RESEARCH ARTICLE

Feasibility of creating a fresh water reservoir in the Arabian Sea impounding the flood waters of Netravathi River

Sreevalsa Kolathayar[1*], T.G. Sitharam[2], R Ramkrishnan[1] and R Subba Rao[3]
[1]Department of Civil Engineering, Amrita University, Coimbatore 641112, India
[2]Department of Civil Engineering, Indian Institute of Science, Bangalore 560012, India
[3]Department of Chemical Engineering and Material Science, Amrita University, Coimbatore 641112, India

Abstract: This paper addresses the feasibility of creating a fresh water reservoir in the Arabian sea impounding the flood waters from Netravathi River. The project schemes comprises mainly two steps: first, the construction of the dyke in the Arabian Sea; and second, the process of natural replacement of salty water by rainwater and surface runoff to the reservoir. The study presents the detailed hydrological analysis of Netravati and Gurupura rivers including estimation of runoff into the sea. The study estimates the surface runoff at inlet and outlets of Netravati Basin along the costal lines of Arabian Sea. The existing land use along the costal lines of Netravati Basin is assessed. The dyke must be designed to separate fresh water from the salty waters of the Arabian Sea considering the tidal variations and wave heights. The bathymetric profiles of the sea bed has been created and presented in the paper. The annual runoff at the mouth of Netravati River was estimated as 388 TMC and just 2.5% of this would be sufficient to meet the present water shortfall of Bengaluru and Mangaluru. The annual sediment load was found to be negligible. The water quality parameters are well within permissible limits ensuring quality water from Netravathi to the proposed coastal reservoir.
Keywords: Netravathi, rainfall, coastal reservoir, bathymetry, runoff

*Correspondence to: Sreevalsa Kolathayar, Department of Civil Engineering, Amrita University, Coimbatore 641112, India; Email: k_sreevalsa@cb.amrita.edu

Received: July 2, 2017; **Accepted:** August 10, 2017; **Published Online:** September 30, 2017
Citation: Kolathayar S, Sitharam T G, Ramkrishnan R, *et al.*, 2017, Feasibility of creating a fresh water reservoir in the Arabian Sea impounding the flood waters of Netravathi River. *Journal of Sustainable Urbanization, Planning and Progress*, vol.2(2): 38-42. http://doi.org/10.26789/JSUPP.2017.02.006

1 Introduction

Development and civilization of human race started with the availability of water in abundance. Mangalore is blessed with River Nethravathi which carries great quantity of water during monsoon and at last end up in the sea. Coastal reservoir (CR) is a very innovative concept which has the potential to store the flood water of river joining the sea and meet the water requirement of water starved cities[1,2]. A fresh water reservoir near the coast would bring a positive transformation in coastal Mangalore in terms of cleanliness, living standard of the people, human resource development and livelihoods.

The project schemes comprises mainly two steps, the first is the construction of the dyke in the Arabian Sea, and the second is the process of natural replacement of salty water by rainwater and surface runoff to the reservoir. Considering the tidal variations and wave heights, the dyke must be designed to separate fresh water from the salty waters of the Arabian Sea. The quantity of flood water will be estimated the possibility to alleviate flooding during high tides in ocean.

2 Study Area

Mangalore (Mangaluru), a coastal city, situated between the Arabian Sea and the mountain ranges of Western Ghats, is the chief port city of Karnataka. Located at 12°52'N latitude and 74°49'E longitude, it is the largest city in Dakshina Kannada district of Karnataka and is one of the most cosmopolitan non metro cities of India. The city is located in the confluence of Netravati and Gurupura rivers with an average elevation of 22 m (72 ft) above mean sea level (Figure 1).

The geology of the city is characterised by hard laterite in the hilly tracts and sandy soil along the seashore[3]. Mangalore is moderately earthquake-prone urban center and is categorised under Seismic III Zone in seismic zonation map of India. Mangalore lies on the backwaters of the Netravati and Gurupura rivers and these rivers effectively encompass the city. The rivers form an estuary at the south-western region of the city and then discharge into the Arabian Sea. Mangalore city has a population of 484,785 as per the 2011 census of India.

2.1 Geography of Netravati River

Globally, this river can be pinpointed at coordinates 12°54'30" N and 75°20'56" E. This river has an apparent breadth of about 200 yards. Its drainage area is about 1,353 m^2. The river bed mainly comprises of hornblende rock containing spangles of mica and small garnets. They act to fetter the river bed. A train passing through Mangalore called Netravati Express is named after this river. A railway bridge was constructed on

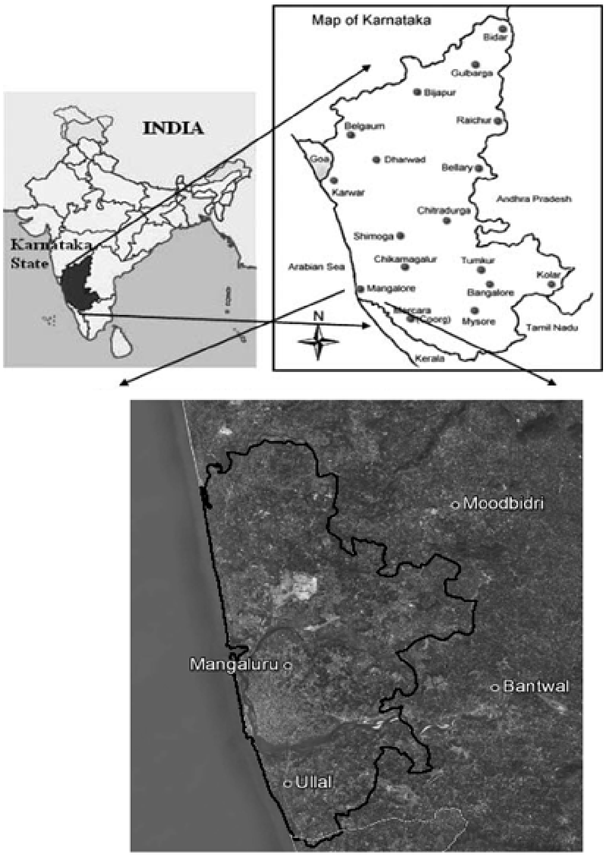

Figure 1. Mangalore map.

Figure 2. Catchment area of Netravati and Gurupur River. (Source: Satellite image from Google)

the Netravati River which served as one of the major gateways to Mangalore. Netravati Rivers railway bridge is considered to be the longest railway bridge built atop a river bank. The nearby cities of Netravati River are Bangady, IshaqIndabettu and Nellyady Town. The catchment area of Netravathi and Gurupura rivers is shown in Figure 2.

2.2 Course of Netravati River

Netravati River originates in the Western Ghats in Bangrabalike forest Valley in Yellaner Ghats of Kudremukha range in Karnataka. The Netravati amalgamates with the Kumaradhara River near Uppinangadi village. Kumaradhara River also originates in Western Ghats in the Subramanya range. When it flows from Uppinangadi, it arrives in the city of Mangalore. After merging with Kumaradhara River, the Netravati then joins the Arabian Sea. As estimated, this river drains large quantity of water into the Arabian Sea every year. Along its course, the Netravati also flows through a popular pilgrim place called Dharmasthala. The navigability of the Netravati River is dependent on small country craft, which has the potential to travel many miles in the river.

2.3 Bathymetry

Bathymetric data gives descriptive picture of the ocean bottom terrain with size, shape and distribution of underwater features. The Bathymetric profile of the ocean bed near the Netravati River is shown in Figure 3.

3 Annual Runoff at Netravati Basin

The Annual Runoff at terminal site of Netravati Basin was estimated and the average annual runoff in Netravati Basin during 1989-2013 was 388.5 TMC (Figure 4). The maximum Runoff was 528.34 TMC during 2007-2008. A minimum runoff was experienced in the year 2012-2013. The standard deviation was 78 TMC during the period.

4 Average Annual Rainfall

The average annual rainfall at Netravati Basin over the decade 2003-2013 is 3,922.5 mm. The standard deviation of rainfall over the decade was 383 mm. A maximum rainfall of 4,427.8 mm was experienced in the year 2009-2010. A major variation in rainfall has not be experienced over the decade (Figure 5). Figure 6 presents the annual sediment load in Netravati River and it is clear that the sediment load is very negligible and hence silting issue in coastal reservoir will not be a major problem.

Table 1. Land use statistics of Mangalore.

Sl No.	Category Descrption	km^2	Acres	Hectares	% Cover
1	Forest	82.4211	20366.70	8242.11	14.50
2	Plantations	38.0133	9393.29	3801.33	6.69
3	Agricultural Land	269.7543	66657.74	26975.43	47.44
4	Water Bodies	13.8627	3425.55	1386.27	2.44
5	Built-up area	106.6617	26356.68	10666.17	18.76
6	Open Areas	57.8781	14301.99	5787.81	10.18
	TOTAL	568.5912	140,501.95	56859.12	100.00

5 Land Use Analysis

Land Use of the area was analysed using remote sensing data from LANDSAT 8 images of resolution - 30 m (visible, NIR,

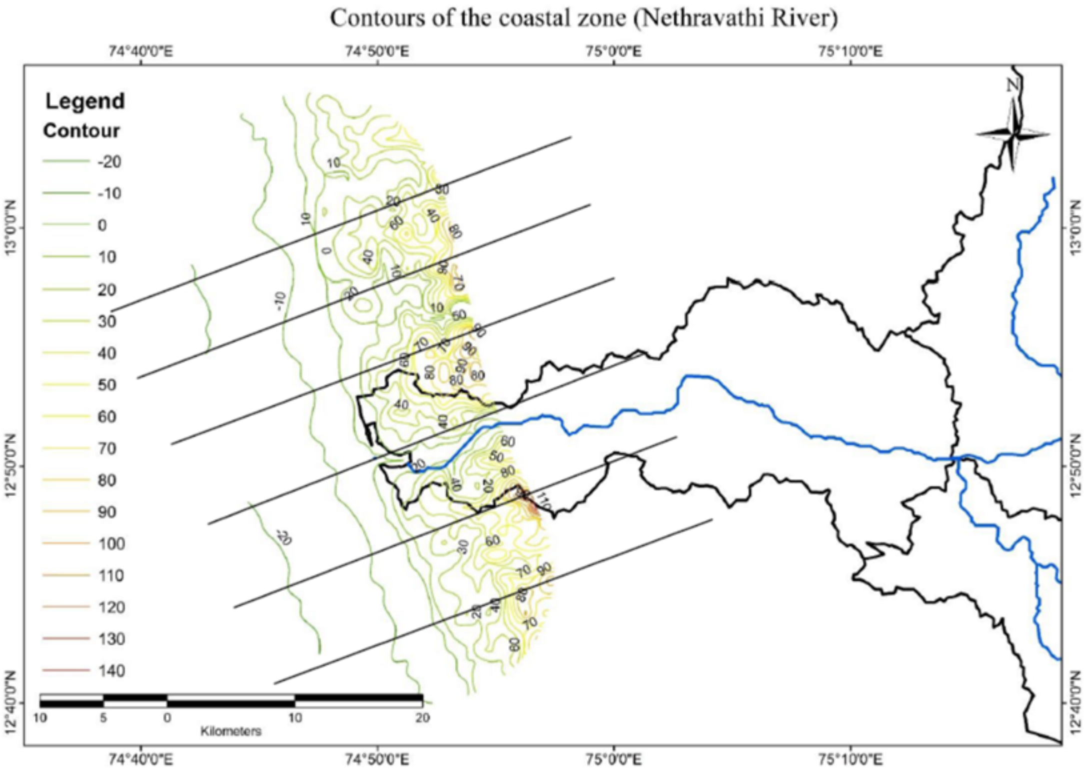

Figure 3. Bathymetry of the ocean bed near the Netravati River.

SWIR); 100 m (thermal); and 15 m (panchromatic) downloaded from a public domain (https://earthexplorer.usgs.gov/). The remote sensing data obtained were geo-referenced and the study area was cropped and extracted. The Landsat 8 satellites has a spatial resolution of 30 m × 30 m (nominal resolution) followed by nearest-neighbour interpolation. A False Colour Composite (FCC) of remote sensing data (bandsgreen, red and NIR) was generated so as to enable the user to identify heterogeneous patches in the landscape. Training polygons were identified and delineated on the identified heterogeneous patches by overlaying the FCC layer on a google earth image using the built-in plug-in in the GIS tools. Uniform distribution and accurate marking of these training polygons was ensured in the study area[4]. Land use analysis was carried out using the built in supervised Gaussian maximum likelihood algorithm. The results obtained are shown in Figure 7 and the statistics are tabulated in Table 1.

From Figure 7, it is clearly visible that most of the population is concentrated towards the Mangalore City bounds, near the mouth of Netravati. Population density keeps on decreasing from the coast to the inlands and a large portion of the area inland is utilized for agricultural purposes. Out of the total 568.6 km^2 area, more than 50% of total area is utilized for agriculture and plantations as visible from the statistics, about 14.5% of the total area (82.5 km^2) is forest area and 18.7% of the total area (106.6 km^2) builts up land. The area covered by water bodies and open areas can vary in different seasons, when the river flows at different levels or when different crops/plants grow respectively.

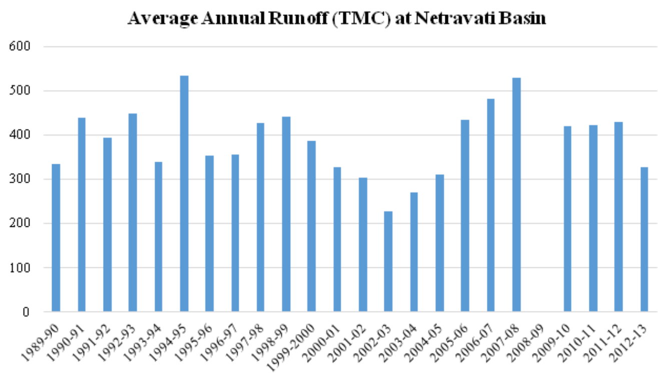

Figure 4. Average annual runoff at Netravati Basin.

6 Conclusions

The average annual runoff in Netravati Basin is eastimated as 388.5 TMC during 1989-2013. Hence it is imperative that a small percentage of runoff of Netravathi is more than sufficient to cater the water requirements of Mangalore and Bangalore. From the data for last few decades, there are hardly any chances of scarcity of water availability in Netravati River. On one side, we are having shortage of water, whereas on the other side, large quantity of water is just flowing into the sea. This necessitates to revisit the current water storage strategies and explore new ways to tap at least a small amount of

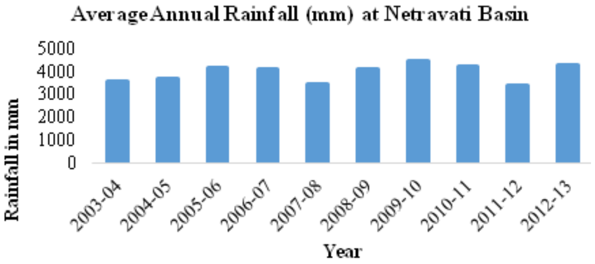

Figure 5. Average annual rainfall at Netravati Basin.

runoff water to meet the water demands of people, which otherwise just flow into the sea. The concept of coastal reservoir emerges as the best solution to meet the future water demands of both Bangalore and Mangalore. The feasibility implications are summarized below.

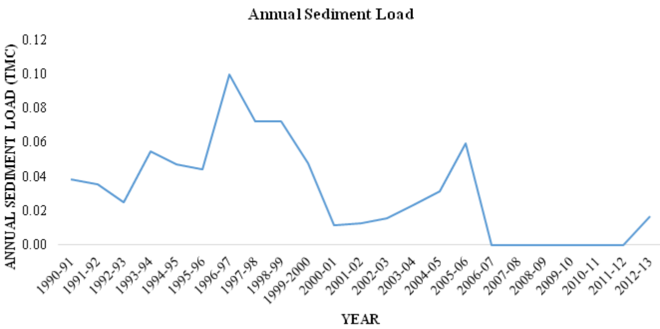

Figure 6. Annual sediment load in Netravati River.

• The average annual runoff in Netravathi is 388.5 TMC. As per Bangalore Water Supply and Sewerage Board (BWSSB), shortfall in demand in Bangalore for 2051 is 26.16 TMC which is 7% of average annual runoff through Netravathi. In 2021, the shortfall in demand is only 8 TMC which is just 2.1% of the runoff.

• There is hardly any chance of silting of reservoir as the average annual sediment load in Netravathi River is 0.04 TMC.

• Iron concentration in ground water is beyond BIS Norms (>1.0 mg/L) in Dakshina Kannada district.

• Radioactive minerals like monazite and zircon are concealed under non radioactive sand layers which attenuates gamma ray activity in Ullal Beach and hence there is no perceptible danger to the human health due to radioactivity.

• The water quality parameters in Netravathi and Gurupura Rivers are in tolerable limits for safe drinking water (far better than that of Godavari and Cauvery) and the water can thus be directly utilised without any major treatment.

• Benefiting sectors due to coastal reservoir are agriculture, prawn culture and sand dredging.

• Creation of coastal reservoir may affect the marine fishing in the area, but it opens up huge possibility of freshwater fishing.

• The seismic hazard in the area is very marginal and hence safe in terms of seismicity (below 0.05g).

• Coastal reservoir can act as a safety structure to safeguard the coastal region from Tsunami hazards.

• The possible renewable energy generation implies that the system will be self-sufficient in energy to meet the energy demands for pumping, lighting and other requirements.

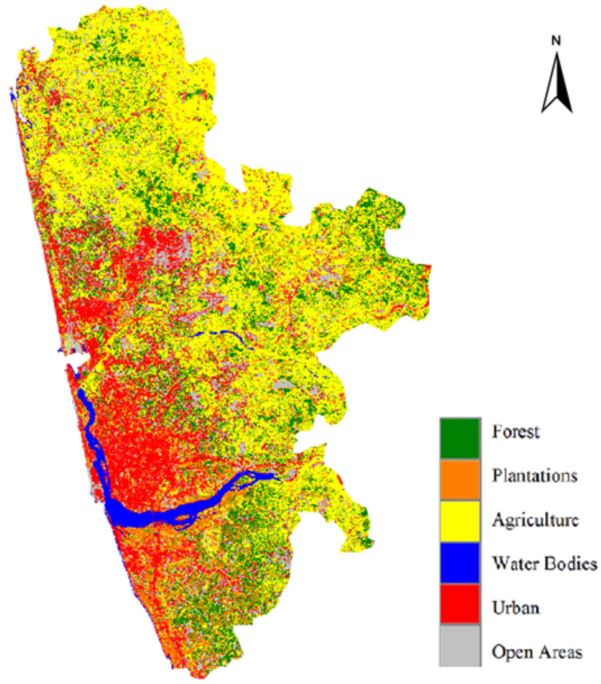

Figure 7. Land use pattern of Mangalore.

7 Acknowledgement

The authors acknowledge the contribution of Mr. Prem Kumar, Ms. Amala Krishnan U S, Mr. Harinath Reddy C, Ms. Nimmy Therese, Mr. Rahesh Hari, Mr. Sharook S and Ms. Sivapriya J for their valuable contributions to this paper. The authors acknowledge Bangalore Water Supply and Sewerage Board, Govt. of Karnataka for funding the feasibility study on coastal reservoir across Netravathi River.

References

[1] Yang S Q, Liu J L, Lin P Z, *et al*., 2013, Coastal reservoir strategy and its applications. In *Water Resources Planning, Development and Management*, InTech, 95-115. http://dx.doi.org/10.5772/52315

[2] Sitharam T G, Rao R S and Kushal S, 2017, Innovative sea based fresh water reservoir to impound river flood waters: an initiative for India's water shortage, E-proceedings of the 37th IAHR World Congress, August 13-18, 2017, Kuala Lumpur, Malaysia.

[3] Hegde A V and Reju V R, 2007, Development of coastal vulnerability index for Mangalore Coast, India. *Journal of Coastal Research*, vol.23(5): 1106-1111. http://dx.doi.org/10.2112/04-0259.1

[4] Ramachandra T V, Aithal B H and Sanna D D, 2012, Insights to urban dynamics through landscape spatial pattern analysis. *International Journal of Applied Earth Observation and Geoinformation*, 18: 329-343. http://dx.doi.org/10.1016/j.jag.2012.03.005

[5] Dakshina Kannada at a Glance, 2015-16, Published by District Statistical Officer, D.K. Mangalore. http://www.censusindia.gov.in/pca

[6] Central Water Commission, 2013, Integrated Hydrological Data Book.