ENVIRONMENTAL FLOW REQUIREMENT AND ITS ASSESSMENT

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ABSTRACT *Environmental flow refers to the water considered sufficient for protecting the structure and function of an ecosystem and its dependent species. This means enough water is left in our rivers, which is managed to ensure downstream environmental, social and economic benefits. So, environmental flow is compromise between the development and the ecology of the river. Environmental flow assessment is required to be done in order to understand the natural flow regime of the river which is required to exist for the sustainability of the ecosystem. The two broad categories of the environmental flow assessment are the detailed environmental flow assessment method and the desktop environmental flow assessment method. Both the methods are further divided into several categories out of which it is the Desktop Analysis that is used mostly. All the methodologies still needs some modifications as these methodologies are not global and are data intensive. In India previously it was the Tennant Method of environmental flow assessment that was used for the computation of environmental flow requirement but in recent years, the Desktop Reserve Model, Flow Duration Curve Analysis and Hydrological Analysis is also made use of. Sound environmental flow management hedges against potentially serious and irreversible damage to freshwater ecosystems from climate change impacts by maintaining and enhancing ecosystem resiliency. Progress has been made, but much more attention is needed. Several governments have instituted innovative water policies that explicitly recognize environmental flow needs. Environmental flow needs are increasingly being considered in water infrastructure development and are being maintained or restored through releases of water from dams, limitations on groundwater and surface water diversions, and management of land use practices. Even so, the progress made to date falls far short of the global effort needed to sustain healthy freshwater ecosystems and the economies, livelihoods, and human wellbeing that depend upon them.*

Key words: Environment flow requirement, Detailed Environment flow assessment, Desktop Environment flow assessment, Flow duration curve analysis

INTRODUCTION

The increase in the number of settlements, development of agricultural activities and increase in urbanization, has led to an increase in the demand of water, due to more consumption of it, and has also brought up changes in the characteristics of the landscape which has occurred due to the removal of vegetation because of coming up of roads, houses, industries etc. Both the reasons combined, have led to the decrease in water levels in the river. The developmental activities that are going on in the present time have led to more abstraction from the river and regulation of river water. Both abstraction and regulation of the river water results in reduction of the stream flow and also affects the natural flow regime of the river which has

impacts on the health of the river that is getting deteriorated day by day. Climate change on the other side is adding pressures on the water resources as both, the increase in temperature and decrease in precipitation, results in the reduction of the run-off and flow in the stream. And in these times when there is lot of pressure on the resources it gets all the more important to have some healthy rivers left, on this planet Earth for the future generations to come. If the level and flow of a river is affected it affects the ecosystem i.e. animal species, fishes, plant species, micro-organisms etc., of the river and the products of ecosystem are economically important for the humankind as they get some long term benefits from these products of ecosystem. To save the ecosystem of the rivers from getting depleted and then to make them available for the human society, the concept of environmental flow requirement has come into existence.

"Environmental flow refers to the water considered sufficient for protecting the structure and function of an ecosystem and its dependent species. This means enough water is left in our rivers, which is managed to ensure downstream environmental, social and economic benefits. Environmental flow is an evolving concept. It is the minimum flow that should be maintained in the river for sustaining the ecosystem of the river or in simple words, it is the ecologically acceptable flow regime. Thus, environmental flow is the compromise between the development like construction of the dams etc. and the ecology of the river. The environmental flow is different from the minimum flow as minimum flow incorporates the flow that is required for the ecosystem as well as the flow required for other basic purposes like drinking, washing, navigation. Environmental flow is not only the quantity of flow that is flowing in the river but also the structural and functional diversity of the river which affects the flow variability i.e. at a particular time or situation, how much water is flowing in the river.

Besides understanding the nature of the river through the concept of environmental flow it is necessary to understand natural flow of the river and what flow regime should be maintained in the river for the survival of the ecosystem of the river and also which landscapes such as, wetlands, floodplains, and estuaries, depend on the river flow. The concept of environmental flow not only helps to understand that what amount of water is required by the river for sustenance of the ecosystem and but also what amount of water should be supplied to the river throughout the year for this purpose. The challenge in the present time is to assess the environmental flow of the river and how the alterations in the flow regime can affect the society.

NEED FOR ENVIRONMENTAL FLOWS: THE BASIS, AND THE POLICIES

International

In recent years, there is a wide agreement that development needs to be 'sustainable', but the development of sustainability is much debated. The

International Law Association (ILA) adopted the New Delhi Declaration of Principles of International Law Relating to Sustainable Development (ILA New Delhi Declaration). This Declaration includes, perhaps a better accepted definition The Declaration expresses the view that: "the objective of sustainable development involves a comprehensive and integrated approach to economic, social and political processes, which aims at the sustainable use of natural resources of the Earth and the protection of the environment on which nature and human life as well as social and economic development depend and which seeks to realize the right of all human beings to an adequate living standard on the basis of their active, free and meaningful participation in development and in the fair distribution of benefits resulting there from, with due regard to the needs and interests of future generations"

The International Watercourse Conventions has some specific provisions:
'Watercourse States shall, individually and, where appropriate, jointly, protect and preserve the ecosystems of international watercourses.'

An ecosystem approach is also reflected in Article 22 on alien or new species and Article 23 on the marine environment of the Watercourses Convention.
Article 22: 'Watercourse States shall take all measures necessary to prevent the introduction of species, alien or new, into an international watercourse which may have effects detrimental to the ecosystem of the watercourse resulting in significant harm to other watercourse States.'

Indian

The National Water Policy, (2002) of India has the following relevant clauses:

".3 in the planning, implementation and operation of a project, the preservation of the quality of environment and the ecological balance should be a primary consideration. The adverse impact on the environment, if any, should be minimised and should be offset by adequate compensatory measures. The project should, nevertheless, be sustainable."

"14.3 Minimum flow should be ensured in the perennial streams for maintaining ecology and social considerations."

The National Environmental Policy (2006) of India has the following relevant material. "Environmental degradation is a major causal factor in enhancing and perpetuating poverty, particularly among the rural poor, when such degradation impacts soil fertility, quantity and quality of water, air quality, forests, wildlife and fisheries. The dependence of the rural poor, in particular, tribal societies, on their natural resources, especially biodiversity, is self-evident." "Economic growth, in its turn, bears a dichotomous relationship to environmental degradation. On the one hand, growth may result in "excessive" environmental degradation through use of natural resources and generation of pollution aggravated by institutional failures. If impacts on the environmental resource base are neglected, an incorrect picture is obtained from conventional monetary estimates of national income. On the other hand, economic growth permits improvement in environmental quality by making

available the necessary resources for environmental investments, and generating societal pressures for improved environmental behavior, and institutional and policy change"

"5.2.5 Freshwater Resources: India's freshwater resources comprise the single most important class of natural endowments enabling its economy and its human settlement patterns. The freshwater resources comprise the river systems, groundwater, and wetlands. Each of these has a unique role, and characteristic linkages to other environmental entities." "The following comprise elements of an action plan for river systems: a) (Not reproduced) b) Promote integrated approaches to management of river basins by the concerned river authorities, considering upstream and downstream inflows and withdrawals by season, interface between land and water, pollution loads and natural regeneration capacities, to ensure maintenance of adequate flows, in particular for maintenance of instream ecological values, and adherence to water quality standards throughout their course in all seasons. c) Consider and mitigate the impacts on river and estuarine flora and fauna, and the resulting change in the resource base for livelihoods, of multipurpose river valley projects, power plants, and industries."

ENVIRONMENT VS DEVELOPMENT

To many, it appears that environmental needs are simply an obstruction to pressing needs for economic development, and even suspect antinational forces to be backing these obstructional strategies. By putting the Human wellbeing at the center-stage, they take a stand that large harm to environment may be unavoidable. Others point out that the societal preference to environmental preservation is low in the early stage of development, but increases as the society becomes rich. (Opposition to restricting carbon emissions by rich nations does not support this). However, as discussed, both the international and national policies stress the need for the development to be environmentally acceptable, and needs to cause minimum adverse impacts. The natural eco-systems provide various goods and services to humans, and these will be affected by environmental degradation. Apart from this, the right to existence of the natural ecosystems, and the species is also to be protected. In any social benefit cost analysis, the negative benefits of environmental damage need to be considered; although their evaluation may require having a good scientific and economic basis.

HOW MUCH WATER IS REQUIRED BY NATURE?

This question cannot be answered satisfactorily. There is no doubt that all the water of the earth was water available to nature, as long as human needs were a part of the natural ecosystems. The ecosystems developed within the water availability, and adapted themselves to the slow climatic changes etc. Mismatches and adaptation- extinctions would have occurred as a part of the process.

When humans, through their intelligence, capability of accumulating knowledge, and acquired skills, started medaling with the natural 'order' of things, the natural ecosystems had to start adaptation to these changes. Both the speed (on the evolutionary time scale and the extent, would make such adaptation to strains at an accelerating pace.

If humans have become an entity distinct from the natural ecosystem, and are seemingly in competition with it, in regard to allocation and use, there is nothing intrinsically 'sinful' about it. Even while the competitions are real, a good sense to adjust through give and take, has to, and will prevail and get reflected in the human behavior. In this context, "Water requirements of the terrestrial and aquatic ecosystem" is a difficult and questionable concept. If we imagine a 'real' natural condition, with humans as hunter- gatherers and a part of natural ecology, all water would have been used by the terrestrial ecosystems, towards forests, farmlands, etc., and by the aquatic ecosystems, the latter including the drinking requirements of animals and humans. It has been argued by some that any anthropogenic use of water is a loss to the ecosystem; and the author would not disagree. But, unless the aquatic ecosystems are destabilized in the process, it would be a quantitative loss of goods and services from the ecosystem, and not a loss of the ecosystem itself. In such a situation, there can be no fixed requirement. There can be different thresholds, and there can be a desirable level, to be decided through a process involving trade-offs. Oversimplification is not desirable.

The worldwide debate about ecology and development has lead to two broad schools of thinking:

· Preserve the natural ecology because it has an 'a priori' right, or

· Preserve the natural ecology because it provides 'goods and services to humankind.

This latter anthro-centric approach is becoming more popular with the environmentalists, since it provides a meeting ground. The National environmental Policy (2006) of India seems to adopt this approach, when it states:

Human Beings are at the Center of Sustainable Development Concerns: Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature"

What Constitutes the Environmental Water Requirements?

The in-stream water at any place on the stream may have to meet, at least in part, many downstream demands. These may include

- Aquatic Ecology
- River Morphology
- Drinking And Domestic Needs Of Riparian Communities
- Traditional Or Established Agricultural And Other Uses Downstream
- New Agricultural And Other Uses Downstream
- Cultural And Religious Needs
- Needs of downstream political units

All these are important, and have to be considered in any allocation.

ENVIRONMENTAL FLOW ASSESSMENT METHODS:

In these times when the ecosystem is in the critical situation environmental flow should be given the utmost priority but still National Water Policy ranks the ecology as the fourth item in the list of priorities of water allocation. Environmental flows are not only important for the sustenance of the ecosystem and biodiversity but also for providing services that are economically valuable and which have long-term benefits to the society. Therefore, for the sustenance of the ecosystem it becomes important to assess the environmental flow requirement which is known as the environmental flow assessment.

Hundreds of methods exist for defining environmental flows. To identify the "best" method - or more likely, methods depends upon the amount of resources and data available, the most important issues and uncertainties and the level of certainty required. At present, EF assessment is considered to be a fresh and important topic of discussion and research. In last two decades various methods for environmental flow assessment have been developed. These methods have been primarily employed in Europe, United States, South Africa, and Australia. India is still in its infancy for the development of these methods. In India, the major interest highlighted in this field was in March 2005, in the first National Workshop on Environmental Flow held in New Delhi.

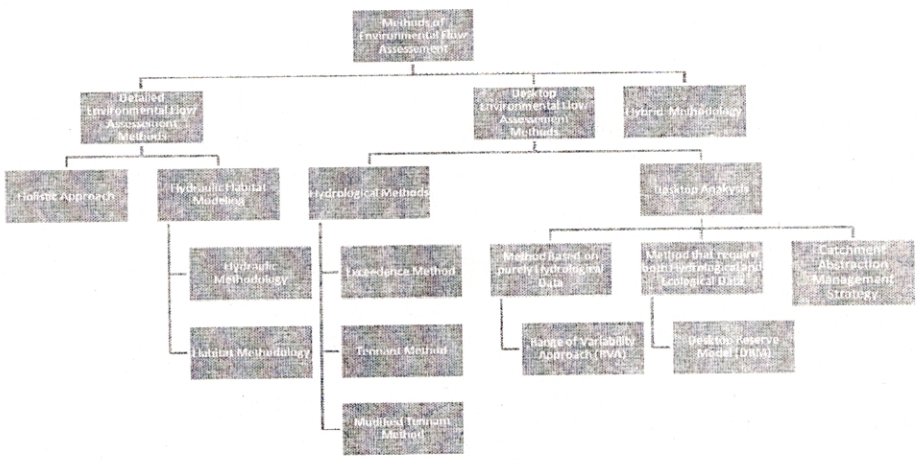

Fig. 1 Chart showing Environmental Flow Assessment Methods

The development of these methods is either for the protection of a particular species or for protecting the ecosystem in a broader view. At present, almost 25 countries have employed these methods of environmental flow assessment. It is expected that the pressure on the rivers will get intensified in the coming times as the population

and development will go on increasing. So it gets all the more important to assess the environmental flow requirement of the rivers so that policies can be generated that can help regulate the rivers effectively, so that ecosystem remains unaffected. There are two broad methodologies for the environmental flow assessment:

- Detailed environmental flow assessment method
- Desktop environmental flow assessment method

Detailed Assessment Method

The detailed assessment method further includes:

***Holistic approach*:**

In this method the whole ecosystem (groundwater, estuaries, and wetlands) view is considered for the assessment in which the flow events which are ecologically and socially significant are identified. The multidisciplinary panel of experts then decides the environmental flow requirement. The disadvantage of the method is that it requires a lot of field work, time and resources for the assessment of environmental flow of a single river basin.

Hydraulic Habitat Modeling

By this method, the changes that occurred in the hydraulic characteristics of a river due to the regulation of the river are assessed. The method is complex, and the assessment done by the method mainly focuses on the effect of environmental flow of a particular species but the whole ecosystem is not considered in this method, as in holistic method. The habitat method, like the holistic method requires lot of data and field work.The hydraulic habitat modeling further includes:

Hydraulic Methods or Hydraulic Rating Methodologies

These methods take into consideration the changes that are occurring in simple hydraulic variables of a river like the river width, wetted perimeter, and river velocity (not considered much). The increases in the hydraulic variables occur with the increase in flow but this increase is non-linear. The rate of increase increases with the flow but a point is reached where this rate starts decreasing with the increase in flow; this point is known as the point of inflection and at this point the increase in flow do not have much effect on the hydraulic variables.

This methodology is advantageous as it gives information about the different flows that get affected by the wetted channel of a river. A wetted channel provides habitat for aquatic life. If a graph is plotted between wetted parameter and discharge curve, minimum flow is adjusted near the inflection point.

The methodology is advantageous for non-uniform irregular channels but disadvantageous for uniform steep-banked channels.

Habitat Methodology

This methodology is the extension of hydraulic methods. The difference between the hydraulic method and the habitat methodology is that, in the habitat method for the assessment of environmental flow requirement both the hydraulic condition and ecological condition are taken into consideration, where the ecological conditions are dependent on the hydraulic condition of the river, whereas in the hydraulic method only the hydraulic parameters are considered. Through the hydraulic method water velocity and depth are determined and then these are compared with the habitat for a particular species so as to understand how much flow is suitable for a particular habitat. When this is done for a range of flows in a river, it can be known that how the habitat changes with the flow. This change in habitat with the flow can be determined through the Instream Flow Incremental Methodology (IFIM). Hence, environmental flow requirement of a river can then be determined by making use of Exceedence Series.

The only disadvantage of the detailed assessment methods is that, these methods are resource intensive.

Desktop Rapid Assessment Method

The Desktop rapid assessment method includes:

Historic methods or Hydrological Methodologies

The methods are worldwide. These methods are based on the hydrological data and are also known as fixed percentage or look-up table methodologies. The methods are based on the concept that the EFR is represented by a particular limit that is set to the minimum flow, so as to maintain the ecosystem of the river. The various methods that are included under this category are as follows:

Exceedence method

The exceedence method uses the exceedence percentiles and flow duration curve. "The flow duration curve is a water resource tool that defines the proportion of time that a given flow is equaled or exceeded." For instance, Q_{95} is the flow that is 95% of the times is equaled or exceeded. Generally 17 percentiles (0.01, 0.1, 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 95, 99, 99.9, 99. 99) are taken into consideration in the flow duration curve. The method is useful for finding out the simple rules for operation of dams or other structures for which ecological data cannot be obtained.

Tennant method (known as Montana Method in New Zealand)

The method was developed in 1976 by Tenant. It was used in North America. The method distinguishes the gamut of Mean Annual Runoff (MAR) into several ecologically relevant ranges at a particular site of a river. For instance, 10% of MAR shows that excess degradation of the river has occurred and it is the lowest limit of environmental flow recommendation and therefore it is undesirable. A 35% of MAR shows that the ecosystem of the river is in good condition, so the MAR of

the river should be maintained at this level. A 60-100% of MAR shows environmental optimum i.e. the river is in a very good health.

The disadvantage of this method is that the method is outdated and the Mean Annual Runoff that is selected is just showing the flow of runoff in the river at annual basis but the variations of flow that are occurring throughout the year are not represented by this method.

Table 1: Showing the recommended percentage of MAR

Objective	Autumn-Winter (%)	Spring-Summer (%)
Flushing or maximum flows	200	200
Optimum range of MAR	60-100	60-100
Outstanding	40	60
Excellent	30	50
Good	20	40
Fair or degrading	10	30
Poor or minimum	10	10
Severe degradation	10-zero flow	10-zero flow

Modified Tennant Method

Tennant method was modified by Fraser in 1978 for the rivers of New Zealand. Fraser recommended that the flushing flows are to be maintained at the time of floods. [10] For instance, 100% of mean flow is considered to be 'optimum'; 75-99% of mean flow is 'acceptable'; 30-74% as 'poor fair'; and 29% or less as 'unacceptable'.

The advantage of historic methods is that they require less of resources. Through the flow data which is readily available, the hydrological data can be calculated. But because of lack of ecological data, the results obtained are uncertain which is disadvantageous. The other disadvantages of the method are that it is time consuming, costly, and precautionary. And, the method used in one region cannot be used in another region without recalibration.

Desktop Analysis:

The method makes use of the existing data for the purpose of analysis. In this method the whole river flow regime is taken into consideration including the seasonality and variability of the flows, therefore, apart from the normal flowing river, dry river and river in floods are also accounted for. The method further includes:

Methods based purely on hydrological data:

The method includes:

Range of Variability Approach (RVA): In this method 32 hydrological parameters are taken into consideration and all of them represent the different aspect of flow variability like (magnitude, frequency, duration and timings of flow). The

estimation of these 32 hydrological parameters is done through the daily flow time series. For the calculation of EFR, it is seen that how much each of the parameter has deviated from its natural variability. All 32 parameters should be within their natural variability for supporting the ecosystem of the river.

The disadvantage of RVA method is that all the 32 parameters estimated in this method may not be of any significant use as some of them may be correlated to each other. And it requires lot of data, as daily flow time series is used which might not be available for every river and for every month or year. So this method can be simplified by using less number of parameters and monthly flow data should be used instead of daily flow time series.

Method that require both hydrological and ecological data:

Desktop Reserve Model (DRM). In South Africa, during the 1980 and 1990s the building block methodology was used in order to assess the environmental flow requirement of a river. For this purpose an improved methodology which has got the same principle as that of BBM was developed. This methodology was also required for estimating the ecological reserve of 1946 quaternary catchment of South Africa. This methodology is known as desktop reserve model. The method was developed by Hughes and Munster in 2000 and further modified by Hughes and Hannart in 2003. In this method Environmental Management Categories (EMC) are determined. Each EMC represents the condition of the river as to which extent it can deviate from the natural flow regime. There are 5 environmental management categories, EMC A shows that the river is in its natural state and there is no or very less modification that has occurred in the river and EMC D shows that the flow regime of the river is highly modified. The description of other classes is done in the table 2.

Desktop Reserve Model is the modification of Building Block Methodology (BBM) in which Building Blocks (BBs) are determined which are the environmental flows that are modified but are acceptable ecologically, these majorly includes low flows, freshes, and larger high flows which occur during floods. For each month of the year BB is determined and there is a difference in a BB in a normal year which is known as 'maintenance requirement' and a drought year which is known as 'drought requirement'. The variability that is seen in between a natural flow regime and the modified flow which is known as hydrological variability index is calculated from the coefficient of variation of the flows of several calendar month and baseflow index (baseflow / total flow). If the variability index is high it shows that the flow regime of the river is more variable.

The analysis that can be drawn from DRM is that in a normal year, stable the flow regime, higher is the environmental flow requirement and less stable the flow regime, lesser is the environmental flow requirement which draws the conclusion that the rivers which have got more variable flow regime will have a lower long-term mean environmental flow requirement.

The advantage of DRM is that it is a comprehensive environmental flow assessment approach and ecologically justified. It requires monthly flow data which is easily available and this becomes advantageous for developing countries.

Table 2: Showing the Environmental Management Classes (EMC)

EMC	Ecological Description	Management Perspectives
A (Natural)	River in pure condition or little modification	Protected rivers and basin
B (Slightly modified)	In spite of modification there is integral biodiversity and habitat	Water supply schemes or irrigation development present
C(Moderately modified)	Due to modification there is disturbances in biodiversity and some species have got extinct	Multiple disturbances like dams, diversions etc.
D (Largely modified)	Biodiversity highly disturbed, alien species persist, many of the native species have got extinct	Multiple and significant disturbances
E (Seriously modified)	Biodiversity has declined, alien species turned to invasive, tolerant native species persists	High population density and exploitation of water resources
F (Critically modified)	Natural habitat lost as complete modification of the ecosystem has occurred, changes irreversible	Management difficult but necessary in order to move the river to higher EMC

Catchment Abstraction Management Strategies (CAMS)

This approach is developed by UK Environment Agency. In this method the four elements: a). Physical characterization, b). Fisheries, c). Macrophytes, d). Macro-invertebrates are considered. All the elements mentioned have to be scored from 1 to 5, 1 represents least sensitivity and 5 represents highest sensitivity. The physical characterization of the river is scored in such a way that the deep rivers are scored 1, as they do not get affected by the changing flow and the shallow ones are scored 5, as the shallow rivers easily get affected by the changing flow. Then scoring of fisheries is done either by expert opinion or flow habitat modeling. When all the four elements are scored, the scores are combined so as to get the Environmental Weighting Band of the river where Band A represents highest sensitivity and Band E represents least sensitivity.

Once the environmental weighting band has been determined, the target shifts to the determination of Flow Duration Curve (FDC) that helps in understanding that

to which extent water can be abstracted from the river. A FDC for the catchment is produced by either looking at the characteristics and climate of the catchment or by adding and subtracting abstractions and discharges respectively from the flow time series. Then depending on simple rules and environmental weighting band, the percentage of low flow that can be abstracted from the river is determined where a low flow is defined as "the flow exceeded 95% of the time (95 percentile on the FDC)". In the same way, the other 16 percentile (0.01, 0.1, 1, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90, 99, 99.9, 99. 99) of the flow are determined so as to get the entire target environmental flow duration curve. This entire environmental flow duration curve has to undergo a judgment from a specialist, after this the FDC is ready to be used for a more detailed analysis of environmental flow requirement.

Table 3: Showing the percentage of Q_{95} flow that can be abstracted at different environmental weighting band

Environmental Weighting Band	% of Q_{95} that can be abstracted
A	0-5%
B	5-10%
C	10-15%
D	15-20%
E	20-25%
Others	Special treatment

Disadvantage of Desktop Analysis Method

All the methods described in desktop analysis are not specific for a particular basin and if a method is constructed for a particular place it cannot be applied elsewhere and if it is necessary to use the method in a new place it requires recalibration of the data.

Hybrid Methodology

These methodologies are the ones that make use of the combination of two or more methodologies described above. In hybrid methodology, the methodologies for the environmental flow assessment can be used along with the other methodologies that are not developed particularly for the purpose of assessing the environmental flow requirement but can be potentially used for this purpose.

LIMITATIONS OF ENVIRONMENTAL FLOW REQUIREMENT

There are various limitations attached to the computation of environmental flow requirement. These limitations are described below:

Lack of Data Availability

The daily flow data or monthly flow data that are used for the computation of environmental flow requirement are not readily available and if they are, then their accuracy is highly questionable. In spite of this, all the methods that are used in environmental flow requirement are data intensive. So it needs some modifications in the methods of assessment of environmental flow and such methods have to be developed that requires less data.

No Method is Global

All the methods for assessing the environmental flow can be applied at the place where they are developed and if these methods have to be used at any other place, then they require recalibration of data. Even the methods are not specific for the basins of the same country. Therefore, a global method for assessment has to be developed that is not specific to a particular country or basin.

Lack of Understanding

The ecological functioning of a river is dependent on the hydrological variations that are occurring in the river but this relationship is not understood properly. This may be due lack of data or lack of understanding at the part of hydrologists.

Lack of Finances

As there is too much pressure on the natural resources of the developing countries, they are in the dire need for the assessment of environmental flow. But due to the lack of finances on their side, there remains a gap in modification of the assessment methods for the environmental flow requirement.

CONCLUDING REMARKS

Minimum flows, also called EFR, refer to a certain minimum flow that should be maintained in a river reach for protecting the aquatic habitat. While there is no argument about the importance of preserving aquatic eco-systems, there isn't much progress towards making allocations for EFR. It is difficult to quantify the EFR. Rational methods by mapping the aquatic flora and fauna demand huge efforts and resources. Arbitrary stipulations do not clarify exactly what benefits will be achieved in return for the water allocated for EFR. Also, for achieving a reasonably healthy habitat, the EFR works out to such a large quantum that it is impossible to provide it. Past experience indicates that allocations for EFR ignoring the human demand remain on paper, and do not get translated into practice.

In this paper the various available methodologies have been introduced. There are a number of existing methods for determining an environmental flow. Look-up

tables and desk-top analysis for environmental flow assessment are used in scoping studies, national audits or river basin planning. Functional analysis and habitat modelling are the most widely applied approaches in impact assessment or restoration planning for single or multiple stretches of a river. These assessment methodologies can contribute to setting management rules and monitoring their impact on river health.

The paper also explains that there are no fixed quantifiable requirements of ecology. The allocation for this purpose is to be based on a scientific analysis of the hydro-ecologic regime, and negotiations amongst stakeholders representing the interest of ecology and other uses.

Improvement of Water quality of river waters should not be linked with Environmental flows/minimum flows as dilution is not a solution to problem when there is too much stress on fresh water resources. The myth that storage structures lead to drying up of rivers needs to be refuted among the common people and activist and construction and proper management of control structures can go hand in hand in maintaining environmental flows as well as to meet up the ever increasing use of water resources.

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