Chapter 9

Approach for Assessing Environmental Flow for River Godavari in the Study Area

9.1 Preamble

The concept of Environmental Flow has been used across the world in various ways. Some of it has been characterized with only survival of fisheries and river ecology, whereas in some other cases, it has been put across as wide ranging context wherein ground water, riverine and flood plains have also been included. The water need is prescribed not only as quantities allocation for various needs which mainly comprises of irrigation, industries and drinking purposes. However, a very strong emphasis has also been given for social and cultural needs. It is very important that in Nashik region, the needs have not been yet recognized officially which will necessitate that water quality and quantity is maintained for socio-cultural needs as well. Some of these needs cannot be only limited to KumbhMela but year round pilgrimage on the banks of Godavari, bathing quality of water and other related rituals etc.

Water quality depends upon the quality of water inlet and outlet of the water body system. The river water distribution varies with aquatic and surrounding population which uses the water for growth. This growth depends upon the water quality which can damage health of surrounding environment. There are various techniques to manage the water quality and quantity of water reservoir. Water quality modelling is also an efficient tool for this. A study has been done on Sieve and Ombrone rivers of Italy where hydraulically both rivers were subjected to massive winter and autumn floods. But reduce to almost a trickle during the summer months, when the river quality becomes critical and it is precisely then that a water quality model is needed (Marsili-Libelli and Giusti, 2008).The short length river compared to the extent required by the self-purification dynamics, point and nonpoint sources play a key role in shaping the model response and have to be accounted for, either by direct inspection or parametric estimation. Further, the varying river characteristics, in terms of morphology, hydraulics and vegetation, require the introduction of variable parameters, thus complicating the originally simple model structure. The calibrated model was used to assess the effectiveness of management decisions regarding the unsolved problems affecting the basin: upgrade the existing wastewater treatment plants and/or control the nonpoint source loading.

9.2 Interim Assessment of Minimum Flow for Godavari

The situation of Godavari River is similar to this because the quantity and quality both of this river is critical from December to Pre-monsoon. Water quality models are available for individual components of the hydrological system such as surface runoff; there also exist basin wide models

addressing hydrologic transport and for ocean and estuarine applications. Often finite difference methods are used to analyze these phenomena, and, almost always, large complex computer models are required. Water quality model can help to make rational management for aquatic and surrounding environment when a river system has many sources of water such as water treatment plant, dam release water at various locations. The quantification of water management also can be estimated for practical and economical point of view. The water quality of river after mixing depends on dilution and decay factor.

$$L_3 = \frac{L_1 * Q_1 + L_2 * Q_2}{Q_1 + Q_2} \qquad \ldots\ldots\ldots\ldots (1)$$

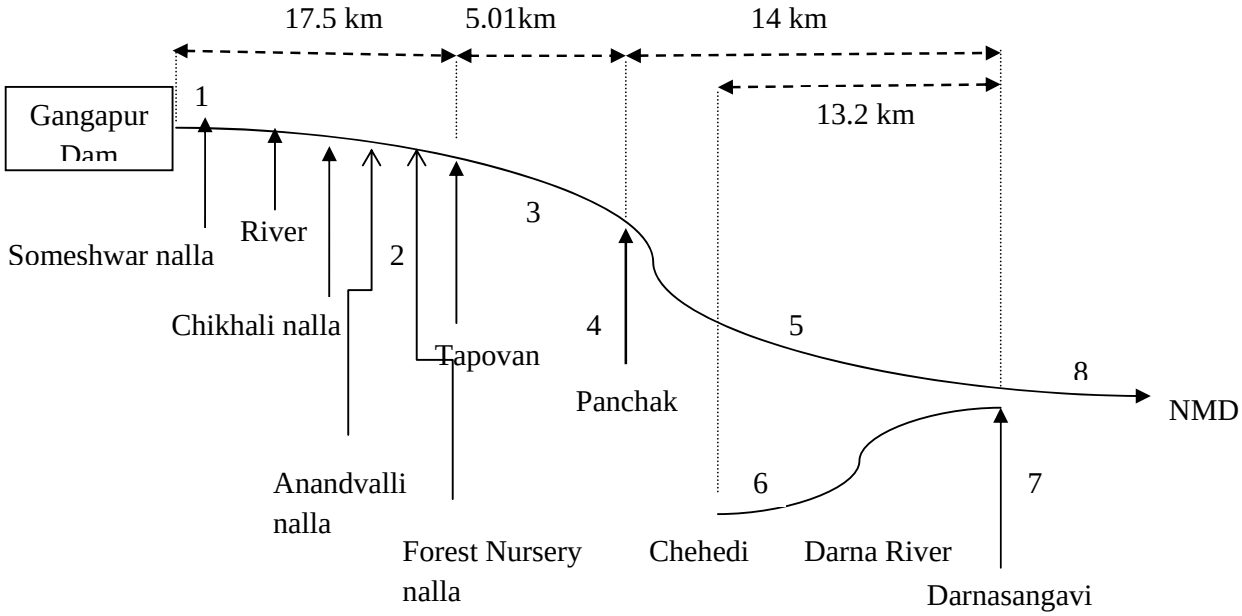
Similarly, BOD has been calculated at location 5, 6 and 8 using

$$L_5 = \frac{L_3 * Q_3 + L_4 * Q_4}{Q_3 + Q_4} \qquad \ldots\ldots\ldots\ldots\ldots (2)$$

$$L_{6\ or\ 8} = \frac{L_5 * Q_5 + L_7 * Q_7}{Q_5 + Q_7} \qquad \ldots\ldots\ldots\ldots\ldots (3)$$

Where $L_1, L_2 \ldots . L_8\ are\ BOD\ at\ location\ 1, 2 \ldots .3\ respectively$ and
$Q_1, Q_2 \ldots . . Q_8\ are\ Flow\ rate\ at\ location\ 1, 2 \ldots .3\ respectively$

The figure below is a schematic representation of river stretch with nallas and STPs. Though all the nallas have been considered only few nallas have been depicted in the Figure.



Overall, BOD decay factor will also be important while computation of final CBOD in watercourse. Conservative estimates have been made for water needs for maintaining AII class in Godavari river.

9.3 River Base Water Quality

Based on NEERI's preliminary assessment of water quality of River Godavari in post monsoon season, it was observed that the BOD values from Gangapur dam to Tapovan upstream were in the range of 3 to 12 mg/L. Higher BOD values were observed near Tapovan due to release of STP effluent at Tapovan. As the post Monsoon sampling was carried out in December, it can be inferred that the water quality does not seem to be highly deteriorated till the month of December. To confirm this, the MPCB water quality monitoring data from 2007 to 2012 was also considered as given in **Table 9.1**.

Table 9.1 : MPCB Water Quality Monitoring Data from 2007 to 2012

Code name	Stn. Code		pH	DO	BOD
a) Two Years Descriptive Data					
Chikhali Nalla Meets Godavari River	2178 (2008-2009)	Mean	7.2	4.4	23.8
		Std.dev	1.41	2.10	12.83
		No of Samples	22	22	22
		% Exceedance	**18.2**	**40.9**	**90.9**
Hanuman Ghat Nashik	2179 (2008-2009)	Mean	7.8	5.2	10.3
		Std.dev	0.61	1.58	5.89
		No of Samples	18	19	19
		% Exceedance	**5.6**	**15.8**	**84.2**
b) Four Years Descriptive Data					
Godavari Near Tapovan	2180 (2008-2011)	Mean	7.7	4.6	12.9
		Std.dev	0.59	1.36	6.47
		No of Samples	43	43	43
		% Exceedance	**9.3**	**23.3**	**93.0**
Kapila Godavari Confluence	2181 (2008-2011)	Mean	7.7	4.7	12.2
		Std.dev	0.54	1.63	8.02
		No of Samples	43	43	43
		% Exceedance	**9.3**	**25.6**	**90.7**
Saikheda	2182 (2008-2011)	Mean	7.8	6.0	5.8
		Std.dev	0.43	0.59	1.62
		No of Samples	43	40	40
		% Exceedance	**4.7**	**2.5**	**60.0**
Nandur Madhyameshwar	2183 (2008-2011)	Mean	7.8	6.3	4.5
		Std.dev	0.31	0.54	1.30
		No of Samples	43	43	40
		% Exceedance	**2.3**	**0.0**	**22.5**

Table 9.1 : MPCB Water Quality Monitoring Data from 2007 to 2012

Code name	Stn. Code		pH	DO	BOD
c) Five Year Descriptive Data (2007-2011)					
Godavari Near Someshwar Temple	2177	Mean	7.9	5.8	6.1
		Std.dev	0.43	0.70	1.95
		No of Samples	23	21	23
		% Exceedance	**4.3**	**0.0**	**56.5**
Upstream Gangapur Dam	1095	Mean	7.8	6.5	4.7
		Std.dev	0.42	0.54	1.57
		No of Samples	54	54	54
		% Exceedance	**7.4**	**0.0**	**20.4**
Panchavati at Ramkund	1096	Mean	7.7	5.5	9.2
		Std.dev	0.42	0.81	4.08
		No of Samples	55	55	56
		% Exceedance	3.6	0.0	85.7

Source: Ref.: Water Quality Status of Water Bodies of Maharashtra with Recourse to Analytical/Statistical Tools, by NEERI.

The amount of water that needs to be released to maintain minimum environmental flow will be lesser in the months from November to January. From February onwards, as lesser water will be available within the river stretch will make the river water quality poorer than AII class standards. The period between February- June is critical for the river water quality. Based on the interim arrangement to maintain AII class, an attempt has been made to estimate water needs from dam while keeping BOD values less than 5 mg/L.

The estimation of Environmental flow was done taking into consideration the BOD values observed in post monsoon season and BOD decay rate over the period of time and also during the examined travel time. The water release data provided by Water Resources Department for the year 2013-14 has also been used for the study as given in **Annexure 23**.

Water release needed from Gangapur dam for maintenance of AII water quality will be for

November to January : 41.6 cusecs for 8 days

For February to June : 125 cusecs for 10 days

The above calculations are done only on the basis of water quality status in the river. The flow requirement for maintaining the ecology will also be considered. This study needs extensive data collection as detailed in the **section 9.4.**

The actual Environmental flow water needs shall be available after the whole ecological, social and environmental need assessment. The quantities of water indicated above are the interim values which can be revised after the comprehensive study is complete.

Since the present report was desirable from an angle to alleviate the current state of the river due to pollution from various sources, NEERI's first set of recommendations on "Environmental Flow" for Godavari was limited to making water flowing in Nashik city region, where KumbhMela is supposed to be held, meet the bathing water quality. The input of sewage and industrial effluents from point and non point sources has resulted in extensive pollution of Godavari river. To maintain the river water quality within A-II quality as per given by CPCB, there is requirement of minimum flow in the river. However, it should be recognized that "Environmental Flow" assessment will need extensive data collection for the river and its adjoining regions for an extended period of time so that a long term recommendations can emerge from the assessment for Godavari River flow and water needs. This assessment would also be useful to all the other rivers in the state of Maharashtra.

The Research report "An Assessment of Environmental Flow Requirements of Indian River Basins" prepared by International Water Management Institute, Sri Lanka, has included study on 17 perennial rivers in India. The study also includes Environmental flow assessment for Godavari river basin. In this report the location of flow information was at Polavaramand Davlaishwaram locations much downstream of the river basin and flow data for15 years is used as indicator of present hydrology.

9.4 Environmental Flow Calculation Requirements

The Environmental Flow assessment methods can be categorized into two methods:

a) Rapid assessment i.e. rapid methods i.e. Hydrological method
b) Detailed assessment methods i.e. Holistic methods, Habitat methods

The most commonly used method is tenant method which is a Hydrological method. It requires minimum 30 years flow data of river. A threshold of 10 % of Mean Annual Runoff is considered to be the lowest limit for Environmental flow calculations. The above mentioned study has used the annual flow data at the two stations in Karnataka i.e. Polavaram and Davlaishwaram which have fairly good flow for the whole year.

Some stretches of Godavari in Nashik region become dry in critical summer months and conditions of no rainfall and hence the methods available for Perennial River cannot be applied while calculating the Environmental flow in for River Godavari particularly in the study stretch. Moreover, the relationship between surface water and groundwater in such systems is complex. Hence the proper assessment method needs be evaluated which will include some aspect of present study methods mentioned above when water surface water is available with consideration of groundwater and aquifer conditions when surface water is not available.

The report "Environmental Water requirements in Non –Perennial systems" includes the methods for calculation of Environmental flow in Non- Perennial rivers. A non- perennial stream is by definition a stream that does not flow permanently. According to this report, the Non Perennial river is classified as :

Non-Perennial				
Semi-Permanent	Semi-Permanent		Semi-Permanent	
No flow 1-25%of time	No flow 1-25%of time		No flow 1-25%of time	
Flow for at least 9 months			Flow briefly only after flood	
	Seasonal	Non-seasonal	Seasonal	Non-seasonal

The following steps can be done for the assessment of environmental flow:

Step-1

- Initiation of RDM (Resource Directed Measures) study
- Define study area
- RDM level and component

Step-2

- Identification of resource units for the study domain

Step-3

Define ecological reserve categories and recommend

- Present Ecological Status for each component
- Ecological Importance and sensitivity
- Social/cultural Importance

Step-4

Quantification of ecological reserve scenarios, water quality and water body

- Catchment system analysis
- Data organization
  - Collection of existing data (Primary data)
  - Collection of additional and analyze information (Secondary data)
- Define operational scenarios
- Provide resource economic consequence

Step-5

Reserve definition and implementation

The calculation of such type of Environmental flow requires following data to be collected

a) Hydrological and Geo-hydrological Data

These data give understanding of the interaction between ground water and surface water. These interactions have high variation with perennial to non-perennial rivers which increase the importance of the water requirement for ecology of the river.

I. Surface water with respect to time

a) Flow Depth of the river
b) Flow velocity or Flow Rate
c) Wetted Perimeter and
d) Water Surface width

In different seasons….. as far as possible

II. Ground water

This is also important because ecosystem such as terrestrial vegetation/fauna, river base flow system (riparian), aquifer and cave ecosystems depend on groundwater to sustain their life. The following data is required for EFA:

a) Catchment base flow of the region in m^3
b) Catchment area in km^2
c) Mean Annual Precipitation (MAP) in mm
d) Mean Annual Runoff (MAR) in m^3
e) Level or pressure of ground water
f) Discharge flux from an aquifer
g) Quality of ground water

b) Water Quality

Water quality should be assessed for surface water as well as ground water because ecology is available in ground and surface as mentioned before. The typical physical and chemical stressors affect the ecology of the river in direct and indirect ways.

a) Heavy metal (Fe, As, Mn, Cu etc.)
b) Ammonia/NH_4
c) Salinity
d) pH
e) Dissolve Oxygen (DO)
f) Temperature
g) Nutrients (Nitrate, Phosphate, N/P ratio)
h) Turbidity
i) Flow
j) Alien Species
k) Total Suspended Solid (TSS)
l) Total Dissolve Solid (TDS)

Time scale should be selected for water quality based on field knowledge of water body. Monsoon and non-monsoon

c) Ecological Status

The ecology of river depends upon biodiversity and the connectivity between different sections of the river. This determines the Ecological Importance and Sensitivity (EIS) and Social Importance (SI) and further index can be made. The ecology system is associated with following parts:

I. Biota (Riparian and In stream)

a) Rare and endangered species
b) Unique (endemic, isolated, etc.) species
c) Intolerant (flow & flow related water quality) species
d) Species/Taxon richness
e) Diversity of types
f) Sensitivity to flow and water quality changes
g) Migration route/corridor
h) Importance of conservation and natural areas
i) Magnitude (frequency and depth) and duration of flooding
j) Retention of water in pans, pools and the subsoil
k) Extension of vegetation cover
l) Structural intactness
m) Percentage cover and recruitment of indigenous riparian species

II. Invertebrates

Aquatic invertebrates are responsible for retention and breakdown organic material and recycling of minerals and nutrients.

III. Fish

a) Intolerance rating per species
b) Frequency of occurrence per species (per fish habitat segment)
c) Health/condition rating per species

The present need of the river in short term to meet A-II water quality warrants that a minimum flow is maintained. This would be combined with all the efforts of discharge of treated sewage up to 10mg/l of BOD and less, as also no solid waste disposal in the river basin. The better quality of treated waste water would also make dilution from minimum flow adequate. However, the future water flow needs will be specified only when all needs have been assessed through NEERI study. The interim assessment of E-flow has been presented with a view of maintaining AII class water quality in Godavari river in the study stretch.