Deciphering environmental flows

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RIVERS, lakes and groundwater aquifers have been abstracted, dried and ecologically degraded worldwide by humans, especially during the last two centuries. The scale of human economic activity has grown exponentially and so has intervention into the natural systems to gain access to increasing volumes of water. The availability of reinforced cement technology and powerful mechanical pumps made such interventions possible, offering a supply-side bonanza. It took a few years to understand the cumulative impacts on the ecological processes on which such a bonanza depended, as in the case of the shrinking of the Aral Sea.

Such cumulative damages have resulted in quantitative decline and consequent inability of the water systems to maintain the various ecosystem services and supplies of water on which the livelihoods of a large number of people depend. This gave rise to a new type of water conflict – between the satisfaction of short-term economic demands of water and the long-term sustainability of the diverse ecosystem processes and services that water systems provide. The rapid decline in the groundwater table in many parts of India and the degradation of flows in most rivers, in both quality and quantity, is a result of looking at water systems within a traditional engineering framework, as a stock of resource to be abstracted as per the demands of the economy.

In the context of wide spatial and temporal inequity in the monsoon dominated precipitation over India, the macro-level picture comparing demand and availability of water is hardly reflective of the realities in smaller parts of the country. Nevertheless, official projections indicate that the total water requirement of India

would outstrip the total availability of about 1100 billion cubic metres by the mid-part of the present century. If the business as usual practice continues, such a situation would create widespread conflicts of immense political significance. Addressing such emerging conflicts, between the perspectives of water as a stock and as a flow, is thus an imperative.

With the quantity of abstractions of water from the natural sources growing rapidly, their impacts on the functioning of the ecological processes involving water systems have become more and more conspicuous. If the initial signals of such ecological degradations are ignored by policy makers, the ecosystem services start to get restricted, making it increasingly difficult to both maintain livelihoods dependent on its sustained availability and to abstract water for meeting other economic demands.

A growing insecurity about the future availability of water has led to new arrangements about its quantitative sharing, across boundaries and across sectors. The numerous transboundary treaties and tribunal awards over shared rivers like the Ganga, Cauvery, Krishna or Godavari, to name a few, exemplify how water sources are seen as a stock from a narrow quantitative viewpoint. The recent disagreement between the Government of India and that of the state of West Bengal on the question of quantitative sharing of river Teesta reflects the same mindset. Further, the website of India's Ministry of Water Resources clearly reveals the commitment of water engineers to the traditional perspective of supply-side solutions, guided by what is now increasingly being known as arithmetical hydrology.

The sources of water – in rivers, lakes and aquifers – have now been degraded to such an extent that the water future for India in both supply terms and ecological sustainability appears uncertain. As a result, conflicts over water are growing, an expression of the dichotomy between the economic perception of water as a stock and its ecological perceptions as a flow in the hydrological cycle. Addressing such conflicts demands ecological knowledge for the identification and articulation of related ecosystem functions and services, which needs time. The need for regulating the abstraction of water from rivers, lakes or aquifers is now widely accepted.

Many documents present the non-human requirements of water in the rivers, lakes and aquifers in terms such as 'minimum flow', 'environmental water allocations', etc. These are, however, ad hoc and not based on an ecological understanding of water; rather, they are at best a reluctant concession of arithmetical hydrology to silence the ecologically informed critics. Nevertheless, such an understanding is crucial for ensuring the sustainability of water systems, and hence, to the continued supply of water in the future days. The term 'environmental flows', which has now come in circulation, is advanced as the golden solution to the already emerged conflicts between economic use and eco-systemic sustainability related to water systems.

As a starting point, it is important to decode the term environmental flows and uncover its implications in management, policy and laws related to water. In the absence of such a clarity in the public understanding, the term itself may run the risk of being misused. An early articulation of the term was advanced by the International Union for Conservation of Nature and Natural Resources.[1] In this perception, environmental flows relate exclusively to the flows of managed water systems, where human interventions have already been made or are likely to be made. This management may involve an addition to the natural flow (as in the case of the Farakka Barrage and river Hooghly-Bhagirathi) or an abstraction of the flow (as in the case of irrigation projects) or a temporal modification of the flow (as in the case of hydropower projects).

As a result of such interventions, the aquatic ecosystems are affected, reducing them to a sub-pristine state of existence (the pristine state being one without any human intervention). Similarly, the recent initiative by several IITs for making a new management plan for the Ganga river basin defines environmental flows as 'a regime of flow in a river or stream that describes the temporal and spatial variation in quantity and quality of water required for freshwater as well as estuarine systems to perform their natural ecological functions (including sediment transport) and support the spiritual, cultural and livelihood activities that depend on these ecosystems'.[2]

Abstraction of water is necessary and interventions are unavoidable for meeting human water requirements. In the perception of the IUCN, environmental flows constitute a flow pattern moderated by human interventions, but in a manner that while the water related ecosystems are altered to a sub-optimal state, they would continue to function, albeit in a partially degraded manner. The scale and type of abstraction of water from a river, lake or an aquifer would be deter-

1. IUCN, *Flow: The Essentials of Environmental Flows*. Gland, IUCN, 2003.

2. GRBMP, Report Code: 012_GBP_IIT_EFL_SOA_01_Ver 1_June 2011

mined by informed negotiation among stakeholders on an acceptable level of ecological degradation. Hence, the claim is that the modification of the flow of water and its ecological impacts would be acceptable to all stakeholders, on the basis of the satisfaction of human water requirements and a sub-optimal functioning of the related ecosystems.

It needs to be clarified that environmental flows consist not only of the quantity of water but represents the annual hydrograph, establishing the periodicity of the flows. They represent a package of water flows and its periodicity throughout the year. Such a modified flow pattern that maintains the periodicity of flow in rivers, lakes or aquifers but changes the quantity of flows by abstraction, is known as 'mimicking of the natural flows.' Under the managed hydrological regime, while the flows would exist in a sub-pristine state, a mimicking allocation would ensure that the aquatic ecosystems and services provided by them are not threatened with extinction but are damaged to an agreed and predetermined extent.

In principle, such an arrangement of compromise offers a platform for negotiated settlement of conflicts over short-term economic use and long-term ecological sustainability of water systems. This will be most useful for policy making and management related to large structural interventions on water systems. Such a mechanism for conflict resolution based on environmental flows is, however, in a nascent stage and needs substantial theoretical and methodological refinement before it can help decision making in government, judiciary, etc. In the absence of such a refinement and clear conceptualization, decisions run the risk of being premature and counter-productive.

The approach is based on the fact that 'rivers and other aquatic ecosystems need both water and other inputs like debris and sediment to stay healthy and provide benefits to people. Environmental flows are a critical contributor to the health of these ecosystems. Depriving a river or a groundwater system of these flows not only damages the entire aquatic ecosystem, it also threatens the people and communities who depend on it. At its most extreme, the long-term absence of environmental flows puts at risk the very existence of dependent ecosystems, and therefore the lives, livelihood and security of downstream communities and industries. The question thus is not whether water abstraction projects are needed, but whether and for how long society can afford not to provide for environmental flows.'[3]

The starting point for moving towards this goal would be the drawing up of a more complete framework for ecological functions and services related to the river, lake or aquifer in question, both in their pristine state and at present, if they are now regulated systems.

From recent discourses an impression seems to have gained ground in the public mind that a win-win mechanism has finally emerged, with which water from rivers, lakes and aquifers can be substantially abstracted without hurting their ecological integrity as long the proper quantity of environmental flows is left out for meeting the needs of the natural ecosystems. Such a concept is simplistic and risky. Environmental flows must not be considered as an unique volume of water that can be estimated *ad hoc* as the need of the natural ecosystems, say 25 per cent of the annual flow. The concept also does not support the idea that the remaining 75 per cent of the water from rivers, lakes or aquifers can be abstracted without payment for ecological damages.

The concept of environmental flows only offers a quantitative indicator, relating managed supply of water with stability and functioning of the aquatic ecosystems. Starting from the pristine flow, any abstraction or addition should be based on a negotiated sub-optimal state of the aquatic ecosystem that is acceptable to all stakeholders and compensation paid for damage to ecosystem services and related livelihoods. Thus, there is no fixed amount called environmental flows, but flows that are allocated on the basis of agreed levels of degradation of the natural ecosystems when compared with the pristine.

If, for instance, the agreement is that a river should remain in pristine state, the total flow of the river would constitute the environmental flows. Elsewhere, in another river, a large part of the total flow may be abstracted, leaving it almost dry. In such a case the agreed environmental flows would be very small. In all instances, the abstractions need to ensure compensation for damages to the functioning of ecosystems and livelihoods. Environmental flows, accordingly, do not prescribe any 'minimum flow' that many policy documents have started to project as the allocation which, if retained in the stream, would justify abstraction of all the remaining flows.

Assessment of environmental flows must be subject to a proper understanding of the diverse ecological processes and ecosystem services related to water systems. Tharme has pointed out the very underdeveloped nature of this new area of water science.[4] Assessments of environmental

3. GRBMP, 2011, op cit.

flows can only be made in relation to identified degradation of ecosystem processes and services, like that of the movement and growth of specific fish species. At present, however, only a small part of the totality of ecosystem processes and services related to rivers, lakes or aquifers can be clearly identified and thus subjected to such assessment processes.

In addition, the totality of environmental flows can be categorized first, as biological, and second, as geomorphological. For the first group, an example can be taken of the flows that are needed to sustain the movement and spawning of fish population, as in the case of the high value hilsa fish in the lower parts of the Ganga basin. The flow of water also generates sediment loads in the uplands and transports them to the floodplains and the delta, generating fertile land for humans and habitat for diverse aquatic biodiversity. Flood flows flush heavier sediments out to the deltas and coasts, clearing the river bed. All these are vital ecosystem services and need adequate flows for their continuation.

For example, when a river flow outpours into the ocean, it is often described by arithmetical hydrologists as wastage of freshwater. For the ecologically informed, however, such flows are necessary for clearing the confluence and also to reduce the ingress of salinity from the oceans. The absence of such ecosystem services would damage the estuaries and coastal habitats and the rich fishing economy based on them.

Environmental flows needed for maintaining such individual ecosystem functions and services can be approximated by modelling, and as of today, hundreds of models are being tried out. However, if ecosystem functions and services of a river, lake or aquifer without human interference are seen in their totality, the related total environmental flow requirements will be very similar to their natural annual flows devoid of any extraction.

Since it is also important to provide water supply to meet human requirements, engineering interventions, large or small, are needed. Any engineering intervention, however small, will invariably impact the ecosystem processes and services related to the source. The challenge is to arrive at acceptable environmental flows based on an agreeable trade-off in which the abstraction of water is socially acceptable, and ecologically sustainable as also ensure that all the damages to livelihoods and ecosystems are adequately met.

Existing procedures for project assessment in India cannot be called scientific from such an ecological and holistic perspective. There is a clear tendency for the promoters of water abstraction projects to disregard ecological linkages and deprive the people whose livelihoods are negatively impacted by water projects. In the absence of a deeper scientific understanding, vested description of environmental flows may be used to get a blanket approval for abstraction projects without paying the necessary compensation. In needs to be stressed that environmental flows do not provide free lunches to any water project.

Even though there cannot be a unique environmental flow independent of an agreed ecologically non-pristine status of water systems, various estimates giving unique amounts of environmental flows have been made for India.[5] 'The estimate turned out to be about 476 km^3, which constitutes approximately 25 per cent of the total renewable water resources in the country. This, however, was not in fact an estimate of EF *per se*, but rather an estimate of the total volume of EF.' Somehow, in this instance, the environmental flows are being shown as absolute, not negotiable and a pro-duct of technical research alone! This closes the door for arriving at a negotiated path for the regulated water systems. And this is a dangerous confusion!

It needs to be stressed that our current state of knowledge of water systems and ecological modelling related to flows of water, what to speak of projecting a single quantitative figure of water requirements as shown above, is inadequate. Such a unilateral prescription of environmental flows or water requirements of aquatic systems as a method for the resolution of water conflicts may actually become the source of many new conflicts. All stakeholders related to water systems need to increasingly understand the basis, scientific or otherwise, of various claims of assessing environmental flows, so that the conflicts between economic demands on and the ecological sustainability of water systems can be proactively resolved and a more robust holistic process of decision making on India's rivers, lakes and aquifers can be put in place.

4. R.E. Tharme, 'A Global Perspective on Environmental Flow Assessment: Emerging Trends in the Development and Application of Environmental Flow Methodologies for Rivers', *River Research and Applications* 19, 2003, 397-441.

5. V.U. Smakhtin, C. Revenga and P. Döll, Taking Into Account Environmental Water Requirements in Globalscale Water Resources Assessments. Research Report of the CGIAR Comprehensive Assessment Programme of Water Use in Agriculture. International Water Management Institute, Colombo, Sri Lanka,2004, 24 pp, (IWMI Comprehensive Assessment Research Report 2); V. Smakhtin, C. Revenga and P. Döll, 'A Pilot Global Assessment of Environmental Water Requirements and Scarcity', *Water International* 29, 2004, 307-317.