and implementing e-flows, the foremost question that would arise is why do we need certain quantity of flows for a particular river or a stretch of the river? What all social, livelihood and ecological needs are to be met through the flows? Hence, setting objectives is at the core of assessing e-flows. A sustainable trade off and negotiation between water use in the river and e-flows can be arrived at only if objectives for e-flows are clearly stated. In India, though there have been some recommendations by various authorities (Courts, Tribunals, Expert Appraisal Committee of the Ministry of Environment and Forests) on releasing e-flows from dams. These recommendations have never been backed by strong objectives about why certain e-flow releases are needed. Objectives will change, based on the river and its various services and values.

The river islands in Teesta river needs flows that will deposit rich silt and nutrients for rice farming

Photo : Latha Anantha

Take the case of the vast Indus Delta in Pakistan or the small Chalakudy River in the Western Ghats. Fisheries are an important livelihood source and biodiversity issue in both these rivers and flows are needed to nurture and protect the fish diversity, breeding and habitats. In Haridwar or at Panch Prayag, certain water levels in Ganga hold special significance to communities performing religious ceremonies. In Meghna and Barak systems in Bangladesh, river depth and flow needs to be amenable to navigation. These objectives are in addition to the overarching objective of maintaining and upgrading riverine health.

It is increasingly said in e-flows literature that the flow regime that should be left in a river is a social choice [2] and that the society should decide about the condition it wants a specific river to be in, from pristine to degraded (which hopefully any society would not wish for!). Whether we want to use all the water for irrigation as in the Krishna basin or change the entire hydrograph by cascade of hydropower dams as planned in the Brahmaputra basin, or pollute the river as in Yamuna or do we preserve the river and its range of other ecological services as well with a futuristic vision is the tough choice that society needs to make while setting the objectives.

Who should set the objectives? Presently, the objectives for setting e-flows are a technical choice and a bureaucratic decision. It is common knowledge that riverine communities in South Asia do not have a significant role in decision making when it comes to managing natural resources like rivers. Large dam projects are being constructed inspite of the long drawn local protests across South Asia. These projects are driven by the development agendas of governments and private dam proponents, far removed from the realities of riverine communities. Genuine local concerns about fisheries, riparian farming, downstream impacts, cultural and spiritual values of the river do not find a reflection in river governance. Considering this reality, devising ways for mainstreaming community concerns and efforts in water management within a river basin in general and e-flows in particular is a challenging task. If communities are not involved in the objective-setting exercise, then the resultant e-flows regime and river health will not be a reflection of 'social choice'.

A number of methodologies like the Building Block Methodology (discussed in detail in the following section) follow different ways for setting objectives for e-flows allocation. One of the tools used is to identify the Ecological Management Class (EMC) of the river or riverine stretch in question. EMC is based on a scoring system that reflects the present ecological status of a river as well as societal management perspective about which class a river should belong to. Classes range from A to F. While Class A reflects a pristine river with a management perspective of protection and restricted infrastructure development, Class F represents a highly degraded river. Management perspective here would be upgrading the class of the river. From the e-flows perspective, higher EMC would mean more water to be allocated for ecosystem maintenance or conservation and close mimicking of the natural hydrograph, while a lower EMC would mean lower e-flows.

Table 1: Environmental Management Classes of rivers for setting e -flows objectives

EMC	**Description**	**Management Perspective**
A	Negligible modification from natural conditions. Negligible risk to sensitivespecies.	Protected rivers and basins a. Reserves and national parks. No new water projects (dams, diversions, etc.) allowed.
B	Slight modification from natural conditions. Slight risk to	Water supply schemes or irrigation development present and/or allowed

[2] O Keefe, Quesne (2009) *Keeping Rivers Alive A primer on environmental flows*, WWF

	intolerant biota	
C	Moderate modification from natural conditions. Especially intolerant biotamay be reduced in number and extent.	Multiple disturbances associated with the need for socio economic development e.g. dams, diversions, habitat modification and reduced water quality
D	High degree of modification from natural conditions. Intolerant biota unlikely to be present.	Significant and clearly visible disturbances associated with basin and water resources development including dams, diversions, transfers, habitat modifications and water quality degradation.
E	Habitat diversity and availability have declined. A strikingly lower than expects species richness	Only tolerant species remain. Indigenous species can no longer breed. Alien species have invaded the ecosystem.
F	Modifications have reached a critical level and ecosystem has been completely modified with almost total loss of natural habitat and biota. In the worst case, the basic ecosystem functions have been destroyed and changes are irreversible.	This status is not acceptable from the perspective management. Management interventions are necessary to restore flow pattern, river habitats, etc (if still possible/ feasible) to move a river to a higher class.

The scoring system for determining the EMC is currently based upon habitat integrity, vegetation, fish, invertebrates, geo morphology, and water quality[3]. However, e-flows objectives will also depend upon a number of other factors like livelihood support provided by the river in terms of fisheries, riparian farming, drinking water supply, social and cultural importance of the river etc. These issues are not covered in the scoring system for EMC. A study conducted by International water Management Institute (IWMI) did try to devise a prototype scoring system for Indian Rivers, which covers some comprehensive issues. However, the authors themselves have confessed that in the study, "***no indicators relating to the social importance of rivers have been considered in the approach, at present. This is acknowledged as a serious limitation and one that needs to be addressed in future work.***"[4]

[3] King et al (2008) Environmental Flow Assessments for Rivers: Manual for the Building Block Methodology (updated Edition)

[4] Smakhtin et al, 2007, *Developing Procedures for Assessment of Ecological Status of Indian River Basins in the context of Environmental water Requirements*, IWMI

However, the scoring systems for determining EMC do not include social, livelihood and downstream aspects of rivers. These are important issues that should influence the e-flows regime. Communities and CSOs can initiate programs which document the various services and values of their rivers. Such documentation can be put to use in a number of ways, one of them being objectives of setting e-flows.

Civil society organisations and movements against dams and movements for saving rivers need to become involved in the e-flows discourse. In fact, e-flows has become an inevitable component of the decision making process with respect to river valley projects. If a civil society organisation decides to analyse the methodology used for assessing e-flows, understanding the objectives of setting e-flows by the dam proponent becomes very important. Even movements and groups can make their own assessment of the objectives. A few critical aspects which need to be considered while understanding / setting objectives are as follows;

Set objectives within the ecological limits and not hydrological potential

The approach towards utilising / allocating / diverting flows for different needs like dams, water diversions for hydro power and irrigation followed by other uses like industries, urban uses, etc. has been based purely on the hydrological potential and yield of the river. The impact of hydrological alterations on river ecology and dependent livelihoods till the river meets the seas has not been assessed so far. Given the deteriorating status of our rivers and against the backdrop of over utilisation / misuse, the future approach which we should demand for is to give priority to assess the ecological loss that has taken place and then plan for future needs with a realistic objective of sustaining the river and the human needs.

Maximisation Vs. optimisation approach

Rather than extracting maximum out of the river system as is happening now, objective should be to ensure enough water in the river for healthy flows. In this approach we are trying to assess the real life scenario of the river, how it is being presently used, where can capping of water use be done effectively, where can the flows be brought back to the river, where the flows should be undisturbed, etc. This is an optimisation approach.

Participation as a prerequisite in setting objectives related to e flows

Objectives depend upon the current status of the river; what the river is being used for in order of priority, the societal choice about how the river should be managed and the environmental demand of the river (which means if there is a drastic decline in fish species/ diversity in a river or a National Park which would be deprived of water, then that will become an objective for allowing e-flows). Wrong objectives should be opposed from the beginning.Setting the best or optimum objectives would entail the involvement of the riverine communities who have been using the river and who understand the different ecological and social needs fulfilled by the different flow regimes.

Objectives have to be made clear at the planning stage itself

In case of upcoming (cascade of) dams, Terms of Reference of Cumulative Impact Assessment (CIA) study should make the objectives for determining e-flows clear at the outset. In an analysis of CIA studies and Basin studies carried out by dam proponents or EIA agencies in India, it has been routinely found that the EMC set for the riverine stretch

is unacceptably low. For example, in the case of CIA Study of Hydroelectric Dams in Alaknanda and Bhagirathi Basins, the agency Alternate Hydro Energy Center IIT Roorkie has 'assumed' an EMC of C and D for these rivers at various cross sections, especially at the *Prayags* (sites of confluence of two rivers, of very high cultural significance). This has automatically resulted in low e-flows allocation for these stretches. As for the Lohit basin study in the North East, which is an unpolluted, undammed free flowing river with excellent water quality and biodiversity, the e-flows assessment which considers a methodology called "Tennants Method" says: ***"Assume fair and degrading conditions prevail in the basin"*** .It is evident that we cannot 'assume' degrading conditions to prevail in a pristine basin. Any e-flows allocation that occurs through objectives and assumptions like this needs to be challenged. Both these studies have been challenged for their faulty assumptions by Civil Society Organisations like RRC and SANDRP[5]. As a response the CIA Study of upper Ganga has not been accepted by the MoEF.

Making the correct assumptions and setting the right objectives, which reflect not only the ecological class of the river, but also reflect the livelihood, social and cultural dependence and value of a river is a crucial pre requisite before assessing e-flows. Communities and CSOs should make an effort at documenting ecological services and goods of their rivers and ensure that these are considered while setting objectives and devising e-flows methodology, so that the true value of the river as well as important hydrological events (like small floods, particular water levels for particular days and needs, etc.) can be reflected in the e-flows regime that will be worked out .

References

1. Table 1: Environmental Management Classes of rivers for setting eflows objectives: Adapted from Indian Institute of Techology, IIT Roorkee. (2011) Assessment of Cumulative Impacts of Hydroelectric projects in Alaknanda-Bhagirathi basins. Report prepared by AHEC, IIT, Roorkee. Submitted to the Ministry of Environment and Forests, Govt. of India.

2. Tharme (2003) *A global perspective on environmental flow assessment: Emerging trends in the development and application of Environmental flow methodologies for rivers,* River Research and Applications

3. Dyson et al (2003) Flow, The Essentials of Environmental Flows, IUCN

4. King J, Louw D. (1998) *Instream flow assessments for regulated rivers in South Africa using the Building Block Methodology.* Aquatic Ecosystem Health and Management

[5] http://www.sandrp.in/hydropower/Pathetic_Cumulative_Impact_Assessment_of_Ganga_Hydro_projects.pdf, http://sandrp.in/rivers/Lohit_Basin_Study_by_WAPCOS_A_mockery_of_e-flows_and_cumulative_impacts.pdf

Stream 5

How much is environmental flows?

Though seemingly easy, arriving at the amount of water riverine ecosystems and downstream communities need can be a complex task. Part of the problem is that we have modified our rivers so drastically that it is difficult to get an idea of what was the natural flow pattern and regime of the river before human interventions. Many developing countries do not have past records of flows which are to be reinstated. Baseline data about riverine ecology is also not available in South Asian countries, based on which flows can be calculated nor is information about social dependence on a river documented. More complex assessment of the ecological and hydrological linkages is totally lacking. At the same time, river waters have been appropriated so drastically that it is all the more difficult to work out a figure that will be acceptable and realistically implementable to all stakeholders and river managers.

The bottom line is that river performs different functions for different stakeholders and flows need to respond to each of these needs, and that of the ecosystem. A regime based on restoring populations of single fish species like the Salmon or the Sturgeons, like in the United Sates will not be applicable in South Asia as the challenges here are so much more diverse. At the same time, an ecosystem approach which looks at ecosystems, but does not consider the religious and cultural needs which are integral to South Asian countries will also have limitations.

What are river flows?

The flow regime which needs to be maintained in the river in terms of magnitude, frequency, timing, duration including rate of change and predictability of flow events and the sequencing of such conditions. The flow regime also includes inter and intra annual – seasonal – daily flow fluctuations that need to be maintained in the river for its various functions

Methods designed to quantify minimum ‘‘in-stream flows’’ to sustain fish appeared in the United States in the late 1940s. With increasing concern about the impact of dams and flow regulations on river biota, the scientific field of ‘‘environmental flows’’ prospered to produce more than 200 methods that can be grouped into four categories: **hydrological rules, hydraulic rating methods, habitat simulation methods, and holistic methodologies** (Dyson et al. 2003, Tharme 2003).

In a surge of developments over the past decade or so, scientists now recognize that arbitrary ‘‘minimum’’ flows are inadequate—the structure and function of a riverine ecosystem and many adaptations of its biota are dictated by patterns of temporal variation in river flows (the ‘‘natural flow-regime paradigm’’; Richter et al. 1996, Poff et al. 1997, Lytle

and Poff 2004). There is now general agreement among scientists and many managers that to protect freshwater biodiversity and maintain the essential goods and services provided by rivers, we need to **mimic components of natural flow variability**, taking into consideration the magnitude, frequency, timing, duration, rate of change and predictability of flow events. What this means is that a reservoir should be operated in such a manner that there are periods of small and large releases to mimic floods as they occur naturally. See below the table taken from Postel and Richter, 2003 for the different ecosystem functions corresponding to different flow pulses.

However, it is also being accepted that the holistic ecosystem methods of calculating e-flows are time and cost intensive. In South Asian countries, a comprehensive program on e-flows does not exist, all the e-flows prescriptions come at a critical time: either when a dam is being built or when a Public Interest Litigation is filed. In case of the former, in the recent years e-flows have been a part of some Environment Impact Assessment (EIA) Studies. However, looking at the shoddy, extremely short sighted and non participatory nature of EIAs, e-flows prescriptions that have emerged from it are arbitrary and not at all reliable, to say the least.

Nowhere is this arbitrary nature of 'fixing' e-flows more evident than India as revealed from the instances cited below:

1. In the report of the Govt of India's National Commission for Integrated Water Resources Development (1999), a provisional projection of the environmental needs has been given as 5 Billion Cubic Meters (BCM), 10 BCM and 20 BCM for the years 2010, 2025 and 2050, respectively. However, no basis is given for these figures. The report accepts, "Estimation of fresh quantity of water needed for managing ecological standards for all water bodies including lakes and rivers on sustainable basis is not possible at present".

The reluctance or inability of ecologists to provide rapid or precise statements on specific ecological flow requirements for individual rivers often leads to tensions, indecision, and poor decisions (Arthington and Pusey 2003). In an effort to provide immediate advice on flows for river ecosystem protection, some scientists are returning to simple hydrological ''rules of thumb'' that purportedly associate degrees of flow modification with likely ecological outcomes. Recent proposals include those based on percentages of mean or median annual flow (e.g., the ''one-third'' proposal for Australian rivers [Cullen 2001]). Such simplistic guides have no documented empirical basis and the temptation to adopt them represents a grave risk to the future integrity and biodiversity of the world's riverine ecosystems. (Arthington et al 2006, the challenge of providing environmental flow rules to sustain river ecosystems)

2. In recent days, it has been observed that the Expert Appraisal Committee which sanctions river valley and hydropower projects in India has evolved a formula for recommending e-flows. It can be judged from its recent decisions that: "according to the current norm adopted by the EAC, the minimum continuous release from the barrage as environmental flow during the lean season will be 20% of 90% dependable flow. During other seasons, the release is to be higher and during monsoon season, the release is to be 30% of the 90% dependable flow in the 10-daily periods[6]. However, there is no scientific basis for taking

[6] Jelam Tamak Hydro Electric Project in Chamoli District, Uttarakhand. Minutes of the 48th EAC, 26 March 2011

this decision. Such water allocation decisions once made, are nearly impossible to be undone. At the same time, in case of the 300 MW Alaknanda Project on Alaknanda river in Uttarakhand state of India, the same EAC accepted project proponents verison of eflows, disregarding not only an MoEF study, but also EAC's arbitrary thumb rule. The e-flows figure thus arrived is so low that the recommended flood season flow (5 cumecs) is less than even the average lean season flows (6.5 cumecs). [7]

Table 1: **Ecological functions of different river flow levels (after Postel & Richter, 2003)**

Low (base) flows	**Normal level:** • Provide adequate habitat space for aquatic organisms • Maintain suitable water temperatures, dissolved oxygen, and water chemistry • Maintain water table levels in the floodplain and soil moisture for plants • Provide drinking water for terrestrial animals • Keep fish and amphibian eggs suspended • Enable fish to move to feeding and spawning areas • Support hyporheic organisms (those living in saturated sediments) **Drought level:** • Enable recruitment of certain floodplain plants • Purge invasive introduced species from aquatic and riparian communities • Concentrate prey into limited areas to benefit predators
High pulse flows	• Shape physical character of river channel, including pools and riffles • Determine size of stream bed substrates (sand, gravel, and cobble) • Prevent riparian vegetation from encroaching into channel • Restore normal water quality conditions after prolonged low flows, flushing away waste products and pollutants • Aerate eggs in spawning gravels and prevent siltation • Maintain suitable salinity conditions in estuaries
Large floods	• Provide migration and spawning cues for fish • Trigger new phase in life cycle (e.g., in insects) • Enable fish to spawn on floodplain, provide nursery area for juvenile fish • Provide new feeding opportunities for fish and waterfowl • Recharge floodplain water table • Maintain diversity in floodplain forest types through prolonged inundation (different plant species have different tolerances) • Control distribution and abundance of plants on floodplain • Deposit nutrients on floodplain • Maintain balance of species in aquatic and riparian communities • Create sites for recruitment of colonizing plants • Shape physical habitats of floodplain • Deposit gravel and cobbles in spawning areas • Flush organic materials (food) and woody debris (habitat structures) into channel • Purge invasive introduced species from aquatic and riparian communities • Disburse seeds and fruits of riparian plants • Drive lateral movement of river channel, forming new habitats (secondary channels and oxbow lakes) • Provide plant seedlings with prolonged access to soil moisture

[7] Dams, Rivers and People, Jan Feb 2012, *Haggling for environmental flows at EAC meetings*

3. EIA consultants with serious accountability and conflict of interest issues like WAPCOS and AHEC, IIT Roorkie have been prescribing e-flows based on supposed state of the art methodologies like Building Block Methodology (BBM). However, even a quick scrutiny makes it clear that they have not followed BBM at all and have prescribed e-flows using arbitrary, non scientific calculations, which ***"will ultimately contribute to further degradation of river ecosystems"*** (Arthington et al, 2006).

Eflows assessment and recommendation using faulty or inadequate methodologies, in the absence of informed community involvement is a sure way of green washing environmentally and socially damaging projects. Communities and civil society organisations need to have their legitimate space in the decision making about e-flows and need to ensure that the prescribed e-flows respond to their needs and traditional rights.
At the same time, adaptive management should form an integral part of any agreement with the dam builders, with a clear clause that downstream flow allocations are liable to change if community based monitoring of e-flows so suggests. This flexibility is also very important from the climate change point of view.

It would be impossible to discuss all the different methodologies in this primer. Since BBM is being widely accepted as a holistic methodology, the same is discussed in detail.

What is Building Block Methodology (BBM)?

BBM, first developed in South Africa, seems to hold promise for South Asia, as it attempts to integrate a number of aspects and can be tailored according to the local needs. The Expert Appraisal Committee, River Valley and Hydro Electric Power Projects of the MoEF, India has accepted the BBM as a preferred methodology for prescribing e-flows.

At the heart of BBM process is negotiations between various stakeholders and experts about requirement of flows for particular needs. This discussion happens through series of meetings. Riverine Social Assessment is also an important part of the BBM where the dependence of the community on the river is assessed. Community can seek the minutes of these meetings, record their opinions about it and should take an active part in the Social Assessment.

Organisations like WAPCOS in India have been using the name of BBM to further completely unscientific methodologies without giving any thought to downstream local needs. The committees which sanction projects are not always aware of these methodologies and may take the agency by its word if it is claimed that a state of art holistic methodology is used. This is what happened in Lohit Basin, where the agency simply recommended 30%, 25%, 20% and 25% of the average flow for 4 seasons of three months each. A number of organisations, including RRC and SANDRP, wrote to the sanctioning body, in this case the Expert Appraisal Committee of the MoEF. Their stand was

corroborated by WWFs submission to the Ministry about the unscientific BBM being used to greenwash huge water level fluctuations, to the tune of 70-1,729 cumecs every single day in lean season.

Introduction to Building Block Methodology

Building Block Methodology (BBM), was one of the world's first holistic approaches (Tharme 1996), developed by the national community of river scientists in water-resources development from South Africa. The BBM is a methodology – a body of methods that together produces an output greater and more all encompassing than the methods could produce individually.It will be important to note here that BBM was developed in South Africa "Recognising that international approaches to environmental flow assessments did not meet South Africa's needs entirely, development of a local approach was initiated". One of the most powerful innovations of the South African approach has been to attempt to define specific management objectives for each river, and often for different stretches of a river. This approach, incorporating a management goal known as Ecological Management Class (EMC), reflects the national reality that most if not all the country's rivers are modified from a pristine condition. An achievable EMC is thus set for each river, related to its present status and importance.

Community involvement and consultation with biodiversity and wildlife experts is also an essential part while setting the objectives, especially about the Environment Management Class of the River; higher the class, better the e-flows. EMC depends not only on the present condition of the rivers (its ecology, natural processes, etc.) but is also a reflection of how the society wants the river to be like. So this has to be through an open consensus. In the absence of this, the AHEC, IIT-Roorkee study for upper Ganga relegated Ganga to Class C!

BBM is based on the concept that some flows within the complete hydrological regime of a river are more important than others for maintenance of the riverine ecosystem, and that these flows can be identified, and described in terms of their magnitude, duration, timing, and frequency. In combination, these flows constitute the Environmental Flow Regime (EFR)as a river-specific modified flow regime, linked to a predetermined future state of the river. A number of specialists in a workshop situation use hydrological base flow and flood data, including various hydrological indices, cross-section based hydraulic data, and information on the flow-related needs of ecosystem components, to identify specific flow elements for the EFR. The process by which important flows are identified for various components of the riverine ecosystem, such as water quality and riparian vegetation, is documented. These requirements are then built into modified flow regimes for both maintenance and drought conditions. Following the BBM Workshop, further routines allow for linking of the EFRs to current catchment climate and reservoir models, hydrological yield analyses and Scenario Meetings (King & Louw 1998).

The recommended flows are identified and their magnitudes, timing and duration decided upon in a BBM Workshop. Initially, thought is focused on the characteristic features of the natural flow regime of the river. The most important among these are; degree of perennial nature; magnitude of base flows in the dry and wet season; magnitude, timing and duration of floods in the wet season; and small pulses of higher flow or freshes that occur in the drier

months. Attention is then given to which flow features are considered most important for maintaining or achieving the desired future condition of the river, and thus should not be eradicated during development of the river's water resources. The described parts of each flow component are considered the building blocks that create the EFR, each being included because it is understood to perform a required ecological or geo morphological function. The first building block, or low flow (baseflow) component, defines the required perenniality or non-perenniality of the river, as well as the timing of wet and dry seasons. Subsequent building blocks add essential higher flows. The important steps in the BBM process are given as Annexure I.

Use of e-flows methodologies in South Asia

Bangladesh is a lower riparian country in South Asia and flows in trans-boundary rivers depend upon upstream releases, mainly from India. The concept of environmental flow is new in Bangladesh. In the water resource management planning and practices, the term "e-flows" has not been used yet. Very few studies on e-flows have been attempted in Bangladesh. IUCN Bangladesh in collaboration with the Department of Environment (DOE) implemented a project titled 'Minimum Environmental Flow Requirement for the Ecosystem'. Under this project, a protocol for assessing the environmental flow requirement was developed with an aim to sensitize the water planning organizations at large, and Local Government's Engineering Department (LGED) responsible for constructing small scale water structures in particular, regarding the e-flows and environmental considerations during water structure designing. The protocol was developed and tested on small scale irrigation dams in the coastal areas. Three rubber dam projects were primarily selected for assessment of flow required for fish movement at specified time during the dry season. These three rubber dams were constructed to irrigate boro rice in dry season. Bakkhali dam conserves about 80 million m^3 (based on25% dependable flow) while the average volume of water lifted from the Bakkhali River for irrigation during the dry season is about 14.9 million m^3. Flow release requirement was assessed for Golda and Hilsa fishspecies. To meet the criteria for fish movement, a minimum of 15.6 and 45.2 million m^3 of water is to be released for Golda and Hilsa, respectively.

Under its Living Ganga Program, WWF India has tried to assess the e-flows required for the Upper Ganga segment of 800 km from Rishikesh to Kanpur. Lasting for three years, the process consisted of 5 BBM meetings in addition to several meetings of the experts and also field visits. Experts and organisations involved in fluvial geomorphology, water quality, hydraulics, hydrology, facilitation, biodiversity, cultural-spiritual and livelihoods were part of the team.

The river was divided into four zones and e-flows were recommended for each zone, based on maintenance, high and low flows. E-flows recommended range from 72% of the Mean Annual Runoff (MAR) for Zone 2 to 47% of the MAR to Zone 3. The report has stated that e-flows could not be calculated for Zone 1 because data from the Tehri Dam was not accessible. At the same time the report is silent on the massive hydropower development that is going on in the Upper stretches of Ganga in Uttarakhand. With more than 135 dams

in different stages of planning to implementation, the flow regime of the region is bound to change entirely.

Responding to e-flows methodology

According to LeRoy Poff, "any methodology that you pick from the state of art choices is a good one. ***The important point is not the methodology, but its implementation.***"

Community based organisations are advised not to spend too much of their precious time and resources in trying to understand a methodology entirely. This is the realm of the e-flows experts. However, what the communities should ensure is whether the adopted methodology integrates and responds to local challenges and if their view points on how a river should flow or not flow is considered in the objective setting, assessment and implementation.

The important points to be considered while assessing a pre selected methodology or suggesting a new one are;

1. Was the community/community representatives/CBOs a part of discussions while selecting the methodology and actually deciding e-flows through the methodology? If not, this is a strong reason to demand for community involvement at this stage.

2. Does it try to mimic the natural hydrograph or does it only deal with bulk figures for a year or two seasons? There should be 3 or 4 different e-flows figures for the 3 or 4 different seasons. There should be stipulations for releasing additional water to create flood like situations depending upon the ecosystem and livelihood needs .

3. Does it respond to community needs like water for cultural and religious needs, water for transport, for riparian farming and drinking water needs (subsistence farming, not large scale irrigation).

4. Does it include a multidisciplinary team of experts not limited to government and dam proponents?

5. Does it provide a legitimate space for communities also in the objective setting (how the community views the river) and implementation and monitoring stage?

6. Does it have a clear mandate of adaptive management, through which e-flow regimes can change in face of changes in flow regimes over years, downstream monitoring and changes in climate?

Finally we also have to keep in mind that any methodology is only as good as it is interpreted and implemented.

Hence,

- An unbiased external agency which has requisite skills to implement and monitor the selected methodology,

- Which is genuinely concerned about downstream impacts and
- Which will not be pressurised in favour of the project proponent

is an important pre requisite of this process. Advocating for such institutions or network of institutions and their democratic functioning is central for efficient and effective water management as well as for effective e-flows implementation.

References

1. Dyson, et.al. 2003. Flow. The Essentials of Environmental Flows, IUCN

2. Tharme , 2003. A global perspective on environmental flow assessment: Emerging trends in the development and application of Environmental flow methodologies for rivers, River Research and Applications

3. Poff, N.L., J.D. Allan, M. B. Bain, J.R. Karr, K.L. Prestegaard, B. Richter, R. Sparks, and J. Stromberg. 1997. The natural flow regime: a new paradigm for riverine conservation and restoration. Bioscience

4. Lytle, D.A., and N.L. Poff. 2004. Adaptation to natural flow regimes. Trends in Ecology & Evolution

Stream 6

Implementation challenges to overcome

Setting objectives and assessment of e-flows can be a major challenge. However, implementing e-flows within a river basin with all its complexities and diverse human pressures and self interests poses a tougher challenge to the governments. Groups working against dams and for saving rivers should understand that e-flows is indeed a complex concept and thus needs to be simplified. E-flows also need to be understood and implementation strategies arrived at within the specific context of the river basin.

If we fail to simplify e-flows concept, it would be difficult for the directly affected communities and the implementers to understand the benefits of restoring flows to the society and to the river with a futuristic perspective. Moreover, for the proper involvement of all the different user / river dependent communities like panchayats, power companies, State Power Boards, Irrigation departments, industries, tourism sector, etc. in the implementation process, facilitation, proper channel of communication, dialogues and negotiation would be required. Whilst simplification is important to assist decision-makers, the principle objective of e-flows in the EFA should be to present clear information about the decisions and trade-offs necessary within the river system for the appropriate environmental flow regime (IUCN).

While discussing about the context, the first question that needs to be tackled would be; what are the priority needs for implementing e-flows among the several problems faced by a river basin? Is e-flows being demanded due to the severe flow regulation and over allocation due to dams and diversions? For instance Krishna, Cauvery, Periyar, Chalakudy, Brahmaputra basins would fall into this context. Is the demand for implementation due to severe pollution to improve water quality through enhancing flows, as in the Yamuna River? Or is it a combination of many equally pressing issues? The socio – political setting within the river basin can also become a decisive factor. There is a need to take these into consideration while planning for implementation.

Current status of e-flows implementation in South Asia

Research and practice in environmental flow assessments is happening within a number of Asia's developed and developing countries including Indonesia, Japan, Korea, Nepal, Pakistan, Sri Lanka and Taiwan. Another six countries, namely Cambodia, China, India, Lao PDR, Thailand and Viet Nam, have expressed interest and are in the early stages of undertaking environmental flow assessments (Tharme 2003, Tharme and Smakhtin, 2003). In leading countries in e-flows in the Asia-Pacific region of Australia, Japan and New Zealand the approach is integrated and implemented into local, regional and state planning processes, and also reflected in national legislation and policies. The Northeast Asian countries of China and Korea, the South Asian countries of India, Nepal and Pakistan, and Southeast Asian countries of Cambodia, Lao PDR, Thailand, and Vietnam have also

adopted the approach and in some cases, may include e-flows in national legislation and policies (IUCN).

Though e-flows implementation is yet to take off in Bangladesh, negotiation with the farmers at the field level and policy and planning level has been identified as the key challenge to establish environmental flows in Bangladesh. E-flows or the 'share of the river' can become a major bone of contention when it comes to allocation of waters (in longstanding dispute) of trans-boundary rivers as in the case of sharing of Teesta waters between India and Bangladesh. As of now, 20 % of the actual flow has been allocated as the share of the river which should not be used by either of the countries. The agreement is yet to be signed and implemented.

Nepal is an upstream catchment nation for many Himalayan trans-boundary rivers like Kosi, Seti, etc. Water supply, irrigation and hydropower projects that came after enforcement of EIA guidelines 1993 have mostly gone through full scale EIA process. For instance, the operation of the proposed 750 MW West Seti Hydro Electric Project will stop water flowing downstream of the dam in the Seti River, except in time of flood. A Re-regulation (attenuation) weir is proposed 6 km downstream of the tailrace outlet. Without the deliberate release of water from the dam to provide adequate water for biophysical and social needs, the Seti River will cease to flow for 19.2 km section of the river between the dam and the tailrace outlet. To maintain the ecosystem functions, a base environmental flow of4 m^3/sec has been recommended to be released from the reservoir.

A number of factors can trigger off and lead to adoption and implementation of e-flows. These may include pressure from grass root communities to improve the flows, political support to the idea due to strong community interest or pressure, a river basin that is critically degraded due to over-allocation or over development, projects that were donor driven or instigated by a river basin organization where e-flows implementation becomes mandatory, etc. E-flows adoption and implementation has been particularly strong where national legislation and policies placed e-flows as a priority within an Integrated Water Resources Management (IWRM) framework and was also integrated into natural resource management plans at the catchment scale.

What are the challenges in e-flows implementation in South Asia?

Implementation is a case to case process whereby what works in one river basin cannot be set as a standard to be uniformly applied in the diverse river systems in the South Asian region. As is evident, e-flows implementation is still at a primal stage in the South Asian countries. However, there are certain basic challenges that would be common for all situations. Some of the important challenges to be addressed in the South Asian context are briefly discussed below.

Ecologically and hydrologically different river systems : We have primarily the larger trans-boundary Himalayan snow melt rivers like the Ganga, Brahmaputra, Indus, the Peninsular and Deccan Indian rivers like Krishna, Godavari, Narmada and the short west flowing rivers in the Western Ghats like the Sharavati, Periyar, etc. The flow pattern in these diverse river systems is different. For instance, the Himalayan Rivers have larger flows during summer when the snow melts. Meanwhile, the short west flowing Western

Ghats Rivers have torrential flows during monsoon and lean flows during the summer. The challenge is to arrive at flow regimes based on the climatic, hydrological and ecological peculiarities of a river basin instead of a uniform standard flow regime.

Direct Dependence on rivers is very high: The population dependence on South Asian river systems is much higher than the European or American rivers. Flowing Rivers and related ecosystems serve as the direct source of drinking water, fisheries, farming for a significant section of the population in South Asia. For instance, the rich river islands and flood plains created by the flows of Brahmaputra, the fertile Thanjavur rice delta created by the Cauvery River in South India are indispensable for lakhs of farmers and fisher folk in these regions. The challenge is therefore to integrate the diverse concerns and flow requirements through a dialogue based – negotiation process backed by studies and expert validation.

Lack of valid and reliable hydrological data base: Reliable hydrological data base is a prerequisite for arriving at a fairly good estimation of the water to be left for the river to perform its ecological and evolutionary functions. We are handicapped by the lack of valid hydrological data base in most of the rivers in South Asia. Most of the dam projects are designed based on flawed or manipulated hydrological data base. In many cases the data base used for conducting the EIA is different from that used for techno economic clearance! Another handicap is related to the lack of reliable hydrological data base on the pre dam status of the river basin. River and rain gauges, the elementary instruments needed for estimation are either not installed or even if installed not calibrated properly, or simply non functional. The challenge would be to engage with the long drawn process of gathering as much ecological and hydrological data for each basin, both pre and post interventions, make the data accessible to the public and make best use of the same to arrive at the optimum flow regime to be left in the river.

Political priorities: Allowing water for the environment is also a political decision or choice in South Asia rather than a purely eco – hydro allocation. The priorities of the ruling political party from local to national to trans national often decide how much flows should be allocated or left in the river for what use. The long pending Teesta Agreement between India and Bangladesh over sharing of Teesta waters and allowing flows into downstream Bangladesh still remains an unresolved issue due to the differing political priorities. Inspite of allocating 10 TMC ft of water for minimum flows under the Cauvery Tribunal Award, the releases are yet to materialise due to political reasons.

Ecological data base deficient: Equally significant is the lack of data on the impact of flow fluctuations or complete flow diversions created by dams on the river ecology. Data base on the number and distribution of different aquatic species maybe there. However, how these species and their habitats including feeding and breeding are impacted by the alteration of flows is not assessed, which more important while is taking decisions for allowing more flows into a dammed river. This means that it is not known how different ecosystem components in different geographical settings react to changes of flow caused by water resources or land development. The impacts of reducing / increasing high, medium or low

flows on fish, invertebrates, riparian vegetation, or sediment regime (which is one determinant of aquatic habitat) are not quantified (Smatkin, V. et.al., 2007).

E-flows in the context of Project level impacts vs river basin level impacts: Cascades of dam projects are being planned across many of our rivers. River basin level EIAs with carrying capacity studies and e-flows assessment inbuilt into them have been demanded by the movements fighting against dams in the Western Himalayas and the North East, especially in the Sutlej, Alaknanda, Lohit sub basins. However, the cumulative impact assessment studies carried out are still inadequate in terms of assessing the river basin level impacts for setting e-flows. The CIAs are ending up as cumulation of project level EIAs in place of river basin level EIAs. In the context of dam cascades being planned across a river, e-flows implementation needs to be addressed beyond a project to a basin level taking into consideration the cumulative impact on flows including between the dams.

Lack of awareness about flows – ecology – community linkages: River basin communities have been living off the natural high and low flows of their river for centuries. These dependencies have been based on innate organic relationships and local wisdom about the river and its flows in place of science or statistics. The technocrats and engineers who take the decision on dams and flows to be left in the river rely purely on data base and allocate percentages of e-flows. There is a total lack of understanding on the organic links between the flows – flow dependent aquatic life and river ecology and community dependencies.

What should be the norms for modified river basins: In those basins where the allocations have already been made/ where dams have already modified the flows, how do we address and implement e-flows? Options like reservoir re-operations, river basin approach to e-flows implementation, capping of use, reuse – recharge, etc. can be recommended. In fact reservoir re-operation is being tried out to improve downstream flows in the Chlakudy river, a heavily dammed small Western Ghats river in Kerala.

Institutional and policy challenges: Apart from the Power departments / companies controlling and regulating the river flows there are various other agencies like the irrigation department, the water authorities / Jal Boards, industries, tourism, etc. which impact the flows. Presently, there is a total disconnect between these different agencies and/or departments managing and using the same river flows. We have a techno – bureaucratic system across South Asia that fails to see the link between continued availability of good quality water and ecosystem health and integrity. Hence, the toughest challenge would be to overcome this barrier of departmentalism. Each user should relate to their contribution towards degradation of the ecosystem, based on which an inbuilt mechanism to ensure e-flows is to be evolved.

E-flows in South Asia are still at a conceptual stage. Though allocations are being made in EIA documents, the methodologies are yet to be finalised or tested. Even the National Water policies do not give ecosystem needs the priority it rightly deserves, except for a few state water policies like Punjab and Odisha in India. Hence, we face the very tough

challenge of evolving suitable policies, legal instruments and institutional framework that will support and enable smooth implementation of e-flows.

Who should be involved in the implementation of e-flows?

As cited above, implementation of environmental flows is not an easy process. Working towards implementing e-flows is a time consuming and long drawn negotiation process. However, it has become inevitable given the very bad shape our rivers are in. Presently, e-flows assessment in the South Asian countries is based more on the available hydrological data base and less on the ecological parameters or socio – economic needs of the communities dependent on the river.

Given the lack of data and other challenges as outlined above, what would work best in South Asian context would be to use a combination of science and community wisdom to arrive at e-flows. Planning, designing and allocation of flows have to be a participatory process. The different roles to be taken by the different stakeholders would be;

Governments at national and sub national levels will have to evolve either new policy frameworks or strengthen existing policies that will recognise that nature / river is also a 'legitimate user of water' and only if water is left for nature can human needs be fulfilled. The policy framework would have to be supported by enabling legal instruments that will facilitate implementation of e-flows, regulate water abstraction, diversion and pollution.

As for trans-boundary rivers like the Teesta, Ganga, Brahmaputra, etc., it is important to look at the river and recognise the role of the river beyond boundaries, how the building of dams or over abstraction by the upper riparian nation would impact the downstream nation's needs and what could be the common minimum points of agreement for sharing water and allowing the river to flow down to the sea. Out of the different needs that need to be taken care of by e-flows, ecosystem and / or cultural needs could be the commonly shared need for allowing / allocating e-flows in the South Asia region.

Research institutions and river experts have the role of assisting the governments in arriving at the optimum flows including trade offs, incentives and alternatives. For instance, one option that could be thought of is incentives to a polluting industry for cleaning up the river and carrying out rain water harvesting and recharge measures to reduce dependence on the river.

Direct river dependent communities have to be consulted by the researchers and experts to learn from their wisdom and integrate their experiences while setting flows. For instance, the flows required for migration of fish upstream for spawning, flows that will enable flood plain rice farming (as in the Krishna and Godavari deltas).

Voluntary organisations / NGOs/ community based organisations may need to play the role of a catalyst or even a mediator in the overall implementation process. Conflicts are bound to arise while setting flows since it may involve compromises in one's enjoyed share of water. Reservoir re-operations would involve convincing dam operators about the

economic benefits of reducing the daily flow fluctuations on downstream farming. Farmers would have to be convinced about the need for 'more crops with less drop of water from the irrigation project'. Different political parties need to be convinced about the direct economic and social benefits of allowing e-flows.

Reservoir operations management as a strategy to release more flows downstream in Chalakudy river basin, Western Ghats

Riverine communities and their allies have been able to stall a seventh large dam – the 163 MW Athirappilly HEP – proposed in Chalakudy River, a small 144 km Western Ghats river. The river would have experienced a daily flow fluctuation of 1:17 if the dam were constructed. However, the groups working in the basin found that the river already experiences a daily flow fluctuation of 1:4 due to the changes in the reservoir operations of the existing Poringalkuthu HEP from base to peak load since the late 1990s. Twenty years daily discharge from the operating HEPs was collected and analysed.

A reservoir operations strategy that would improve the summer flows by changing the ratio of monsoon: non – monsoon discharge to about 34: 66 from the existing 43: 57 is proposed. Operation of the Poringalkuthu is proposed to be reverted back to base load from the present peak load. Making use of the storage space at Poringalkuthu for summer needs, by keeping the water level in the reservoir at nearly FRL up to the end of January and using only inflows for power generation in December and January is also proposed. These steps will ensure a steady water availability of about 1.5MCM per day at a rate of just above $17m^3$/sec to meet downstream requirements including that of a major irrigation project (MIP).

- A minimum release of not less than $2m^3$/sec suggested to be released to the main river from below the MIP and this is expected to be increased gradually
- The peak power generation from the basin will show a slight reduction of 8 – 16 MW, but the total generation as well as summer generation are bound to increase.

The local self governments in the river basin, the concerned departments, local organizations, members of parliament and legislative assembly have been apprised of the strategy, their consensus obtained. The river basin organization is working out an implementation strategy of the Reservoir Operations Management (ROM) through local institutional mechanisms and up-scaling them to the river basin level. Guiding principles for ROM relevant for other river basins is also being worked out (Latha.A et.al. 2012)

References

1. Tharme, R. 2003 A global perspectives on environmental flow assessment:Emerging trends in the development and application of environmental flowmethodologies for rivers. River Research and Applications, 19:397-442.

2. Tharme, R. and Smakhtin, V. 2003 Environmental Flow Assessment in Asia:Capitalizing on Existing Momentum. Proceedings of the First Southeast AsiaWater Forum, 17-21 November 2003, Chiang Mai, Thailand.

3. IUCN. Review of the Status and Use of E-flows Approach in the Asia – Pacific Region.

4. Smakthin, V. et al, 2007, 'Developing procedures for assessing ecological status of Indian river basins in the context of environmental water requirements', Research Report no. 114, IWMI.

5. Latha.A., S.P.Ravi and Rajneesh,P. 2012. Linking Lives, Reviving Flows. Towards Resolving Upstream Downstream Conflicts in Chalakudy River Basin : Action Research Report , Pune : Forum for Policy Dialogue on Water Conflicts in India

Stream 7

Monitoring e-flows

Once implementation of environmental flows is put into place, the next most important step would be to ensure that the flow regime decided upon is maintained. Monitoring mechanisms, while assisting in controlling river flows also helps to demonstrate the contribution of e-flows towards enhancing the ecological, economic and social benefits of improved flow regime.

While monitoring of e-flows in developed countries is geared more towards supervising the benefits of e-flows releases on ecosystems and ecosystem services, unfortunately in South Asia, monitoring is a much basic issue, which implies checking whether the prescribed e-flows are actually being released or not! And even that is at a nascent stage. Experience from across the globe reveals that in order to actually have e-flows in our rivers, perhaps the most crucial aspect is monitoring of the agreed releases. Communities can be an asset in such assessments who indeed have the first right to monitor the health of the rivers they depend upon. Unfortunately, most often they do not have any role to play in this. In the absence of these checks and balances, the project proponents get away with not releasing e-flows.

In India, e-flows are being assessed under the Cumulative Impact Assessments as mentioned in earlier sections. For example, when the Ministry of Environment and Forest, Government of India was approached under the Right to Information Act as to who will ensure that hydropower developers release minimum water flows in the downstream areas, the ministry replied that the developer itself will ensure that! But why should the developer bother about this when such releases would reduce the power generation of its project at least in 9 lean season months (SANDRP, Dams, Rivers and People Feb 2011)? The overall record of agencies like MoEF when it comes to monitoring compliances of environmental clearance conditions is so bad that communities and stakeholders will have to be a part of monitoring, if results are to be seen.

To cite another instance, the one member High Power Committee, of Avay Shukla, Additional Chief Secretary Forests constituted by the Himachal Pradesh High Court visited and monitored various environmental compliance issues of 11 hydropower dams (only those under construction) above 100 MW in the Himalayan State of Himachal Pradesh. It should be noted here that Himachal Pradesh is currently constructing more than 30 large hydropower dams on Sutlej River itself, with many more coming up on major rivers Ravi, Chenab and Beas. Hundreds of mini and micro hydel projects are planned on the tributaries. These tributaries are the lifelines of the communities as they depend on these for water supply, irrigation and operating water mills or *gharats*. Himachal Pradesh is perhaps the only state in India which has a High Court Directive in place for all dams to release 15% of the mean flow of the respective rivers downstream at all times as minimum flows. What this committee noticed, not surprisingly, NONE of the 11 dams release the meagre 15% of flow for the downstream. This situation only highlights the fact that just putting e-flows releases

in conditions of sanction of reservoirs would not serve the purpose. Effective monitoring mechanisms are a pre requisite to ensure timely releases of even minimum flows leave alone e-flows.

It is indeed ironical to see that the section of society which faces nearly all the consequences of dam building and irresponsible attitude towards allocating e- flows, has no part to play in the monitoring mechanism which ensures that e-flows are being released. Even small hydro power dams in the Himalayan States of Himachal Pradesh and Uttarakhand have diverted flows of entire *khads* or smaller tributaries of rivers through tunnels, diverting all the irrigation and drinking water required by the communities. In case of Gaj II Hydro electric project by a private company in Kangra, Himachal Pradesh, standing wheat crop of the community was left high and dry as water was tunnelled and diverted. Dead fish in the dry riverbed stand testimony to the reality of e-flows allocation. Responses to a series of RTI applications filed by Himdhara to the agricultural department of Himachal Pradesh has revealed that in villages located in the area affected by the Karchham Wangtoo project, by 2009 almost 43 out of 167, ie almost 26% of water sources, had dried up and in 67 sources, almost 40%, the discharge had reduced. Similar data has been provided for four other project sites in different parts of the state – all revealing that villages located not just along the tributaries, but even above the tunnels of hydel projects are being impacted severely.

In the case of larger rivers flowing through cities too, agencies are showing absolute lack of interest in allocating e-flows. For example, the first mandate of the High Powered Committee constituted in January 1998 following the Supreme Court order in WP 537/1992 was: “To assess the requirement of minimum flow in the river Yamuna to facilitate restoration of the desired river water quality”. However, the HPC has never fulfilled this mandate. There has been no assessment about the requirement of minimum flows in the river Yamuna as per that mandate. The HPC just assumed that 10 cumecs (cubic meters per second) water is sufficient for Yamuna. The Central Water Commission itself has agreed in a subsequent meeting that this figure of 10 cumecs flow is not based on any assessment, but an ad hoc assumption, which is on a much lower side.

The following aspects need to be ensured in effective e-flows implementation, whether it is part of environmental compliance mechanism or part of a river basin management process.

1. There should be access to information on the e-flows releases from the upstream reservoirs to all the concerned riverine communities and monitoring committees.

2. Effective community monitoring can be ensured only if atleast the most directly affected riverine communities are involved in all the different steps from objective setting, implementation to monitoring.

3. A monitoring committee should be instituted for each dam which includes community representatives, independent experts, local voluntary organisations, government officials responsible for monitoring and dam operators and authorities. These should visit the dam site when the actual releases are being made ideally every month, or at least once in three months, when releases may change. They should certify that the agreed releases are actually being delivered. It should be noted that e-flows is not a static but a dynamic process. Hence there is a need for periodic review of the data and e-flows release patterns.

4. Size of the monitoring committee and the community representation would depend upon the installed capacity of the project, the type of operation of the project (peaking or base load in the case of hydropower projects) and the extent of downstream impacts which in turn would determine the distance upto which monitoring would have to be carried out. In the case of interstate rivers, monitoring committees would have to be formed for each downstream state till the point where impacts are being felt. They should represent sections like riparian farmers, fishermen, urban population, students, naturalists, etc. depending upon who can perform the role the best.

5. Simple measures like poles with level markings and corresponding months should be set up on river banks, bridges or river beds to indicate the approximate level from where to where the water should reach when releases of a specific quantum are made. This will not only help in monitoring e-flows, but can also be an effective safety measure in case of peaking projects.

6. The monitoring team should look into the hydrological data (historical series, discharges from reservoirs atleast once every month), changes in hydraulic features (river depth, vegetation, bank erosion, sand deposits, etc.) environmental outcomes (improvement / changes in aquatic ecosystems, riparian ecosystems, environmental services like water quality improvement, improvement in wild life habitats) social outcomes (increase in fish catch, safe drinking water) satisfaction of cultural needs, etc. depending upon the river basin.

7. There should be clear roles and responsibilities about flow releases and if the monitoring committee reports that required e-flows are not being released, there should be accountability measures put into place to penalise the concerned officials and or dam companies.

8. The results of the monitoring should be communicated back to all concerned within the river basin on a timely/ seasonal basis. In Australia, the Queensland Government has a unique system of issuing report cards on monitoring to the communities. These are based on ecosystem health indicators developed for the river basin.

9. Though this primer is focussed on e-flows related to dams, pollution from various sources and water abstraction for drinking water also affect the quality and quantity of flows. Hence, in the long run it is very important to list the number of human uses that affect the flows and arrive at the appropriate flows based on the various interventions. E-flows may have to be arrived at with respect to each of these uses and releases planned, implemented and monitored within a river basin management framework.

10. If possible, take atleast one or two dammed rivers as a test case and put into place a rigorous ecosystem health monitoring program for both pre and post dam scenario. This can be carried out with the involvement of the riverine communities to exclusively monitor the ecosystem changes due to e-flows implementation taking more number of parameters.

Dam developers, governments and stakeholders need to understand that the environmental consequences of hydropower dam development and operations cannot be predicted with complete certainty. To be ecologically and socially sustainable, water and energy development and management need to be perpetually informed by monitoring, carefully targeted data collection and research, and further analysis to address new uncertainties or surprises. Therefore, a program of monitoring, evaluation, and adjustment—commonly referred to as *adaptive management*—should be fully and explicitly integrated into a river whose flows have been altered by development or a re-operation plan so that management approaches can be continually modified in response to increased understanding or changes in human or ecosystem conditions.

Stream 8

Enabling instruments for e-flows

'Ecology does not influence governance and links between human well being and ecosystem well being are not acknowledged'

It is easy to state that once implementation and monitoring mechanisms are put into place proper allocation of e-flows can happen. However, in real life, things seldom materialize the way we envisage. The system of water and river governance followed in South Asia or the lack of it pose several hurdles in effective implementation of e-flows. The most critical one is the lack of policy components or legal instruments which can enable e-flows implementation to become mandatory on part of the water managers – technocrats and governments. Most important is the lack of political willpower to usher longstanding reforms in the system of governance.

All the South Asian countries have either National Water policies in place or are moving towards comprehensive framework laws on water. The National Water Policy (draft) document of Pakistan takes note of the necessity of e-flows for the Lower Indus delta in no ambiguous terms. However, the adoption and implementation of e-flows appears to be occurring slowly[8]. The Draft National Water Policy (NWP) for India; Section 1.3 (vii) merely says that "ecological needs should be given due consideration". However it is high time that ecological needs should be given equal priority with drinking water needs in the Indian context. The Draft NWP also states that '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'. It will ultimately depend upon how these policy statements get translated into law or get included within an e-flows setting framework.

Let us discuss in brief on the enabling elements in the NWP in Bangladesh. The NWP of Bangladesh recognizes that "water is essential for human survival, socio-economic development of the country and preservation of its natural environment" and "there is a growing need for providing total water quality management, and maintenance of the eco-system". Issues of the natural environment and water related impacts on fisheries are major concerns of the National Water Management Plan (NWMP) under the NWP. The shift in focus is evident from the NWP recommendation that rules for water allocation will be developed for in-stream needs (ecological, water quality, salinity control, fisheries and navigation) during low-flow periods; for off-stream withdrawal (irrigation, municipal and industrial, power), and for groundwater recharge and abstraction. Allocation for non-consumptive use (e.g. navigation) would imply ensuring minimum levels in water bodies used for that purpose.

The NWP also recognizes fisheries and wildlife as integral aspects of economic development and puts emphasis that availability of water for fisheries is important for sustenance as well as commercial ventures. It recommends the following measures:

[8] IUCN Report: Review of e-flows status and use in the Asia Pacific

a. Fisheries and wildlife will receive due emphasis in water resource planning in areas where their social impact is high.

b. Measures will be taken to minimise disruption to the natural aquatic and water channels.

c. Drainage schemes, to the extent possible, will avoid state-owned swamps and marshes that have primary value for waterfowl or other wildlife.

d. Water bodies like baors, haors, beels, road side burrow pits, etc. will, as far as possible, be reserved for fish production and development. Perennial links of the water with the rivers will also be properly maintained.

e. Water development plans will not interrupt fish movement and will make adequate provisions in control structures for allowing fish migration and breeding[9].

The above set of recommendation under the NWP, resonates the concept of e-flows. However it is recognized that changing the mindset of planners, negotiating with them, as well as with the users would be a huge challenge. Taking cue from the road map suggested by IUCN, inputs to strengthen effective e-flows implementation from a policy – legal perspective are placed before the river activists, planners and policy makers. The below points can serve as a summing up of the previous seven sections to a large extent.

1. Raising awareness and capacity building among the diverse users, direct river dependent communities and departments on the need and significance of e-flows. Aiming at a fundamental change in the mindset to view a river system from an ecosystem perspective. It is very important to relate e-flows as an ecosystem need with economic gains. ***In the long run it would become imperative to introduce 'ecosystem as a legitimate user of water' within a policy and legal framework.***

2. Good data base on the water level / flows required for different uses and species is lacking in South Asia. Hence, time and resources for the development of a scientific basis based on rigorous methodology for assessment of e-flows – flow requirements for different species, for competing uses, tradeoffs required for flow requirement among different species and water uses etc is the need of the hour. ***Make it legally mandatory to provide correct data base on hydrology and ecology to the different river communities and make the agencies accountable for the accuracy of the data base so as to make the process transparent and accountable.***

3. Monitoring the effect of e-flows releases on the health of the river ecosystem. IUCN outlines three important aspects that need to be monitored; 1) the river flow in relation to baseline conditions, short term to assess whether day-to-day or seasonal variations in flow are achieved and long term to determine the year-to-year variability of flows, 2) the response of the eco-system in order to assess whether the

[9] IUCN report E-flows synthesis and roadmap for Bangladesh

ecological objectives are being achieved. This could require long term monitoring since the eco-system may adapt slowly to any change in flow. Although monitoring is often focused on key indicator species, it should cover as many elements of the eco-system as possible to capture any unforeseen changes, and 3) the social response to ecosystem change: to identify where and to what degree communities rely for their livelihoods on fish or other related resources.

4. ***Legally enforce the determination of the first user right of the river over its waters before any planning or design of new structures or intervention.*** All the South Asian countries sharing the Himalayas are in the race to build as many dams across the rivers flowing through their territories. Hundreds of dams are in the pipeline without giving any regard to the need or right of the river to flow. Rivers would flow through tunnels instead of the natural river channel for hundreds of kilometers if all the proposed dams get commissioned. There are absolutely no scientific and common sense based criteria to even assess the optimum distance between two dams to allow breathing space for the river leave alone e-flows. The Ministry of Environment and Forests in India is in fact seeking suggestions from civil society groups and river experts on this. Hence it becomes a necessity to legally put in place the 'water to be left for nature' even before the planning and design stage. In other words first determine the flows and then plan. Once user rights get established over a power project or irrigation scheme, it becomes difficult to step in.

5. ***Make participation of all concerned users including directly river dependent communities in the assessment, planning, implementation and monitoring of e-flows legally mandatory.*** As already discussed in the previous sections, e-flows are arrived at and decided upon in the Basin or Cumulative Impact Assessment studies without consulting the affected communities (e.g. Lower Demwe Project in the Brahmaputra basin). Arriving at e-flows needs a multi stakeholder dialogue based negotiation process. Based on the health of the river basin, if the communities decide that the river cannot take in more dams, it should have legal standing.

6. ***Take the enabling components from existing legal and policy instruments for integrating into smooth implementation of e-flows.*** For instance, in Nepal, as per the National Water Strategy (NWS) 2002, principles related to sustainable water resource development include setting priorities for conservation of biodiversity, endemic, rare and endangered species and wetlands habitat. It also highlights the need for justifying environmental acceptance and to minimize wetland ecosystem destruction while developing water resources. The Hydro Power Development Policy, 2001 of Nepal intends to generate electricity at low cost by utilizing available water resources. It has also highlighted un-interrupted water release, which is higher, either of ten percent of the minimum monthly average discharge or minimum required quantum as identified in EIA report. The policy also provisions for protection of lower riparian water use rights or availability of water through developing legislative measures applicable to projects for which license is not required or being operated after obtaining the license (Ministry of Water Resources (MOWR), 2001). The Irrigation Policy 2003 is very particular in releasing minimum

flows to avoid adverse effects on downstream biological diversity. It also asks appropriate measures to protect ground water resources from over abstraction (MOWR, 2003)[10]. A detailed analysis of the existing legal framework for protecting flows taking India as an example is presented below

****

Existing Legal Framework and Court directions for protecting flows in India: Need for strengthening

That India and other South Asian countries should have a strong law for ensuring e-flows in rivers is an indisputable fact. Though most of the South Asian countries have various policies, laws and acts which can be used effectively, the reason for not translating into effective e-flows implementation largely lies somewhere else.

Article 51A (g) of Indian Constitution imposes obligation on State and individual to protect and improve environment and to have compassion to the living creatures. Acts like **The Water (Prevention and Control of Pollution) Act, 1974, The Wild Life (Protection) Act, 1972, The Forest Conservation Act, 1980 and the powerful Environment Protection Act, 1986 can be used effectively to demand for e-flows in the river.**

The Wildlife Protection Act (1972): Section 35(6) – "No person shall destroy, exploit or remove any Wild Life including forest produce from a National Park or destroy or damage or divert the habitat of any wild animal by any act whatsoever or divert, stop or enhance the flow of water into or outside the National Park, except under and in accordance with a permit granted by the Chief Wild Life Warden, and no such permit shall be granted unless the State Government being satisfied in consultation with the National Board that such removal of wild life from the National Park or the change in the flow of water into or outside the National Park is necessary for the improvement and better management of wild life therein, authorises the issue of such permit."

In a welcome decision in February 2008, the proposal for clearance for survey for the Chambal Development Scheme involving four hydropower projects on Chambal River in Rajasthan was rejected by the Standing Committee of National Board for Wild Life (NBWL). However, the same NBWL could not use the same Act to save Chambal from water diversion to Dholpur Thermal Power Plant when all studies, including one by Wildlife Institute of India, said that any more diversion of water from the National Chambal Sanctuary will affect endangered species like Gharial.

Similarly, when NBWL member Asad Rehmani mentioned in his report that Chief Wildlife Warden from state of Assam should not give permission to huge water level fluctuations that will be caused by the Lower Demwe Dam on the Lohit River in Arunachal Pradesh, Chief Conservator of Forests from Arunachal Preadesh and the Arunachal Pradesh Government said in response that "The provision has far reaching implications such as

[10] IUCN Report E-flows Synthesis and Road Map for Nepal

rights of upper and lower riparian states and geopolitical issues and therefore the provision may require examination at appropriate level regarding its careful application in inter-state cases keeping in view the spirit of the provision in the Act". The dam received wildlife clearance from the MoEF without any more questions about this provision.

In a landmark decision in 2011, the Allahabad High Court ordered State of Uttar Pradesh to release at least 50% of the water from the Narora barrage into the river channel and limit water withdrawal to 50% of the water release. It noted that decreasing water levels are an important reason behind the deteriorating water quality of Ganga in Uttar Pradesh. This Interim Mandamus was issued in response to a PIL regarding the deteriorating water quality and water quantity in the Ganga, just before important river related festivals.

The judgement raised some important points; it strongly linked the issue of water pollution with decreased flows. This is an important point as it enables civil society to use the Water (Prevention and Control of) Pollution Act to demand for e-flows.

The High Court, after examining the daily pollution levels in the Ganga, submitted by the Uttar Pradesh Pollution Control Board framed 3 fundamental issues:

"(a) Can the State draw unlimited quantity of water from a river even to the extent of rendering its main stream a dry zone?

(b) Can the State because of drawal of water from upper portion of river Ganges render its quantity or quality of water completely unfit for human use even for bathing purposes?

(c) Can the natural resources like river Ganges permitted to be completely destroyed by drawing unlimited quantity of water for irrigation purposes?"

The Court had ordered the Irrigation circle Allahabad, to release 1,100 cusec water in the river channel, till the time water is not released in the river from Tehri. The High Court further opined that "there should not be withdrawal of water from main course more than 50% and at best 50% of the river water could be diverted for other purposes". (www.elegalix.allahabadhighcourt.in). This is one of the major examples of High Court actually ordering e-flows release. However, whether this is actually happening or not is not clear. When SANDRP team visited Narora Barrage in November 2011, these releases were not being made.

In response to a public interest petition case filed in 1992 to seek the enforcement of measures to stop the high rate of pollution in the river Yamuna at Delhi, **High Power Committee appointed by the Supreme Court,** recommended that 10 cumecs of freshwater flows should be maintained in the river from Tajewala Barrage as the river enters National Capital Delhi to maintain perennial flow. However, riparian states interpreted this conveniently; Haryana is supposedly transferring 4 cumecs of fresh water into the river just below Wazirabad barrage and the riparian states, in a mutually agreed ration, supposedly releasing remaining 6 cumecs. However, this means that there will never be the meagre 10 cumecs flows throughout the length of the river while it passes through

Delhi. Delhi also sucks the river dry at Wazirabad Barrage. This is not being monitored and to the best of our knowledge, no treated freshwater enters the river.

As we have seen in the earlier sections, Himachal Pradesh notification said that all hydropower dams should be releasing 15% average annual flows at all times. This was not happening at any of the 11 hydropower dams, producing more than 100 MW, inspected by the one person high power committee set up by the High Court of Himachal Pradesh.

Tribunal Orders: Both the Cauvery Water Disputes Award Tribunal and Krishna Award Tribunal from Peninsular India have mentioned provisions for minimum flows (10 TMC in the case of Cauvery Award and around 16 TMC in the case of Krishna Award). However, both the Awards are currently being challenged in the Supreme Court and no e-flows are being released by any riparian state.

Notifications: Following fasts and agitations by a number of spiritual groups, the Union Government in October 2010 decided to abandon the plans to construct hydropower projects on Bhagirathi River upstream of Uttarkashi in Uttarakhand and issued a draft notification in July 2011 declaring the 135 km of the river as ecological sensitive zone. Currently the dams stand scrapped, but the notification is not yet finalised, and the Uttarakhand Government is protesting vocally to reverse this notification.

All in all, unfortunately in the current scenario, though it may seem that there are a number of legal instruments which can be effectively used to ensure e-flows releases, there are very few successful examples of actual implementation. A useful law, or a successful court decision does not translate into e-flows releases. Though legal frameworks are essential, they need to be backed up by constant pressure by communities and effective monitoring, lobbying and advocacy.

****

The Environmental Flows Network (2004) succinctly puts it, 'An ideal situation for e-flows in the Asia-Pacific region would be where environmental flow requirements are a dynamic process written into legislation provided by water managers and monitored by a government body or river basin organization with assistance from a research organization.'

As water scarcity hits harder, as more and more rivers run dry, as climate change becomes more and more discernable, it will become inevitable for governments to work towards e-flows with an 'intergeneration equity' and 'common river futures' in mind. Hence, it is extremely important for groups engaged in movements against dams, for restoring rivers, for various river users to start working through their existing national / regional / local water governance systems to use the opportunity towards a water resources planning and management framework where ecosystem takes the centre stage using e-flows as the entry point.

Stream 9

Time to take Environmental flows to river basin level

Are we seeing the river and its catchment or the flows alone ?

Environmental flows is presently viewed and considered within a dam discourse framework. In other words, the flows needed for the river to maintain its ecological – hydrological – livelihood – cultural functions when dams and / or diversions regulate the flows are considered under the ambit of e-flows. In reality e-flows is about allowing the necessary flows close to the natural flow regime to maintain the ecological integrity of the river for performing its diverse functions. However, within a river basin we cannot consider e-flows with respect to dams in isolation from other uses of the river which can also affect the quality and quantity of flows.

In the context of Cumulative Impacts

Even allocating e-flows within a dam's discourse context is highly skewed. Allowing water for the environment and downstream needs has become mandatory for cumulative impact assessment (CIA) of cascade of dams coming up across a river, as in the case of Alaknanda – Bhagirathi, Lohit, Chenab basins in the Himalayas. In place of e-flows being considered as a critical condition with respect to decision making whether or not to grant environmental clearance to a project, flows is presently being used in India within the CIA assessment as a legitimisation and formality for more destructive dams after allowing some percentages of flows downstream. CIAs are unfortunately turning into cumulation of individual EIA studies and not the cumulated impact of the cascade of dams on the downstream flows right upto the sea or confluence with another river. Even the distance that needs to be maintained between two dams so as to allow life to return into the river or to establish connectivity of the tributary with the main river is not considered.

Our rivers are reeling under multiple threats. While dams are definitely the direct and often irreversible modifiers of flows, other activities in a river basin that abstract or regulate flows, that affect surface flows or ground water recharge, can change the flow regime in the river. For instance, pollution is posing as a major threat to rivers which affects the quality of flows and the aquatic biodiversity in particular. Mining for different purposes (iron ore mining, coal mining, laterite and granite quarrying, etc.) in a river catchment is capable of diverting surface flows or even permanently clogging streams which otherwise would have contributed to the seasonal flows. Sand mining in river beds is capable of increasing the flow velocity (sand deposits slow down the flow and enable recharge) again affecting normal flows. Deforestation reduces the natural absorption and infiltration of surface flows and increases surface run off thereby affecting the natural flow pattern.

Take the case of the larger Himalayan catchments of the Ganga, the Indus and the Brahmaputra where hundreds of dams are being planned by the different South Asian countries. These mountains are young and seismically fragile. They are already degraded due to decades of deforestation for agriculture and timber. Opening up new areas for dam projects that too cascade of dams in the name of run of the river schemes would simply invite more disasters. The signs are already there. The Tehri reservoir is rapidly losing its

storage capacity due to siltation. In fact, media reports say that an island was formed in the reservoir two years after its impoundment (The DNA newspaper, 2008). Since February 2007, the sixth tallest dam on earth has started inducing landslides. Moreover, it is also cited that the lifespan of the dam has been reduced to thirty years due to the impact of deforestation of the Himalayas. More than 300 dams are planned across the various tributaries of Ganga by India. If all these dams are allowed to be constructed, the massive silting up would drastically reduce the annual silt carried by the river to the plains and upto the deltas impacting several hundreds of kilometres of the river ecology and dependent livelihoods, agriculture and economy of the river sharing states. There are live examples all over the world where this is already happening. The Nile delta and the Mississippi delta are shrinking due to the large number of dams already blocking the flows and rich silt brought down by the river. As the silt load reduces, the river tends to flow rapidly downwards, scouring the banks to compensate for the lost silt, making the river steeper and more dangerous.

As more and more water gets diverted or extracted from the river basin, lower would be the downstream flows. In many rivers in the Western Ghats, salt water ingress into the river and coastal aquifers has been reported in summer due to the reduced downstream flows. In the short west flowing rivers like Periyar and Chalakudy, salinity has been reported even 30 km upstream! Saline ingress impacts the operation of drinking water schemes in the river. These two are heavily dammed and diverted rivers.

Hence, if a river basin has all / most of the above interventions, the cumulated impact of all these human interventions would be visible in the flow alterations. While planning for new dams unless the impacts of the existing interventions are understood and integrated into the studies, the cost of underperformance of the projects and / or unintended ecological and social impacts would be very high.

> The need to look at e-flows beyond the flows in the rivers is clearly illustrated by the viewpoint that water is needed for direct evapo-transpiration through forests, wetlands and other lands, all supporting distinct ecologies and other functions of terrestrial ecosystems, apart from aquatic ecosystems. The latter would then be understood as 'environmental flows', and both together would constitute 'water to be left for ecosystem needs'. This is an interesting view, given that first, the requirements of terrestrial ecosystems are currently not explicitly considered, and second, that at present the '*environmental flow requirements (EFR)'* and *'environmental water requirements (EWR)'* are normally taken as synonyms (except rare cases when EWR is used to denote the total volume of EF)
> (Mohile, Gupta: 2005 and Smakhtin, Revenga and Döll: 2004).

In India, CIAs are erroneously considered as basin studies by the MoEF . This primer puts forward the important view that it is time dam induced impacts on flows are considered at a basin level. ***For both hitherto undammed rivers where dam cascades are planned and in those cases where a new dam is planned in already dammed rivers, basin studies should***

precede any EIA or CIA assessment. Basin studies imply assessment of the present status of the river basin with respect to the following minimum parameters

a. Hydrological potential already utilised in the basin for various needs (including groundwater as excessive use of groundwater also has impact on river flows)

b. Extent of degradation / health of the catchment

c. Extent of interventions in the basin like dams, diversions, industries, mining, thermal and nuclear plants etc. which are already abstracting / using water from the river and the catchment and their impacts on the basin

d. Assessment of the existing flow regime in the basin and its adequacy to meet the various present and future ecological and socio – livelihood needs in the basin

e. The ecological status of the various basin components like riparian forests, flood plains, mangroves, deltas, aquatic biodiversity etc. depending upon the basin which ensures that the river can sustain more interventions

f. Ecosystems values provided by the river, this is also very relevant in the context of climate change.

Against this basin wide context, there is a need for river basin communities and river activists to expand the scope of environmental flows as an advocacy strategy to a river basin level. ***There is a need to arrive at the appropriate flows within the larger umbrella of all the different interventions within the river basin. In other words, groups should demand for basin studies and basin level assessment of cumulative impacts of all the existing interventions including all existing developments and then assess the impact of new developments within this larger canvas***.

In the context of Basin Planning

Based on the understanding that all land broadly falls within some watershed boundary, the flow regime to be left for the environment, right from the first order stream watersheds to the main river basin, denotes the water for environmental needs at a river basin level. Herein lies the significance of a watershed based approach to river basin restoration and management, which would automatically ensure that water is left for fulfilling its various evolutionary and ecological needs, which in turn would ensure the healthy status of river systems for society (Joy.et.al.2011)

River activists and movements fighting against dams should be fully aware that it is virtually impossible to restore our rivers or their watersheds to their previous pristine status and flow regime. In most rivers the flows have been regulated, diverted or over abstracted to a large extent and the morphology and character of the river and its micro watersheds has been severely altered. Unless pre intervention data on ecological and hydrological parameters is available, which is highly unlikely in most cases, it is impossible to set

standards for restoration. E-flows is hence a compromise between competing demands and ecologically secure rivers. They have to be looked at in this context. They can never be a replacement to free flowing rivers and secure ecosystems.

Most of the time e-flows is misinterpreted as assignment of percentages of mean annual run off or flows. E-flows is not a static one time allocation of numbers either. In fact it is much more than quantification or volumetric allocations. It is river basin specific and can change over years. Hence there is a need to move away from the concept of percentages to a 'flow regime' concept for the entire basin. The flow regime would include;

1. **Magnitude of flows** - how much flows or what level
2. **Duration** – how long do certain flows or levels last
3. **Timing** - when do certain flows or levels occur
4. **Frequency** - how often do certain flows or levels occur
5. **Rate of change** - how fast do flows or levels change from one condition to another[11]

These flow regimes need to be worked out through the participation and involvement of the different users within the basin including dam builders / hydro power companies and project proponents. In this approach, each user will have to provide water back to the ecosystem and contribute to the flow regime.

Such a mechanism of arriving at and allocating flow regimes can effectively work only under an Integrated Water Resources Management (IWRM) approach to river basin planning. This in turn is to be interpreted as the process of coordinating conservation, management and development of water, land and related resources across sectors within a given river basin, in order to maximize the economic and social benefits derived from water resources in an equitable manner while preserving and, where necessary, restoring freshwater ecosystems. Hence Integrated River Basin Management (IRBM) gives more stress to building in ecosystem conservation into basin planning. E-flows is the most integral part of an ecosystem approach to basin planning process. Any development present or future within the river basin will depend upon the flow regime that needs to be left in the river.

A river is a highly complex and dynamic ecosystem in itself. Over millions of years water in every form (rain, dew, snow, etc.) has been moulding the contours of a river basin, creating new channels over hundreds of years, suddenly shifting courses, meandering etc. Different species have adapted to different niches and habitats, different flow regimes, high and low flows, right from the first order stream to the estuary. Hence arriving at the appropriate flows is indeed a challenging yet inevitable task.

In such an approach while demanding for basin level studies as detailed above, some of the non – negotiables which the river communities and their allies should advocate for in the

[11] Richter et al. 1996, "A Method for Assessing Hydrologic Alteration Within Ecosystems."(*Conservation Biology*)

context of dams and diversions for power generation and irrigation / drinking water are as follows:

1. Options assessment framework developed by WCD should indeed become a pre requisite – are new dams the only option, have sufficient diverse set of options at different scales been evaluated including their cost – benefits, have these options been presented by the communities or imposed upon them etc.

2. The needs of river communities whose dependence does not alter the flows should not be compromised while taking decision on dams and flow regimes.

3. The new dam project(s) should not infringe upon the flows required to meet the basic drinking water and livelihood needs like fisheries.

4. Flows needed for wild life / protected areas should not be impacted by the new project.

5. Public consultations should be mandatory for downstream communities till the distance upto where the impacts can be felt.

6. The minimum distance between two dams needs to be arrived at based on the flows needed to restore the ecological integrity including aquatic biodiversity in the stretch.

7. Stretches of rivers recognised to be important for fish diversity or iconic species like Mahseer and river dolphins, riparian vegetation, river islands etc. should be left free flowing.

8. Dams cannot be allowed on all tributaries. Atleast some tributaries within a river basin should be left free flowing in order to contribute to the lean season flows / drought years.

9. For already dammed rivers, reservoir re-operations management strategies need to be worked out, implemented and monitored by the river communities with the full co-operation of the power developers.

10. In the case of those rivers where the consistent under performance of hydro / irrigation project has been proven based on facts and figures or in case the ecological and social costs outweigh the benefits, decommissioning of the structure is the best option to restore the flow regime.

Everyone loses if we fail to account for environmental flows. Hence, e-flows are the most appropriate connecting link for restoring flows within a river basin planning framework.

ANNEXURE 1

Steps for implementing a BBM

(based on King, Tharme & DeVilliers (eds) , 2008, *Environmental flow assessments For rivers: Manual for the Building block methodology*, Water Research Commission South Africa)[1]

1. **Preparation for the workshop:**

    a. Appointment of a study coordinator.

    b. Determination of the present habitat integrity of the area likely to be affected by the development.

    c. Holding of the Planning Meeting: During this meeting, the study area is formally delineated, the results of the video survey are considered, present relevant knowledge on the river is assessed, and representative reaches and sites are tentatively identified. (Which stretches of the river would be directly affected by flow manipulations from the proposed development and thus should be dealt with in the workshop? Which reaches and sites in combination could represent the river within the study area? What do we presently know about the nature of the river ecosystem in the study area?) The specialist team meets for the first time, and should include, as a minimum: an hydrologist; hydraulic modeller; fluvial geomorphologist; aquatic chemist; ecologists specialising in studies of fish, aquatic invertebrates and instream and riparian vegetation; and a social consultant.

    d. In addition, representatives from local communities should be an integral part of this meeting as they can indicate numerous links between the above topics. Identification of representative reaches and sites within the study area.

    e. Completion of a social survey of the study area.

    f. Determination of the importance of the study area (ecological, social, cultural, etc.).

    g. Determination of the Ecological Management Class (Refer to Stream 4 on Setting Objectives for e-flows) for the river in the study area.

[1] This is an overview of the BBM Process. The entire BBM Manual published by the above authors is a useful resource. It can be accessed at:
http://www.wrc.org.za/Pages/DisplayItem.aspx?ItemID=3675&FromURL=%2fPages%2fKH_AdvancedSearch.aspx%3fk%3dbuilding%2bblock%26

h. Description of the natural and present daily flow regime.

i. Surveying and hydraulic analysis of channel cross-sections at each site.

j. Assessment of the geo morphological characteristics of the study area.

k. Completion of biological surveys at selected points throughout the study area, and of literature surveys.

l. For seasonal sand bed rivers, analysis of groundwater hydrology at each site.

2. The workshop

Session 1: A visit to each site by the full team.

Session 2: The exchange of information.

Session 3: Compilation of the Environmental Flow Requirement (EFR): Identification and description of the EFR for each site is done in a specific way. After general discussion of the kind of flow regime that would facilitate maintenance of the EMC, required flows are identified month by month, starting with the low flows. For each month, each river specialist except the hydrologist and hydraulic modeller is asked to describe the low flow needed from his or her perspective, stating its significance as knowledge and data allow. Required high flows are then described in a similar fashion.

Throughout the process, the hydraulic modeller interprets the implications of flows described, in terms of depth, wetted perimeter, velocity, or areas inundated, using the surveyed cross-sections and plots of the various hydraulic relationships. The details of the flows identified are added one by one to a blank EFR table of discharge (rows) versus calendar months (columns). Each addition is described in terms of four criteria: magnitude, timing, frequency and duration, with relevant **motivation** (reasoning) being supplied by each contributing specialist. Floods up to those with a three-year return period are described, and the continued occurrence of larger ones is checked separately during the whole-catchment analysis in the Feasibility phase. Usually, each entry remains within the limits of the natural hydrograph, with the **EFR thus being a skeleton of the natural flow regime**. Each entry is also identified as a volume of water and a percentile on its calendar month's FDC (Flow Duration Curve). This allows biologists and others to understand the implication of flows they have asked for in terms commonly used by engineers. Finally, the low flow and high flow components of the EFR are expressed as percentages of the mean annual runoff and median annual runoff.

As consensus is reached on the EFR for a BBM site, the flows requested are compared to the natural hydrograph for the site, as a check that realistic figures have been produced. **Flows are also recommended that will stress the river ecosystem in drought years, for such stress and variability in flow is felt to be an essential, natural feature of the rivers**. Capping low flows may also be identified, to guide on upper limits for high volume dam releases down the river. Plenary report-back sessions are convened when appropriate.

Session 4: **The final session of the workshop:** The final session consists of following activities. The recommended flow regimes for all the EFR sites are compared, to check that there are no major mismatches in what is proposed. Statements are made regarding the environmental acceptability of the options considered in the workshop. Further necessary work is identified and usually falls into three categories: short-term research required to address serious uncertainties, so that the EFR can be refined if necessary; medium-term research required to improve the BBM; and long-term fundamental research on subjects about which little is known. A post mortem of activities also takes place at the workshop, and any other statements that participants wish to make are noted and discussed if necessary. Reports on all these activities form part of the workshop report.

BBM EXPERTS: Who are the integral part of the workshop

- habitat integrity specialist;
- hydrologist;
- social scientist;
- workshop facilitator and/or coordinator;
- riparian vegetation specialist;
- fish specialist;
- aquatic invertebrate specialist;
- fluvial geomorphologist;
- hydraulic modeller.

Steps of the process:

One of the important parts of the BBM process, which makes can make it responsive to local needs is the Assessment of Social Use of Riverine Resources. This is a step where a number of inputs can be provided by the local communities:

The objective of the social assessment in the BBM is to provide information on the use of riverine resources by rural communities, and on the importance of a healthy riverine ecosystem, from a community perspective, for sustaining their livelihoods. In essence, this involves understanding with communities the importance of, and their reliance on, run-of-river flow for providing resources such as fish; riparian plants for food, thatching, medicinal and other purposes; and areas of multiple use such as floodplains and pools. **The social assessment used in the BBM differs from other, more conventional sociological assessments in that it not only requires describing the resources that are used, but also their ecological identities and relevance in terms of riverine ecosystem functioning.** The challenge facing those compiling information for this part of the BBM study is to provide an ecosystem link to the sociological assessment. **Finding ways to understand and capture peoples' perceptions regarding the relationship between river flow and resources, as well as historical changes in resource availability, are key issues in making this link.**

This is especially important while working on a **block for cultural use**. As was described by Shri. Ravi Chopra, from People's Science Institute, Dehra Dun, India, who worked with WWF India is developing BBM for the Upper Ganga Basin, the people's perception about water for cultural needs was complex to put in numerical terms. While some devotees said that even a drop of water in is enough to make it into a sacred river, some stressed that Ganga must be the full, providing river, as envisaged by the pilgrims.

Additional recommendations for how the process should be conducted include the following:

- workshop sessions should be conducted at the host villages and preferably at the river;
- where possible, the consultant should live on site, or close to it, during the appraisal;
- the consultant should be able to speak the local language, or at least one person who can speak it should be employed as scribe and facilitator;
- when possible, the relevant biophysical specialists, particularly the ecologists, should participate in the sessions in order to facilitate the identification of species and lead further key discussions where appropriate.

Finally, it should be noted that with participatory methods, much of the data analysis and presentation takes place on site, because each piece of information gathered is used in the subsequent session.

SEQUENCE OF ACTIVITIES

- Identification of potential communities and selection of study sites
- General identification of riverine resources used and of their location and extent
- Identification of resource users and of key focus groups
- Prioritisation of the relative importance of each resource or use within each use category
- Seasonality of use
- First link with flow: identification of general riverine water levels associated with each resource
- Second link with flow: the quantity and seasonality of flow
- Third link with flow: past and present riverine conditions
- Determination of the Desired State of the river
- Collation and cross-checking of information with the Building Block Methodology specialist team