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Environmental flow: Water Quality Assessment of a Mula River

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Abstract: The Mula Irrigation Project comprises, a storage dam near village Baragaon Nandur, Taluka: Rahuri, District, A'nagar, with two canals off-taking directly from the Dam to irrigate lands along both the banks of Mula River, as well as along the right bank of Pravara river. The project has been planned to harness the water potential of Mula River, a right back tributary of Pravara River in the Godavari basin. As such, a need arises to regulate the reservoirs for releasing the adequate water in the river throughout the year for maintaining downstream ecosystem as well as flushing flow once in a year to ensure regeneration of species in the river flood plains. Accordingly, it is essential to estimate environmental flows for this river. In the present study, the environmental flow requirement at two gauging sites one in upstream and other is downstream of Mula dam have been carried out using Lookup Tables, Tennant and Modified Tennant method (Tessman method). Modified Tennant method is found to be preferred to estimate the environmental flow requirements, which is more acceptable for allocating EFR on monthly basis. Also find out water quality from the water sample considering colonies of pathogenic bacteria and physico Chemical Properties.

Keywords: EFR, Lookup Tables, Tennant Method, Modified Tennant Method, Mula River, E-coli.

Introduction

Rivers are one of the most important common resources of the region. The region also shares some of these rivers with other nations beyond its political boundaries. Rivers help share water services, biodiversity, climate and livelihoods for millions of people. Rivers are also crucial for the water, energy, food and agriculture security for the people of the region. All the above of the downstream side changed due to complete stoppage of water. The Mula River is one of the Sub-tributary of Godavari Basin and it has a great religious significance in Maharashtra. A large number of pilgrims assemble on the banks of Mula River and take holy dip to worship the river as mother. Since, a dam has been constructed on Mula River system for creating storage of water for meeting irrigation and drinking demands. As, such , a need arises to as certain adequate flow to be maintained for survival of flora and fauna of the river apart from other needs of the people for drinking, irrigation and bathing etc. **In the present study, Environmental Flow Requirement (EFR) of Panegaon and Kotul gauging sites of Mula River has been assessed using Lookup Tables (WCD 2000; UK-Q_{95}; 75% of Q_{95}), Tennant and Modified Tennant methods (Tessman Method).**

STUDY AREA

Location details are given in Fig.No.1 and Table.No.1

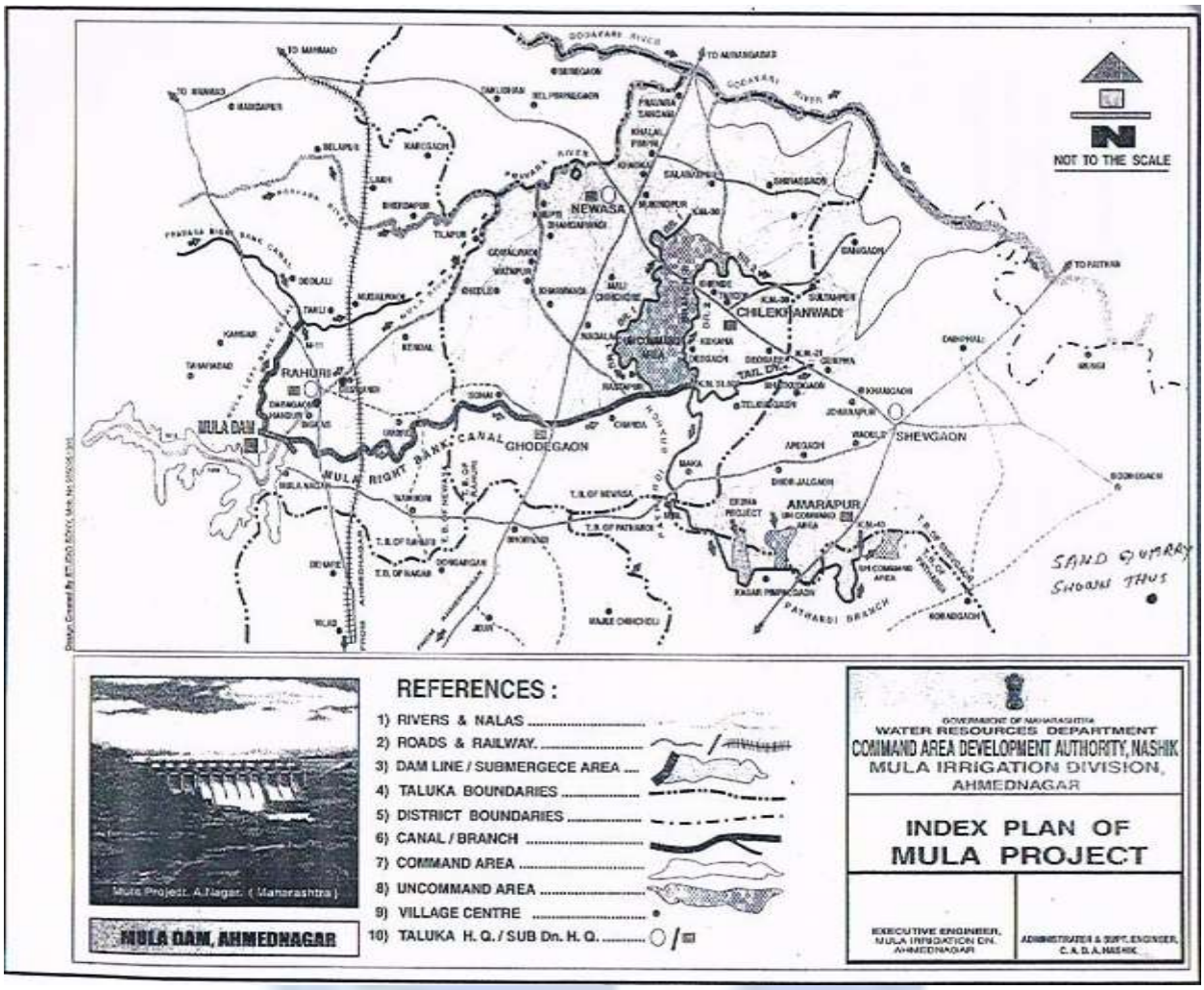

Fig. 1: Location of Gauging Stations

Table 1: Location-wise hydrological characteristics of the Mula River

Sr. No.	Gauging sites	Site code	Lat. (N)	Long (E)	Elevation (m)	Annual rainfall (mm)
1	Panegaon	R2	19^0 48’	74^0 79’	587.00	119
2	Kotul	R1	19^0 52’	74^0 00’	674.01	501.8

MATERIAL AND METHODS

In the present study, discharge data for 22 years(daily discharge data converted into 10 daily data) (1989-2011) was used to estimate EFR at Panegaon located on the Mula Stream.EFR has been estimated using Hydrological Index Method such as Lookup Tables, Tennant and modified Tennant methods. Under the lookup tables, the recommendation of WCD 2000, UK-Q95, 75% of Q95 have been used in the study. Apart from the above, Tennant and modified Tennant (Tessman method) methods have also been used to estimate EFR of the river at Panegaon and Kotul gauging station. Tennant (1976) considered the three factors of wetted width, depth and velocity as being crucial for fish well being. Tennant (1976) method is based on measured variables concerning physical, chemical and biological parameters along 58 transect from 11 different streams at 38 different discharges. Accordingly, Tennant proposed that certain flow could achieve the maintenance of particular amounts of habitat and this method uses a percentage of the mean annual flow (MAF) for two six month periods to define conditions of flow related to fishery, wildlife, recreation and environmental resources as per Table2.

Table 2: Tennant Scheme of EFR for different habitats

Description of Flow	April to September	October to March
Flushing flow(from 48-96 hours)	200%MAF(Mean Annual Flow)	Not Applicable
Optimum range of flow	60-100%MAF	60-100%MAF
Outstanding habitat	60%MAF	40%MAF
Excellent habitat	50%MAF	30%MAF
Good habitat	40%MAF	20%MAF
Fair or degrading habitat	30%MAF	10%MAF
Poor or minimum habitat	10%MAF	10%MAF
Severe degradation	<10%MAF	<10%MAF

The conditions of a particular habitat given by Tennant(1976) means that if the quantity of water that the basin managers can provide for EFR is < 20% of MAF(10% during April to September and 10% during October to March) then the environmental quality of the habitat in that reach will be "severe degradation" .And if a "Good habitat" is desired, then at least 60% of the MAF must be allocated for EFR,40% during April –September and 20% during October to March. The Tennant method is dependent on the provision of extensive flow data and the relationship between habitat suitability and proportions of mean annual flow, which forms the basis of this method, is still least examined in India. The Tennant method was further modified by Tessman method called as Modified Tennant method or Tessman Method. Tessman adopted Tennant seasonal flow recommendation to calibrate the percentage of Mean Annual Flow (MAF) to local hydrologic and biological conditions including monthly variability. The description is shows as below:

i. Monthly minimum equals the mean monthly flow (MMF), if MMF <40% of MAF
ii. If MMF > 40% of MAF, then monthly minimum equals 40% MAF
iii. If 40% MMF > 40% of MAF, then monthly minimum equals 40% MAF
iv. The flushing flow criterion is still a requirement to be met on an annual basis.

The colonies of E-coli found out and also find physico-chemical properties by collecting water sample from the various station in the Mula River and analysis is done on the laboratory of Soil Science, Pathology and microbiology.

RESULTS AND DISCUSSION

The EFR requirement of Mula River at Panegaon and Kotul gauging sites has been estimated using Lookup Tables (WCD 2000;UK-Q_{95};75%of Q_{95}),Tennant method (Table 4) and Tessman method (Table 5).According to lookup Tables (Table3),the results reveal variation of environmental flow requirement(EFR) from 55.87422 to 54.8 cumec for Panegaon gauging sites of the Mula River. From Table 6 and Table 7 environmental flow requirement (EFR) from 256.33 to 63.77 cumec. It is evident from Table4, that a flow in the order of 223.49 cumec during April to September and 111.74 cumec during October to March would be necessary to maintain a "good habitat" at Panegaon gauging sites of the river. Similarly to maintain an "Excellent habitat" at Panegaon a flow in the order of 279.37 cumec during April to September and 167.62 cumec during October to March has been estimated using Tennant method.Table 4 also indicates that flushing flow for a period of 48-96 hours should be provided once in a year during April to September in the order of 1117.48 cumec at Panegaon gauging site which would be essential for breeding , regeneration of flora and fauna of the river.

It is evident from Table6, that a flow in the order of 1025.32cumec during April to September and 512.66 cumec during October to March would be necessary to maintain a "good habitat" at Kotul gauging sites of the river. Similarly to maintain an "Excellent habitat" at Kotul a flow in the order of 1281.658 cumec during April to September and 768.99 cumec during October to March has been estimated using Tennant method.Table 6 also indicates that flushing flow for a period of 48-96 hours should be provided once in a year during April to September in the order of 5126.632 cumec at Kotul gauging site which would be essential for breeding ,regeneration of flora and fauna of the river.

Table 3: EFR at Panegaon gauging site of Mula River using Lookup Tables

Gauging sites	MAF (cumec)	WCD 10% MAF(Cumec)	UK Q_{95}(Cumec)	75%of Q_{95}(Cumec)
Panegaon	558.74	55.874	73.07	54.80
Kotul	2563.316	256.33	85.03	63.77

Table 4: EFR estimated by Tennant method at Panegaon and Kotul station

Description of Flow	April to September (Cumec)	October to March (Cumec)	April to September (Cumec)	October to March (Cumec)
	Panegaon		Kotul	
Flushing flow(from 48-96 hours)	1117.48	Not Applicable	5126.632	Not Applicable
Optimum range of flow	335.24 – 558.74	335.24 – 558.74	1537.98 – 2563.316	1537.98 – 2563.316
Outstanding habitat	335.24	223.49	1537.98	1025.32
Excellent habitat	279.37	167.62	1281.658	768.99
Good habitat	223.49	111.74	1025.32	512.66
Fair or degrading habitat	167.62	55.87	768.99	256.33
Poor or minimum habitat	55.87	55.87	256.33	256.33
Severe degradation	<55.87	<55.87	<256.33	<256.33

Table 5: Monthly EFR of Panegaon and Kotul gauging site in Mula River by Tessman Method

Month	Panegaon		Kotul	
	MMF	EFR	MMF	EFR
Jun	2.288	2.288	123.33	123.33
Jul	30.79	30.79	942.41	942.41
Aug	223.62	223.49	1034.33	1025.32
Sep	184.15	184.15	381.60	381.60
Oct	117.89	117.89	81.62	81.62
Nov	0	0	0	0
Dec	0	0	0	0
Jan	0	0	0	0
Feb	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
MAF	558.74		2563.37	
40% of MAF	223.49		1025.32	

As discussed earlier, EFR at Panegaon gauging site was also estimated using modified Tennant Method (Tessman method).The results are given in Table5, which indicate that MAF of river at Panegaon gauging site in the order of 558.74 m^3/s and 40% of MAF becomes 223.49 m^3/s .As per the modified Tennant method, if MMF less than 40% of MAF then EFR should be equal to MMF of that particular month i.e.; MMF of Panegaon station in June month is 2.28m^3/s it which is less than 40% of MAF(223.49m^3/s),therefore, EFR for the month of June should be 2.28m^3/s. If MMF of a month is greater than 40%of MAF then EFR of that particular month should be 40% of MAF for that month i.e.; MMF of August is 223.61 this is greater than 40% of MAF, therefore the EFR of August should be 223.49 m^3/s. Graphical representation of monthly distribution of EFR estimated using modified Tennant method has been shown in figure 2 and figure 3.and E-coli colonies has been shown in table No.6, 7, 8. And physico-chemical properties has been shown in Table 9 and it is within the permissible limits of WHO.

Table 6. E-coli Preseason (Stagnant water sample) on date 2/2/14

Name of Station	Level	Date	C. F.U. counts per ml	
			10^5	10^6
Baragaon Nandur and Rahuri Budruk	Top	2/2/14	Nil	Nil
Rahuri Khurd	Top	2/2/14	$14 *10^5$	$16*10^6$
Deswandi	Top	2/2/14	$5*10^5$	$53*10^6$

Table 7. E-coli Postseason (flowing water sample) 3/12/14

Name of Station	Level	Date	C. F.U. counts per ml	
			10^5	10^6
Baragaon Nandur	Top	3/12/14	Nil	Nil
Rahuri Budruk	Top	3/12/14	$2 *10^5$	$1*10^6$
Rahuri Khurd	Top	3/12/14	$9*10^5$	$8*10^6$
Deswandi	Top	3/12/14	$42*10^5$	$49*10^6$

Table 8. E-coli (Rainy season) 5/6/14

Name of Station	Level	Date	C. F.U. counts per ml	
			10^5	10^6
Baragaon Nandur	Top	3/12/14	Nil	Nil
Rahuri Budruk	Top	3/12/14	$27*10^5$	$13*10^6$
Rahuri Khurd	Top	3/12/14	$97*10^5$	$85*10^6$
Deswandi	Top	3/12/14	$47*10^5$	$53*10^6$

Table 9. Physico chemical properties of water sample of Mula River (Rainy season)(5/6/14)

Name of Station	Level	Ca	Camg	mg	PH	EC	TDS	COD
Baragaon Nandur	Top	2.9	3.1	0.2	7.8	0.499	319.36	950
Rahuri Budruk	Top	2.4	2.9	0.5	8.0	0.823	526.72	1605
Rahuri Khurd	Top	2.3	3.9	1.4	9.2	0.651	416.64	870
Deswandi	Top	4.9	6.1	2.2	8.5	0.317	202.88	1309

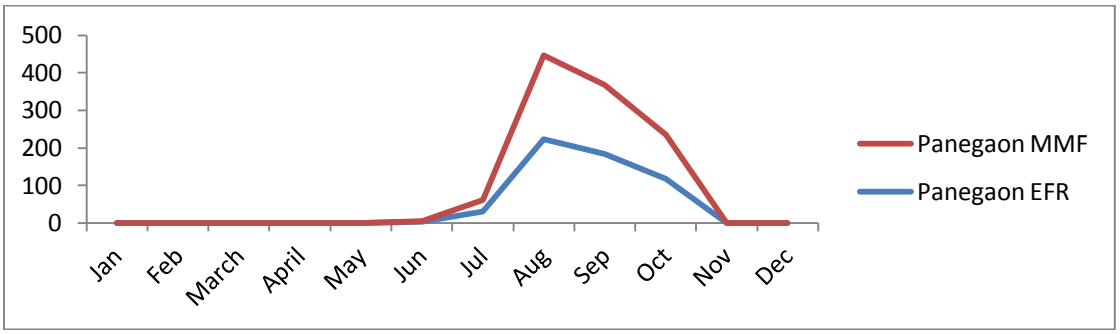

Fig. 2: Graph between monthly natural flow and EFR at Panegaon station

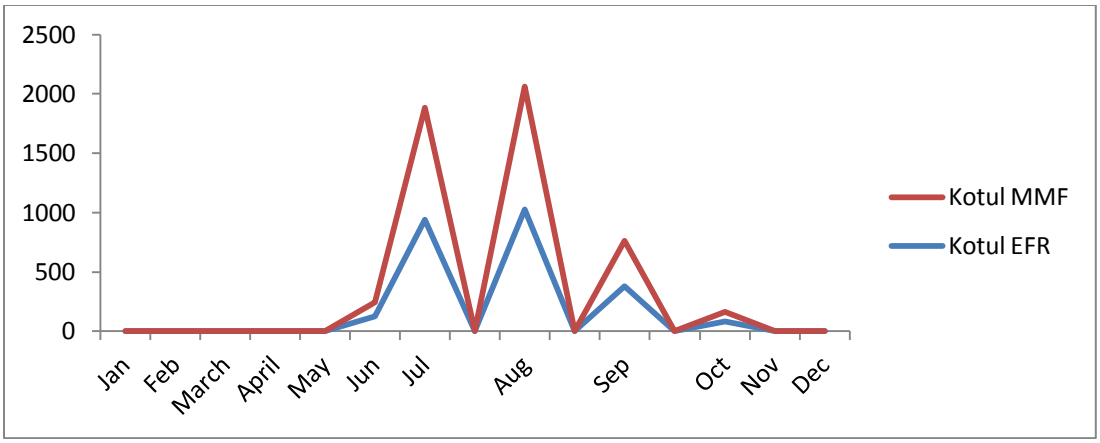

Fig. 3: Graph between monthly natural flow and EFR at Kotul station

CONCLUSION

In this study, environmental flow of Mula River at Panegaon gauging site has been estimated using various hydrological index methods, viz lookup Tables(WCD 2000; UK-Q95;75%of Q95), Tennant as well as Modified Tennant methods respectively. According to lookup tables as used in the present study, reveal variation from 55.87 to 73.5cumec for Panegaon gauging site and for Kotul it is 263.33 to 63.77 cumec. The results of lookup Tables may not be appropriate to recommend as EFR because these results were hardly found to represent even the poor flow condition (10%of MAF) of Tennant method for cases.

The Tennant method gives relatively more choices to recommend EFR varying from outstanding habitat to inferior habitat based on field condition and project priorities. But its modified method of EFR is also available. Alternatively, Modified Tennant method appears to be preferred to estimate the environmental flow requirements, which is more acceptable and allocating EFR on monthly basis. E-coli has been found in three station except Baragaon Nandur. Physico –chemical properties are within the acceptable limits. Therefore water quality of Mula River is within the permissible limits based on the data. However, the findings of the present study are based on the hydrological data , field and laboratory data only.

REFERENCES

[1]. AHEC (Alternate Hydro Energy Centre), 2011.Assessment of cumulative Impact of Hydropower Projects in Aleksandra and Bhagirathi Basin, IIT, Roorkee (Public Information).
[2]. Babu, K.L. and Harish Kumara, B.K., 2009.Environmental flows in River Basins: A case study of River Bhadara, current science, 2009 Vol.96, Feb.2009.
[3]. CPCB 2001.Central Pollution Control Board, Environmental Atlas of India. National Atlas & Thematic Mapping Organisation, Kolkata.
[4]. Jha,R; Sharma, K.D. and Singh, V.P; 2008.Critical appraisal of methods for the assessment of environmental flows and their application in two river system of India, KSCE Journal of Civil Engineering, Volume 12,Number3.
[5]. Narmada Control Authority (NCA). website: www.nca.gov.in
[6]. Smakhtin, V.U. and N. Erivagama, 2008.Developing a Software package for global desktop assessment of environmental flows. Environmental Modelling & Software, Volume 23, Issue 12 (December 2008), Pages 1396-1406, Elsevier Science Publishers B. V.Amsterdam, the Netherlands, The Netherlands.
[7]. Stalnaker, C.B.and Arnette, S.C. (Eds), 1976. Methodology for Determination of Stream Resource Flow Requirement: An Assessment.199 pp. (US Fish and wildlife Service, office of Biological Services, Western Water Association: Washington DC.)
[8]. Tennant, D.L, 1976: Instream Flow Regimes for fish, Wildlife, Recreation and Related Environment Resources, Fisheries 1(4);6-10.
[9]. Tharme, R.E.; 2003.A global perspective on environmental flow assessment: emerging trends in the development and application of environmental flow mehodologies for rivers Freshwater research institute, University of Cape Town, Rhodes gift, 7701, South Africa.
[10]. Tharme, R.E. and King, J;1998.Development of the Building Block Methodology for Instream flow Assessment and supporting Research on the Effects of Different Magnitude Flow on Riverine Ecosystems. Water Research Commission Report No576/1/98.