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"ASSESSMENT OF ENVIRONMENTAL FLOW FOR MUTHA RIVER IN PUNE CITY"

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ABSTRACT

In Maharashtra, the river Mutha in Pune district has been nearly turned into drainage stream along its stretch in Pune city. The 15 Km stretch of Mutha River starting from downstream of Khadakwasla dam to its confluence with Mula River is considered for environmental flow assessment. The Tennant Method is adopted for the study. Average Annual Flow (AAF) is estimated using historical flow data of the stream at Dattawadi gauging station (Tal Pune). E-flow is recommended in terms of certain percentage of AAF corresponding to the general conditions of flow (ranging from flushing to poor) in two phases of the year.

KEYWORDS :*AAF, Ecology of river, E Flow, Mutha River, Tennant method.*

INTRODUCTION :

The flows of the World's Rivers are being modified due to construction of dams/weirs for agriculture and urban supply, hydroelectric projects, maintenance of flows for navigation, discharge of polluted water and structures for flood control. In many cases, these modifications have adversely affected the ecological and hydrological services provided by water ecosystems. Unfortunately, Indian rivers also have been viewed at as only providers of water and receivers of waste water and effluents. The ecosystem links between upstream, mid stream, floodplains and riparian areas have not been the focus of any river improvement schemes or developmental projects. Each river system has an individual flow regime with particular characteristics such as seasonal pattern of flows, timing, frequency, predictability and duration of extreme events (e.g. floods and droughts), rates of change and other aspects of flow variability. Each of these hydrological characteristics has individual as well as interactive regulatory influences on the biophysical structure and functioning of the river and floodplain ecosystems. This also includes physical nature of river channels, sediment regime and

water quality, biological diversity/ riverine biota and key ecological processes sustaining the aquatic ecosystem. Deviations from natural flow regime result in drastic change in the riverine ecosystems and fishery structures in the downstream (K. D. Joshi & D. N. Jha, ICAR, 2014). All this human interference in river ecosystem is on the verge to be taken care of. A need has been felt to maintain minimum fresh water flows called as E flows or Environmental flows in the rivers to regain the riverine ecosystem.

Definition of Environmental Flow: E flows or Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and wellbeing that depend on these ecosystems.

METHODS FOR ASSESSMENT OF EFLOW:

A global review of the status of environmental flow methodologies revealed the existence of some 207 individual methodologies recorded for 44 countries (Tharme R.E., 2003). These methods are based on various criteria, including hydrological (e. g. Tennant, Q90), hydraulic rating (e. g. wetted perimeter), habitat simulation (e. g. IFIM, PHABSIM) and holistic methodologies (e. g. Building Blocks Methodology). In the South Asian region, developments in understanding environmental flows and their assessments have been initiated since the beginning of the 21st century (Gopal B, 2013). River management issues, including estimation of environmental flows and their effective implementation are still in the developing stage in India; hence limited literature is available on environmental flow studies in Indian rivers. It is a general apprehension among environmentalists, planners and the common masses that the construction of dams and barrages causes great loss to the rivers; so the consequences need to be estimated or quantified.

Table No. 1: Comparative statement showing features of various methods

Type of Method	Example	Data and time and funds requirement	Approximate duration required	Relative confi-dence in output
Hydraulic Rating Methods	Wetted Perimeter method	Moderate	6 to 12 months	Low
Hydrological Methods	**Tennant** , Modified Tennant Method (Exceedance), Q95	Moderate to Low	1 to 5 months	Low
Habitat Simulation Methods	IFIM, PHABSIM, Expert Panels	Moderate	6 to 24 months	Medium
Holistic Methods	Building Block Method (BBM)	High	2 to 5 years	Maximum

METHOD ADOPTED FOR STUDY:

In this paper, for assessment of eflow the Tennant method is adopted. It is an example of hydrological methods. Hydrological methods primarily use hydrological data for making e flow recommendations. They are simple, rapid and inexpensive desktop approaches. They require only flow data of the stream. It is suitable for the rivers having gentle slope. The method is also applicable to many of the stream types. It can set threshold flows or regimes. Majority of challenges have been successfully defended by this method. (The nature controversy report, 2008)

Tennant used stream gauging records and worked for 30 years at 117 cross sections of river system to calculate eflow and established range of base flow conditions and associated level of habitat conditions generated by various flow regimes using AAF. Tennant's method reserves an amount of water for each of the seasonal periods of April- September and October-March

Table No. 2: Criteria of the Tennant Method

Flow Rating	Recommended Base Flow regime(Percentage of Average Annual Flow)	
	October - March	April-September
Flushing or Maximum	200	200
Optimal Range	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	Less than 10	Less than 10

STUDY AREA:
MUTHA RIVER:

Geologically the realm of Mutha Basin is roofed by Deccan volcanic rock of the continental theolietic province of Bharat having Eocene epoch age (about fifty five to fifty six million years) The origin of Mutha is within the lower hill ranges of jap flanks of N-S, trending Sahyadri ranges, flowing towards eastward then SE –wards up to Khadakwasla then redeeming NE direction to flow in nearly plain space until it meets Mula stream at Sangamwadi in Pune town . attributable to laborious and big rock?moderate to carefully sloping plain, with large rock- basalts domination.

T errain, the bulk of stream bed is comparatively shallow , rocky and wide. The fifteen klick stretch of Mutha stream ranging from downstream of Khadakwasla dam to is confluence with Mula stream at Sangamwadi bridge is taken into account within the gift study .

Fig No.1: Mutha River

PRESENT STATUS OF MUTHA RIVER:

- After construction of Khadakwasla dam, the perennial nature of Mutha stream are changed in artificial walled channel and stringer flow , pounding or dry course, at places specifically downstream, except time of year. Water isn't allowed to be due dam storage, to stay it for increasing demand and reserving all quantity of storage water for drinking. Explosive increase, poor urban management, urban congestion in Pune city has overburdened the resources including
- All the 90 % untreated waste water is continuously being discharged into the stream and what the flow we see in the stream is only drainage and effluents. There is no any evidence of live ecosystem in the stream (Parineeta Dandekar & Himanshu Thakkar, 2012)

- The stream divides the city in two parts and flows through center of it. Across the river there are total 14 bridges out of which 10 pass through the city. Hence the appearance of the stream is also one of the important aspects to be considered. The stream looks and smells like a drainage gutter.
- The alteration has led to depletion in water quality, establishment of invasive species and loss of biodiversity (Parineeta Dandekar & Himanshu Thakkar, 2012)
- The large-scale excavations being carried out in various projects generate thousands of tons of
- The large-scale excavations being dispensed in varied comes generate thousands of loads of trash, that is handily drop in or round the dry channel, that get washed away more downstream throughout rain reducing their carrying capability drastically , besides destroying all vegetation on slopes if any .The trash raises the bed level and also the flow is usually obstructed throughout serious rain and as a results of that the water changes its course inflicting widespread devastation making an attempt to divert their direction of courses, or inter-linking them, as a result of such associate degree action is lik ely to make imbalance. it'd upset the natural balance and adversely have an effect on the surroundings. it's dangerous to unnaturally monitor the natural courses of the watercourse .
- In 2014, the Pune Police discovered that marijuana plants were being grown on the riverbed near Kharadi which is the indication of presence of decreased water.

METHODOLOGY:

The river Mutha is studied at Dattawadi river gauging site for water discharge from 1982 to 2009. Dattawadi is situated 7 km to downstream of Khadakwasla dam. The river discharge is measured daily at site by Hydrology Project Division, WRD, Pune. The data are collected and arranged month wise to get Monthly average flow. The Average Annual Flow (AAF) is estimated using monthly average flow. (Table 4)

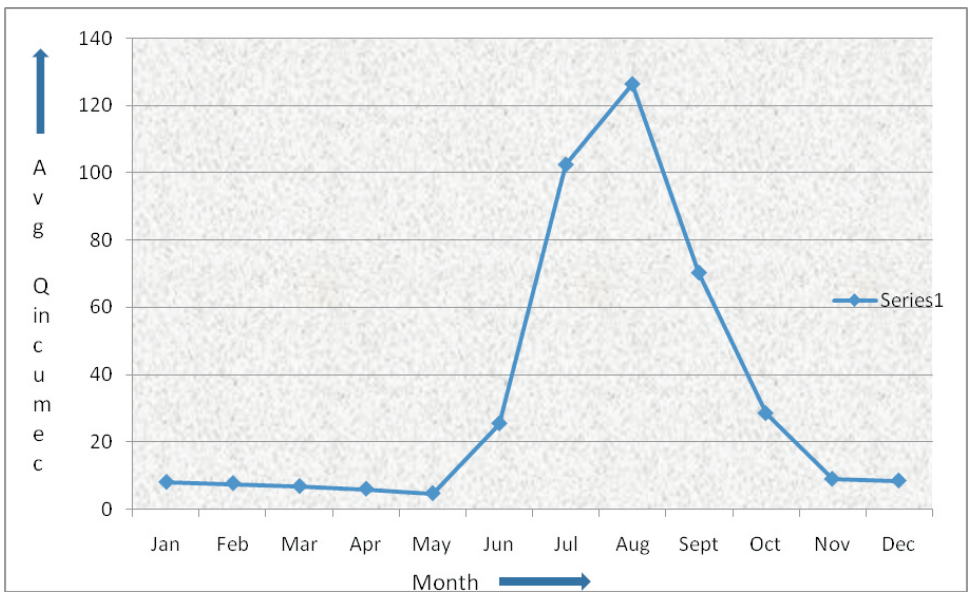


Fig. No. 2: Monthly Average Flow of the stream.

RESULTS& CALCULATIONS:

Average Annual Flow for the stream is estimated as below Average Annual Flow = Sum of Monthly Average flow from Jan to Dec/ 12

∴ AAF = 403.2063/12 cumec

∴ AAF = 33.60 cumec

Table No. 3: Estimation of Environmetal Flow for two phases of the year

Flow Rating	October – March(cumec)	April-September(cumec)
Flushing or Maximum	67.2	67.2
Optimal Range	26.88	26.88
Outstanding	13.44	20.16
Excellent	10.08	16.8
Good	6.72	13.44
Fair or Degrading	3.36	10.08
Poor or minimum	3.36	3.36
Severe Degradation	Less than 3.36	Less than 3.36

Fig No. 3: Expected Water Flow regime in Phase I i.e. October – March for Mutha River

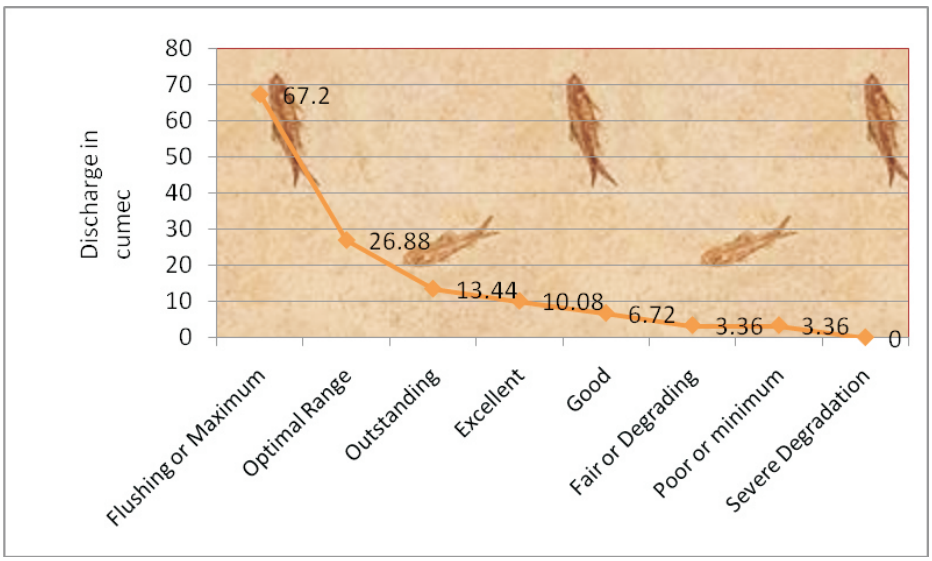
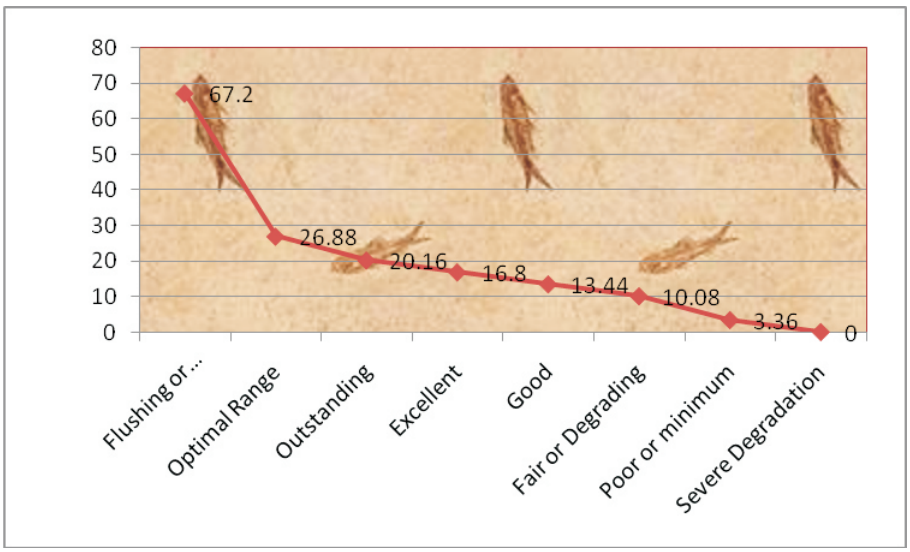


Fig No. 4: Expected Water Flow regime in Phase II i.e. April-September for Mutha River.



CONCLUSION:

On analysis of 19 years water discharge data by Tennant method of the river Mutha at Dattawadi site, it is concluded that minimum quantity of water discharge in Mutha River should be 3.36 cumec in Phase 1 i.e. from Oct to March and it should be 10.08 cumec in Phase II i.e. from Apr to September (Table 3) assuming that treated waste water is discharged in the stream. It is observed that in the month of April and May the desirable minimum range of discharge is hardly achieved and is much below the par. Another flow regimes should also be focused step by step to restore the river ecosystem.

RECOMMENDATIONS

Following recommendations are proposed for fulfillment of Environmental flow in river Mutha in months of April and May:

Drinking water supply per capita of Pune city is almost more than double the standard measures. There is no any curtailment practice in water supply except the years of drought. Therefore, if the water supply is reduced to standard amount; the saved amount of water then can be released into the river by introducing an outlet to water supply pipeline near Khadakwasala dam.

This proposal will give following advantages:

- Environmental flow needs of the stream will be fulfilled.
- As per Pune Municipal Corporation Water Supply and Drainage Dept report (February 13), the standard water supply should be 135 lpcd but in Pune the water supply is 321 lpcd. High rate of water supply is resulting in higher sewage flows. Total water supply to city is 1250 mld ie 14.5 TMC per year. If 50% of water supply saving is achieved ie 7.25 TMC per year then it will reduce the stress on sewage treatment plants (STPs) and unused fresh water will be available for river channel.
- This fresh water release into river will help to improve the appearance of river.
- Also the discharge of fresh water into river at about o.6 TMC per month will dilute the pollutants concentration emerging through few unauthorized outlets of untreated waste water discharge.
- It will help to fulfill the ecological needs of the stream.
- The river confluences with river Bheema at downstream. All the discharge (subtracting conveyance, use and evaporation losses) of river Mutha is accumulated in Ujjani reservoir constructed across Bheema river. The live content in the reservoir is observed below MDDL for about 6 to 7 months of the year (negative contents). The additional water supply in river Mutha throughout the year will increase the storage of Ujjani reservoir and additional water will be available for drought prone Solapur district.
- The increased water supply will increase the depth of water in stream. By proper planning and designing water transport will be possible through the stream. Water transport is the cheapest way of transportation.

Implementation of E-flow is comparatively easier, as, only provision of an outlet of required dimension to the water supply pipeline is needed. This water supply pipeline emerges out of khadakwasala dam. By discharging the flow of fresh water diverted through this newly introduced pipeline into the river; we can achieve the required amount of E-flow. It is feasible solution and therefore simpler to execute.

Environmental flow assessment is a combination of scientific and social elements – scientists can do the best assessment of flow needs, but they won't be implemented unless people know why the

flows should be left in the river, and think that it is important to do so. The most effective way of getting the science accepted is to embed the environmental flows process in an overall basin management process, which combines the use of the river with its protection.

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Table 4: Monthly Average Discharge of Mutha River at Dattawadi.

Year →	1982	1983	1986	1987	1988	1989	1990	1991	1992	1993	1994	1996	1997	1998	1999	2005	2006	2007	2008	2009	monthly average
Discharge in cumec																					
Jan	8.1	7.4	8.4	7.0	7.4	8.4	8.4	8.3	7.4	7.4	8.4	7.4	8.8	7.3	9.4	7.6	8.4	7.4	8.2	8.4	8.0
Feb	8.1	7.4	7.6	7.3	7.4	7.4	7.4	8.3	7.6	7.4	7.4	7.4	8.8	6.3	8.4	7.6	7.4	8.4	7.2	7.4	7.6
Mar	7.5	7.4	7.3	4.3	6.4	6.4	6.4	7.3	7.3	7.4	6.4	7.4	6.8	6.3	7.4	6.6	6.4	6.4	7.2	6.4	6.7
Apr	6.0	6.4	6.0	4.3	5.5	5.4	5.4	6.3	6.0	6.4	6.4	6.4	6.8	6.3	6.4	6.6	5.4	4.4	6.2	6.4	5.9
May	5.5	5.4	4.7	4.3	4.4	4.4	4.4	4.3	4.7	5.4	4.4	4.4	4.8	4.3	4.4	4.6	4.4	4.4	5.2	4.4	4.6
Jun	11.1	11.4	7.2	6.5	11.4	2.5	65.1	54.9	50,7	19.4	56.8	11.4	46.8	8.3	12.4	30.6	20.1	20.4	10.4	76.4	25.4
Jul	141.7	29.6	9.9	7.2	105.5	56.7	225.5	148.5	222	56.7	445.1	63.5	44.1	31.5	121.0	82.2	179.3	30.5	56.4	111.9	102.5
Aug	152.1	263.2	27.4	17.6	115.3	71.0	266.4	180.1	98.7	76.5	99.9	25.8	301.6	31.9	58.1	168.7	155.4	38.5	227.9	153.0	126.5
Sep	21.3	33.0	12.3	17.7	72.3	28.4	74.2	36.9	69.1	56.0	165.8	70.4	13.6	78.6	55.1	128.0	37.7	5.2	209.4	220.6	70.3
Oct	19.4	29.6	15.4	21.8	17.2	21.9	60.3	32.2	14.4	43.3	19.4	49.6	11.3	19.4	54.6	19.4	21.2	8.2	45.4	45.4	28.5
Nov	8.4	8.4	9.3	8.5	9.9	8.5	9.6	8.4	8.4	9.4	8.4	9.8	8.3	9.4	8.4	8.4	9.4	9.2	9.4	8.4	8.9
Dec	7.4	7.4	7.3	7.4	9.9	8.4	9.3	8.4	8.4	8.4	8.4	9.8	8.0	9.4	7.4	8.4	9.4	8.2	9.4	7.4	8.4

Source: Water Resources Department, GoM

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