EFA AND THE IMPACTS ON RIVERS ECOLOGICAL INTEGRITY

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Abstract

Environmental or Ecological Flow Assessment (EFA) as escalated set of methodologies is becoming an important toolbox to assess from rivers' flow natural regime to its ecological integrity. Hydrological approaches and methods are the basis to identify the natural flow regime and its alterations caused by water subtractions or hydraulic infrastructure. Results are complemented with hydraulic measurements and associated to habitat availability and connectivity among aquatic, riparian and coastal communities. In addition, holistic approaches consider environmental services for people and comparison of water allocation scenarios. Due to the condition of many rivers which are over-allocated, polluted and losing biodiversity, it is recognized that EFA is needed as part of approaches both at strategic level in the integrated water resource management IWRM and as part of EIA for large hydraulic projects. During more than ten years a national standard on ecological flows was under development in Mexico and it was finally issued in September, 2012. This standard explains different methods for determining ecological flows in basins, sub-basins or river reaches. Using these methods the urgent need of reserving water for ecosystems in basins which still have high ecological importance and low water use stress is on progress. The Mexican water agency and other institutions and NGO's are working this year in a program to implement ecological reserves in three less developed regions where there are natural protected areas. On the other hand, capacity building activities are in place for EFA and, people from several institutions are being trained on the standard application. Future work consider EFA holistic studies and implementation to follow up ecosystems' responses under an adaptive approach to balance flow alterations, water uses and ecosystem recovery from impacts.

Environmental Flows and its assessment

Environmental flow is an amount of water that is kept flowing down a river in order to maintain the river in a desired environmental condition in terms of water quality, quantity and distribution required to maintain the components, functions and processes of aquatic ecosystems on which people depend. As the concept has evolved, there has been significant development of approaches to the assessment of environmental flows which consider the natural variability in magnitude, duration, timing, frequency and rate of change (Richter, et al., 1997).

Environmental flow assessment is based on the assumption that there is some 'spare' water in rivers that can be used without unacceptably impacting on the ecosystem services that the river provides. Then, it is both a social and a scientific process, with a social choice at its core. There is no one correct environmental flow regime for rivers – the answer will depend on what people want from a river in terms of conservation and use, (O'Keeffe & Quesne, 2009).

The National Commission of Water set a regulatory standard to estimate water availability in the country since 2000 (NOM-011-CNA-2000). Under its application a general balance for groundwater and surface water has been obtained and issued as availability agreements for approximately 605 aquifers and 738 basins. This standard points out an environmental allocation only as an annual volume because methods to estimate ecological flows were not standardized in the country.

The new technical Ecological Flow Standard (NMX-AA-159-SCFI-2012) issued in September, 2012 considers two criteria to classify basins or river reaches under different Environmental Objectives “EO” (A, B, C or D): 1) water pressure as percentage of allocated water and 2) its ecological importance (based on high biodiversity sites and low eco-hydrological alteration) (Figure 1). Ecological flows can be obtained as reference values as percentages of annual average flow or volume, which are higher for EO “A” in blue and diminishes gradually for B, C and D in red, using approaches like modified Tennant (García, et al., 1999), WWF (WWF & Fundación Río Arronte, 2011), IHA-RVN from TNC and any other recognized hydrological method.

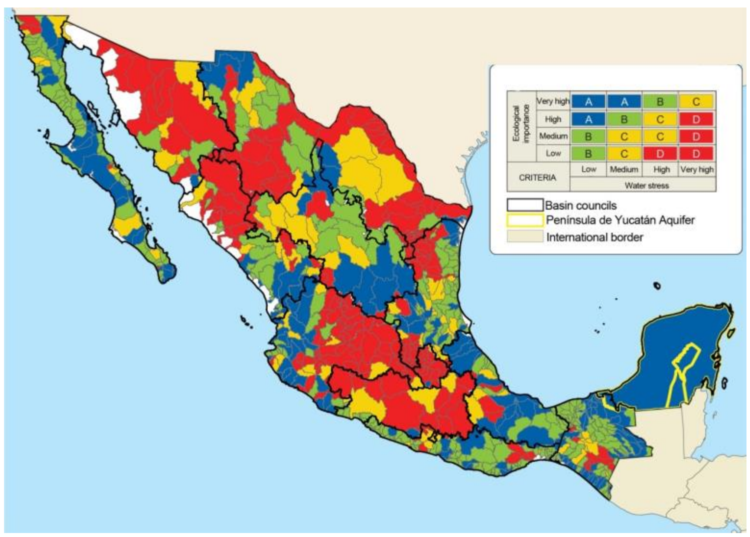

Figure 1 Environmental Objectives of the Mexican basins (WWF, Fundación Río Arronte, & CONAGUA, 2012a)

EFA Methods and application

At present, the Mexican EFA standard calls for the application of hydrological method as the basis for reserve or allocate water for the environment. Therefore, according to the EO’s, the reference values (annual volume or flow) as well as the components of a flow regime are stated as follows:

1. Percentage of average annual flow (AAF) or volume (AAV) with different seasonal percentages
2. Percentage of monthly average flows MAF

3. A base flow during dry season not less than the minimum historical monthly flow (MinF)
4. A volume associated to an ordinary regime (TVOR)
5. A volume related to the frequency of flood regime (TVFR) with a return period of 1, 1.5 and 5 years within 10 years for EO "A" and less for the other EO's.
6. Thresholds for hydrological parameters of ecological importance to be considered to limit alterations (monthly flows, 1, 7, 30 and 90 days minimum and maximum flows).

These approaches can be applied at basins, sub-basins or river reaches as it is pointed out in Figure 2. If 20 or more years of hydrological data are available the alteration degree can be estimated too. The Mexican flow standard also describes some initial experiences in using habitat simulation with PHabSim program and holistic methods BBM building blocks methodologies.

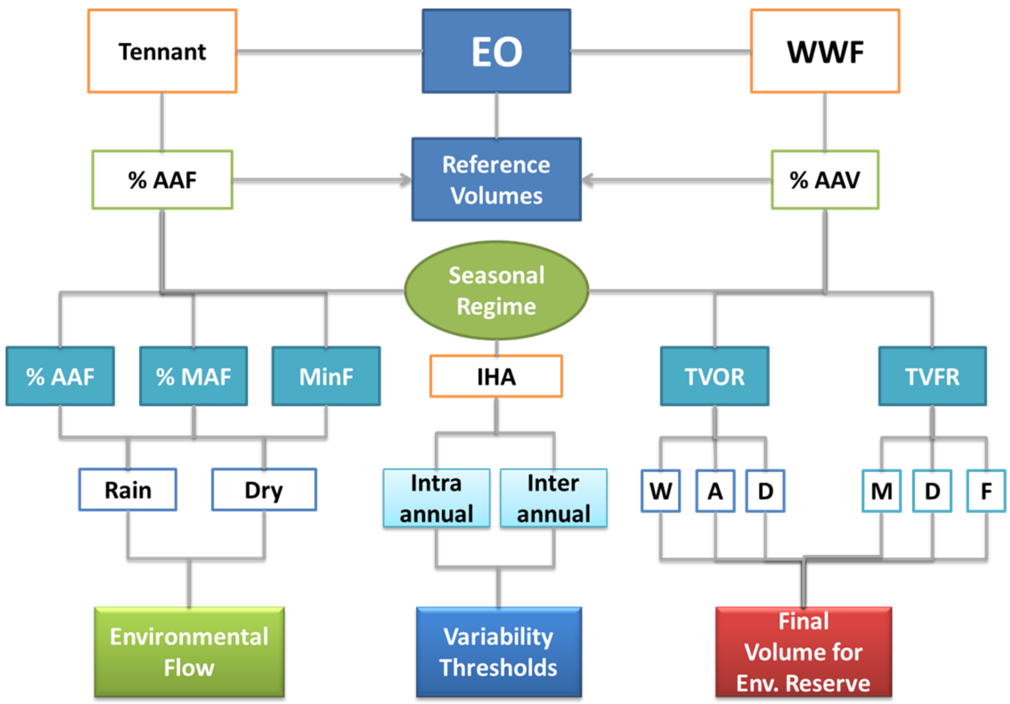

Figure 2 EFA hydrological approaches in the Mexican Standard

EFA and integrative approaches

Due to many rivers are suffering from over-allocation, pollution and biodiversity impoverishment (Vörösmarty et al., 2010), EFA is needed at higher planning levels like the integrated water or river resource management IWRM, water allocation policies and sectorial or regional plans or programs which include water management such as hydraulic or hydropower development, irrigation, sanitation, etc. Thus, EFA can be assessed for a region or basin, or can be part of the EIA for large hydraulic projects like dams with different flow alterations e.g. in dry seasons, all year long or daily for hydro picking power generation.

During EIA for a project, it might become clear that EFA is needed if impacts are going to be caused on a freshwater ecosystem. Although most gathered information for EIA can be used for EFA (Hirji & Davis, 2009), due to the scope of a holistic EFA some specific information could be needed for aquatic organisms such as their life cycles associated to hydrological patterns, river bed geomorphology and habitats availability or connectivity, etc. For social issues it could be more clear the need to include in EIA environmental services (food, recreation, flood safety, connectivity to wetlands, etc.) o even issues related to water governance, allocation policies and so on. This kind of information is requested as complimentary when an EIS is submitted to review in Mexico.

As stated by (Hirji & Davis, 2009), "Water resources planners, EIA practitioners, and social scientists need to recognize the importance of impacts that arise downstream of projects and include EFA techniques in their toolkits, so that EFA is effectively absorbed into planning studies, EIA’s, and SEA’s".

EFA and Water Reserves

Due to the classification of water bodies in relation to its water availability and ecological importance, an urgent output was the identification of basins with high level of conservation to preserve water for their ecosystems. The Mexican water agency Conagua and WWF-Mexico are working on setting environmental water reserves. Under this approach, they are developing specific studies to justify and implement the three first water reserves (Figure 3).

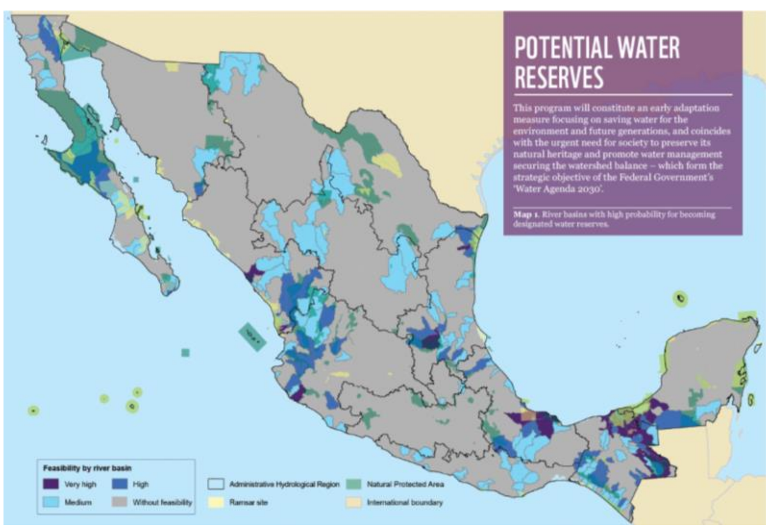

Figure 3 Potential Environmental Water Reserves (WWF, Río Arronte Foundation, & CONAGUA, 2012b)

These reserves are going to be decreed by the presidential resolution since environmental water use is at fourth level of allocation priority in the National Water Law.

For instance, a Water Reserve is seen as an instrument to ensure environmental goods and services of the hydrological cycle that preserves the functionality and connectivity of ecosystems. The main criteria to identify water reserves are: 1) Water availability and stress (management units); 2) Biodiversity importance; 3) Water extraction restrictions; 4) Presence of hydraulic infrastructure (large dams); 5) Irrigation Districts; 6) Overexploited aquifers; 7) Population density and 8) Intensity of water measurement.

Conclusions

In this paper the main EFA methods and approaches have been described in general but it is recommended to review them carefully and look for their application at different levels of planning stages for regional programs or at project level.

Counting with a technical EFA standard will help to address assessments for which it is recognized the need of specific training and interdisciplinary approaches, even more for the application of holistic methods. At present a capacity building project is in place in the country and during the last trimester of 2012 after the standard publication, more than 120 people from different institutions were trained on its application, mainly using hydrological methods and approaches. Although, examples using more advanced methods are planned for some basins.

EFA can be complimentary to EIA case studies were issues like water quantity and quality and aquatic ecosystem are going to be impacted. EFA points out the recognition of the natural flow regime to be resembled with the minimum alteration possible. This is regime can be associated to processes like land use changes, and can determine basin transport processes (sediments and nutrients), water quality, habitat configuration, biodiversity distribution and species life cycles.

Developing integrated studies on these topics, adding water policies and governance could be beyond EIA scoping. Therefore, it is important to identify which EFA topics are more related to upper levels of planning to improve the regional scope that reduces issues to be solved in an EIA of one project. For example allocating policies that recognize conservation objectives are going to be more effective to protect a river before one project face challenges to recover water for it. Thus, biodiversity conservation policies through natural protected areas need to include water reserves for the environment. At project level EIA and EFA could be load with bad water management policies or cumulative impacts in a region under a difficult situation to resolve just by one project.

As stated by The Brisbane Declaration, 2007: "Water resources planners, EIA practitioners, and social scientists need to recognize the importance of impacts that arise for regional hydraulic plans and downstream of projects to include EFA techniques in their toolkits, so that EFA is effectively absorbed into planning studies, EIAs, and SEAs to protect rivers' integrity".

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