Making a case for estimating environmental flow under climate change

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A case for incorporating requirements of water quality and water quantity under climate change in estimating environmental flow (Eflow) is presented. Despite the developments in Eflow assessment technologies worldwide, such studies are given little attention in practice. Eflow estimates for a given river stretch need to be modified accounting the present and future water availability. Water quality and water availability can be incorporated in Eflow estimations through an integrated water quality and hydrological modelling for any basin. This framework can be extended to simulate the future scenarios (quality and quantity) by inputting future precipitation and temperature projections from global climate models.

The recent attention on 'minimum flow' or 'environmental flow' requirements is due to the realization that any management and design of sustainable water resource systems, for the present and future, should consider the ecological, environmental and hydrological integrity of the region, in addition to the demands of the society. The beginning of the 21st century witnessed the development of various methodologies for estimating environmental flow (Eflow)[1] and thereby the necessity of providing minimum flows in a river stretch has drawn worldwide attention. It is worth mentioning here that Eflow has been estimated based on desktop methods or rapid assessment techniques using information of past flows, i.e. as a percentage of any percentile of dependable flow. A few studies have also adopted holistic methods or detailed assessments, such as habitat and ecosystem modelling in estimating Eflow[2]. However, none of these assessments has taken into account two major factors: (i) minimum flow required to maintain water quality in the river stretch, and (ii) future water availability in the basin. These two factors need to be considered in any Eflow assessment method. Climatic variables such as air temperature and precipitation affect river flows and the mobility and dilution of contaminants, hence affecting water quantity[3] as well as water quality parameters[4]. However, few studies have considered this aspect during estimation of Eflow. These aspects are important for ensuring provision of required Eflow in a river. The aim of this note is to present a case for incorporating requirements of water quality and quantity under climate change in estimating Eflow.

Despite the developments in Eflow assessment technologies worldwide[1], such studies are given little attention in practice. Often, the assessment of water needed for environmental purposes is constrained due to the limited database. Among the studies assessing Eflow requirements, water quality criterion has been omitted, claiming that 'Dilution is not a solution to pollution'[5]. While this argument is valid for river stretches without any pollution contributions from drains, it does not hold good for cases where river stretches are left dry due to upstream storages/diversions and carry polluted water from the drains only. For the latter case, the discharge flowing through the river stretch is polluted irrespective of the treatment provided and does not have the opportunity to self-cleanse. In such cases, a minimum flow should be provided to satisfy the water quality requirements along the stretch.

While the practice of draining pollutants into any river has been adopted, taking into account the self-cleansing power of any river, the current practice of leaving the river stretch dry, due to over-exploitation of upstream or due to changes in climate, is not justifiable. Even with stringent treatment policies for drains discharging into this stretch, it might be left always polluted due to the zero flow condition in most months in a year. These factors place emphasis on the need for considering water quality information in the estimation of Eflow. However, since societal demands of river water, such as drinking, irrigation, industrial uses, etc. have to be given priority, it is also essential to estimate water availability in a given river stretch at present as well as in the future. Thus Eflow estimates need to be modified to reflect this additional requirement.

The above discussion indicates the need for considering aspects of water quality and water quantity in estimating Eflow for a given river stretch. Figure 1 shows a schematic of interlinking of different aspects in estimating Eflow. Water quality and availability can be incorporated in Eflow estimations through integrated water quality and hydrological modelling for any basin. This framework can be extended to simulate the future scenarios (quality and quantity) by inputting future precipitation and temperature projections from global climate models. The stepwise methodology to estimate the future water availability and changes in water quality is detailed here. (i) Downscale the future air temperature and precipitation projections from various climate models over the basin and obtain the uncertainty in these projections. (ii) Estimate the future water availability and associated uncertainty through hydrologic modelling of the basin, using the above projections. (iii) Generate the possible future changes in pollution loadings. (iv) Estimate the future water temperature and associated uncertainty from future air temperature projections. (v) Perform water quality modelling of the river stretch with outputs from steps (iii) and (iv). (vi) Estimate minimum flow to maintain water quality for all plausible scenarios.

The above-mentioned aspects are important in estimating Eflow for any river and need to be considered in detail to ensure sufficient water flow in the river with desired water quality. It is also important to note here that we only intend to highlight the need for incorporating water quality aspect during estimation of Eflow and do not suggest that provision of Eflow to river system should be the main approach for tackling river pollution. It is well established that the best solution for tackling river pollution is to stop discharge of polluted water into the river. However, attainment of this goal might take time depending on availability

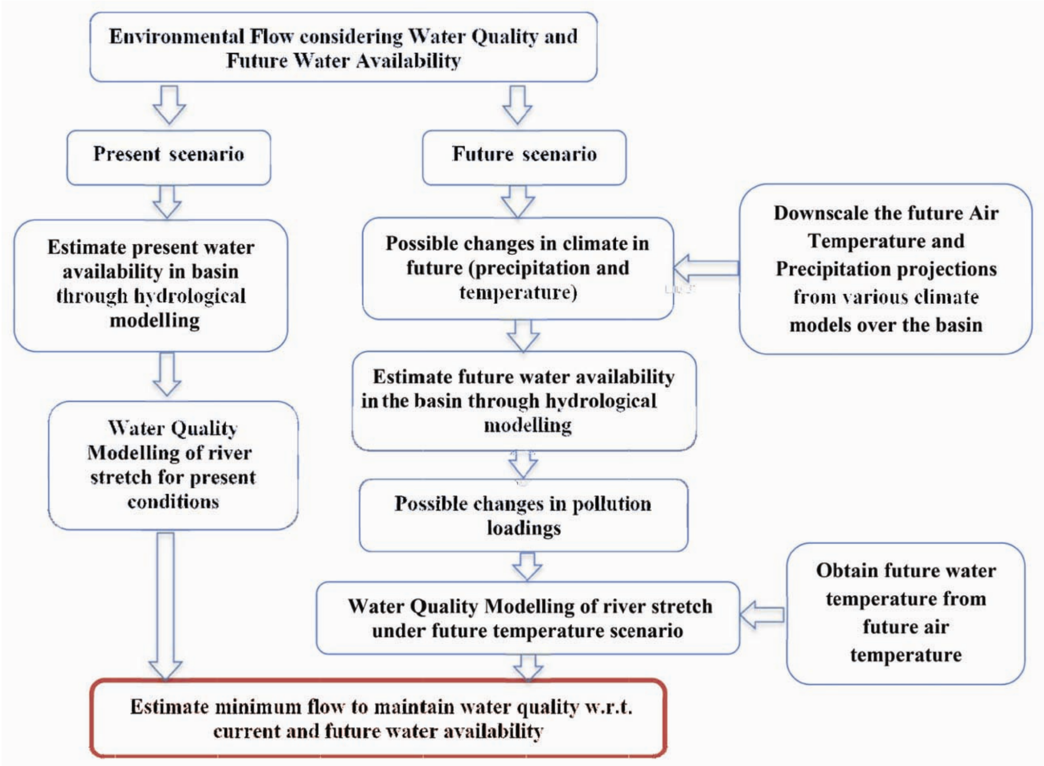

Figure 1. Schematic of interlinking of factors influencing estimation of environmental flow.

of technology, stakeholder's interests and Government policies, and is expected to be implemented in a stepwise manner.

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