

Salinity Intrusion in Valapattanam River, Kerala

Arun Raj N
Department of Civil Engineering
VNIT
Nagpur, India

A D Vasudeo
Assistant Professor
VNIT
Nagpur, India

Abstract— Saltwater intrusion is the movement of saline water into freshwater aquifers which leads to the contamination of drinking water sources, change in environment, defoliation in crops, harm to aquatic life etc. Saltwater intrusion occurs mainly due to human and natural activities. Valapattanam River is a coastal river which flows through Kannur district, Kerala. All west flowing rivers of Kerala experience salinity intrusion problem which is more in northern Kerala. It has been documented that tidal ranges, upland flow, condition at the mouth, runoff, change in river bed, temperature, and precipitation are some of the factors contributing to the salinity propagation along the river. To keep track and for constant monitoring, measurement of the salinity of the river has to be done. It had been observed that the same river was prone to manual illegal dredging and hence bathymetric surveys were carried out to get the change in river bed due to unsystematic dredging. Salinity variation at different places over the depth along the length of the river is also studied. The factors causing salinity intrusion at Valapattanam River are also determined. In the Valapattanam River, the main cause of salinity intrusion is decrease of upstream runoff which causes innumerable degradation to the ecology of this great Indian River.

Keywords— Dredging, precipitation, runoff, salinity intrusion, temperature, tidal range.

1: INTRODUCTION

Valapattanam River is the largest river in Kannur district located in the south Indian state of Kerala, which is the major source of irrigation and domestic purposes. With the growth of population, quick industrialization and urbanization the water supply demand is increasing day by day. Since salinity intrusion is making a great problem in Valapattanam river basin in the recent years. Salinity intrusion has a serious effect on the water supply in the Valapattanam river basin area in the recent years.

Global warming which causes sea level rise, reduction in runoff, increase in temperature and decrease in precipitation and river bed sand dredging for construction material and the navigable channel dredging in the estuary rivers, due to these factors the salinity intrusion in recent years is getting more active, the duration is getting longer and affected scope is getting larger and the intensity is getting stronger. These factors affecting salinity intrusion is experimented in Valapattanam River by comparing the present data with previous year data. The tidal propagation along the river and the effect on salinity intrusion is found out and salinity intrusion along the course of the river and the level of salinity along the depth of the river is analyzed.

2: STUDY AREA

Valapattanam River is the largest river in the Kannur district located in the South Indian state of Kerala. Valapattanam River with a length of 110 km. Valapattanam River originates in the Western Ghats of Kodagu, the Brahmagiri Reserve forest in Karnataka at an altitude of 900-1350m above the sea level and drains into Kannur district. The river has a basin area of 1867 km² out of this 1321 km² in Kerala and 456 km² basin areas in Karnataka. Pazhassi Dam is the reservoir in Valapattanam River.

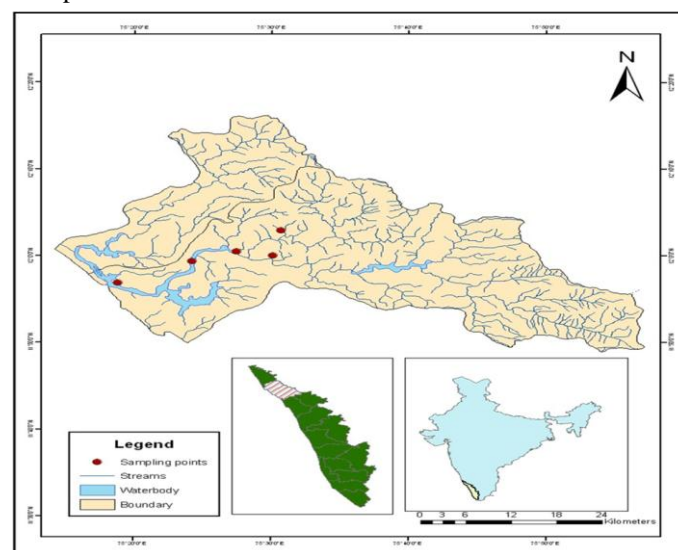


Fig 2.1: Study area

3. METHODOLOGY:

3.1 Preliminary survey:

Before starting the main survey various investigations have to be done. By knowing all the features of the river preliminary survey is conducted. To find the salinity from almost all portion of the river. Using Global Positioning System GPS, sampling stations at an interval of 3 km is being selected. Sampling is done by travelling in boat. From each station samples are taken using water sampler. Samples are collected at surface, bottom and from middle portion and tested in salinometer. Values such as salinity, temperature, TDS, conductivity and pH are obtained.

3.2 Selection of stations:

After preliminary survey across the Valapattanam River the amount of salinity from every 3 km are obtained. For the continuous survey of 26 hours 5 stations are to be selected. Based on various factors these 5 stations are selected as shown in Fig 2.1. The factors are:

- The amount of salinity should be more
- Station should have maximum depth
- Transportation availability should be near the banks of the station
- Should have a good place to fix tidal range.

Table 3.1: Description of stations in Valapattanam River

Sl no.	Station code	Location	Latitude	Longitude
1	V1	Azheekal	11°56'50.04"	75°18'47.98"
2	V2	Parassinikadavu	11°59'17.72"	75°24'10.44"
3	V3	Chikkikadavu	12°0'32.98"	75°27'31.7"
4	V4	Pavunnur kadavupalam	11°59'58.36"	75°30'9.09"
5	V5	Sreekandapuram	12°02'53.07"	75°30'42.38"

3.3 Data collection:

Salinity values were collected from different points. For the preliminary survey, five stations were selected along the Valapattanam River which were represented as v1, v2, v3, v4, v5. Data were collected from the centre of the river in a stationary boat placed at centre. For the measurement of salinity, water samples were taken from different depths and the amount salinity in water was obtained using salinometer. All these readings were taken in 30 minutes interval. A continuous 26 hours survey was done for that experiment.

3.4 Bathymetry survey:

Bathymetry is the study of underwater depth of lake or ocean or rivers. In other words, bathymetry is the underwater equivalent to hypsometry or topography. Bathymetry involved the measurement of river depth through depth sounding. Now the bathymetry data are collected using echo sounder.

4. ANALYSIS OF FACTORS AFFECTING SALINITY INTRUSION:

In the Valapattanam River, there are many small rivers forming the main river network. The behavior of the salt tide is mainly controlled by the upstream runoff and downstream tidal current. When the high saline tidal water mass in the continental shelf flows into the estuary during the flood tidal period, the salt water diffuses and mixes with the fresh water coming from upstream, which makes the water in upstream river salty and causes salinity intrusion. Some of the main factors affecting salinity intrusion in the Valapattanam River are: river topography, the sea level variation, increase in temperature, decrease in precipitation etc.

a) Runoff:

Runoff is an important factor which determines the salinity intrusion. For conducting this study monthly discharge data of Valapattanam River for the years 2012 and 2013 are collected. From the obtained data the runoff in Valapattanam River has gradually decreased mainly during monsoon season. As the upstream runoff get reduced salinity intrusion increases. Reduction in rainfall is the main cause for the reduction runoff.

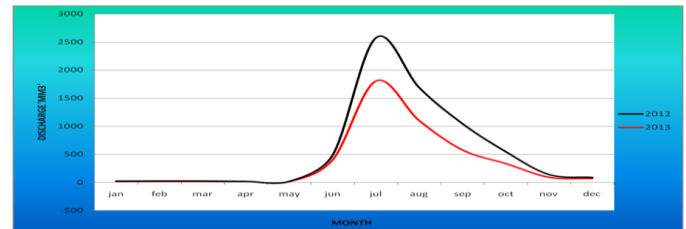


Fig 4.1: Variation of runoff

b) Change in river bed:

Due to unsystematic sand mining from Valapattanam river there occurs a sudden variation in change in river bed at a particular reach. The change in river can be considered as one of the main factors of salinity intrusion. As the river bed goes down the tendency of saline water to enter into river increases. From the graph below it is clear that human activities are also a cause for salinity intrusion.

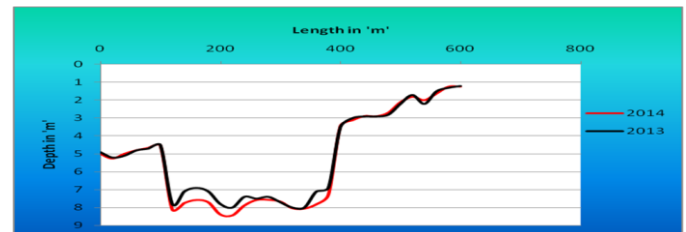


Fig 4.3: Temperature variation in Valapattanam river basin

c) Temperature

Day by day temperature is varying. Temperature variation is due to global warming and which result in the melting of polar ice and leads to sea level rise and causes salinity intrusion. In Valapattanam river to study that temperature is a factor that causes salinity intrusion previous four years monthly temperature data was collected and analyzed. From the analysis it clears that year after year temperature is varying. This varying in temperature leads to sea level rise which leads to salinity intrusion

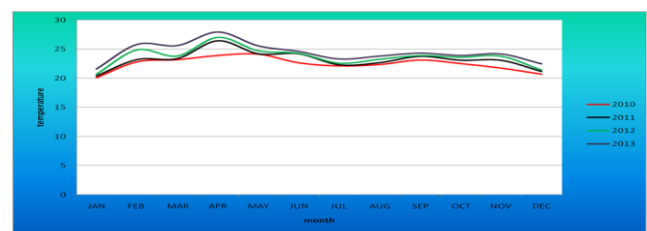


Fig 4.3: Temperature variation in Valapattanam river basin

d) Precipitation:

Precipitation is one which controls the runoff in a river. If the precipitation is less it reduces the runoff and leads to salinity intrusion in river. To know whether precipitation has the same effect on salinity intrusion of Valapattanam river basin the precipitation data of previous four year data are collected and analysis is done. After analysis it is clear that the range of precipitation is decreasing year by year. By this we can say that decrease in precipitation leads to decrease in upstream runoff and results in salinity intrusion.

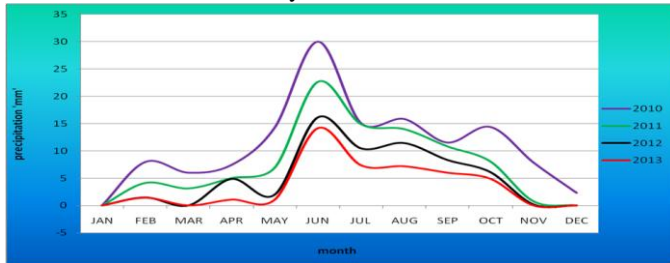


Fig 4.4: Variation of precipitation in Valapattanam river basin

5. BATHYMETRY

To get the river bed variation bathymetry survey is done. Bathymetry survey is done at stations v1, v2, v3, v4. Valapattanam River is a major area for unsystematic sand mining. So variation in river bed is observed by comparing the present bathymetric reading with previous year's bathymetric reading. From analysis it is seen that the river bed has gradually lowered when compared with previous year data. The main reason is sand mining.

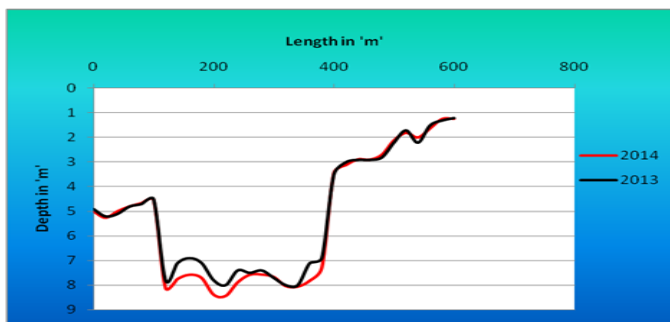


Fig 5.1: River bed variation at station v1

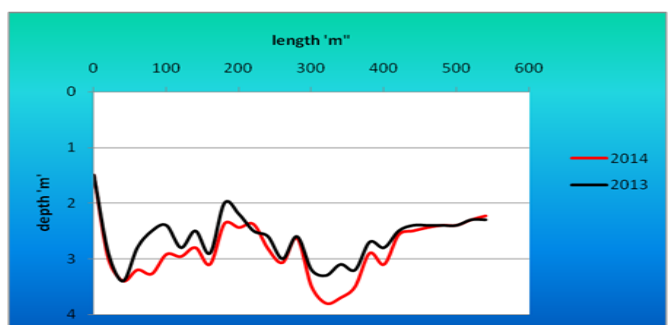


Fig 5.2: River bed variation at station v2

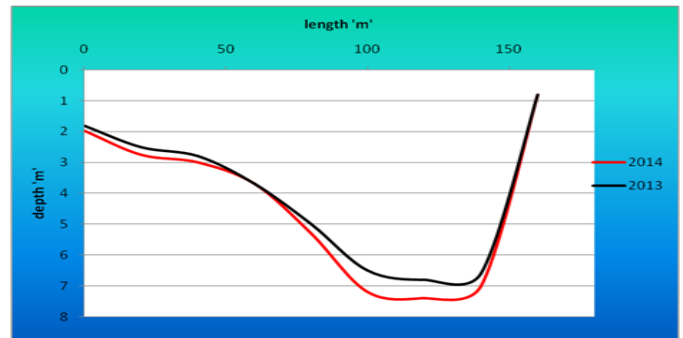


Fig 5.3: River bed variation at station v3

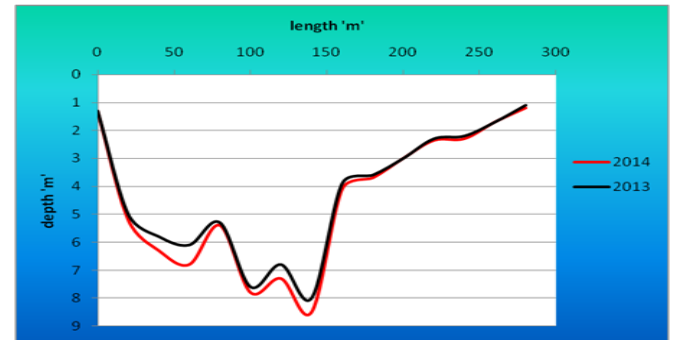


Fig 5.4: River bed variation at station v4

6. SALINITY IN VALAPATTANAM RIVER

Salinity in Valapattanam River is obtained both in along the course of the river and along the depth of the river. From the experiment it is found that salinity intrusion is more in Valapattanam River. Also found that during tidal propagation salinity intrusion is more in Valapattanam River. Salinity intrusion in the study area is more during high tide and salinity intrusion less during low tide session. From the experiment it is clear that above the salinity along the course of the river decreases as on going to upstream portion of the river. At the mouth of the river salinity is more and as the distance increases salinity decreases. Salinity along the depth of the river increases as the depth increases. Salinity at the surface of river is less compared to salinity at the bed of river. Salinity increases gradually as going from surface to bottom. The salinity variation result in Valapattanam River is shown below.

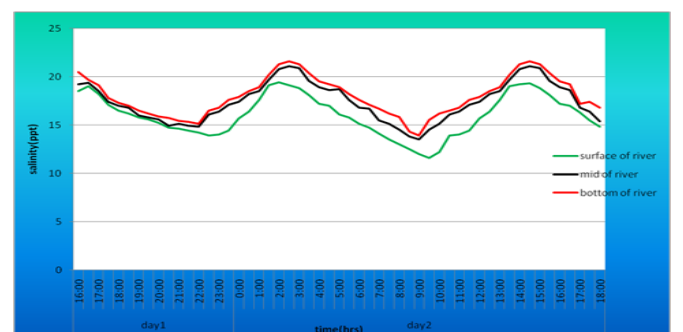


Fig 6.1: Salinity variation at station v1

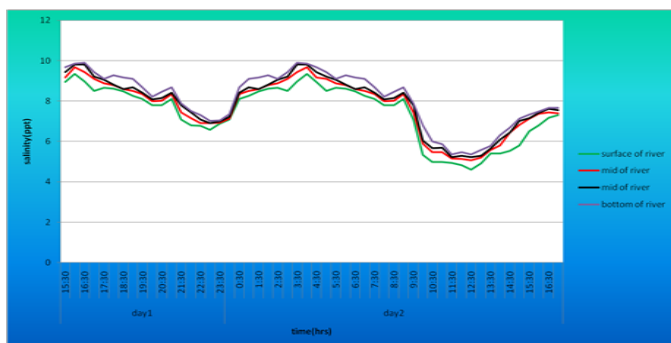


Fig 6.2: Salinity variation at v2

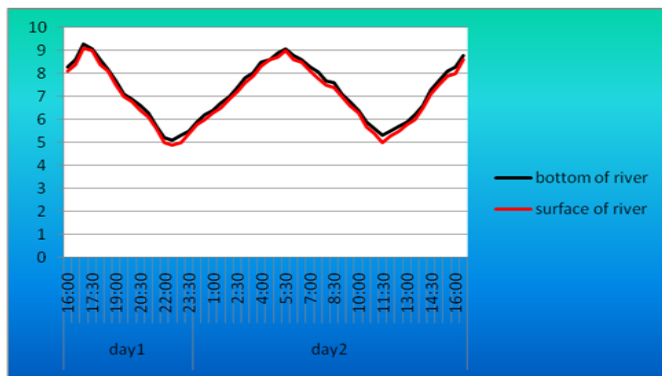


Fig 6.3: Salinity variation at v3

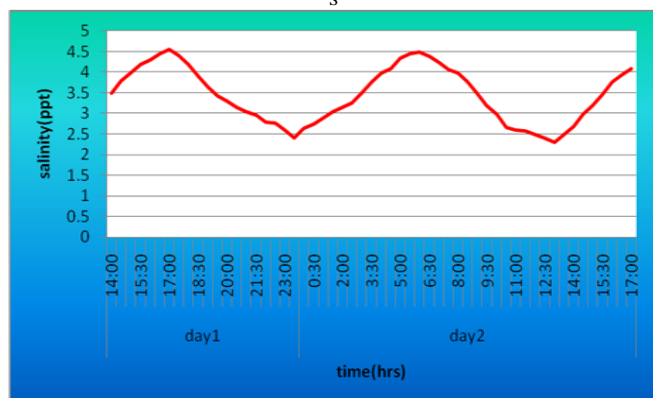


Fig 6.4: Salinity variation at station v4

7. CONCLUSIONS

From the experimental study it is found that salinity intrusion is very much affected in Valapattanam river basin. Salinity values were collected from different stations and are analyzed. From the studies it is proved that salinity along the course of the river varies as the distance increases. Salinity is more at the mouth of the river and salinity decreases upstream. The variation of salinity along depth was also measured. Salinity is less at the surface of the river and increases with depth.

The bathymetric values obtained from four stations are compared with previous year data and the change in river bed is found out. Due to unsystematic dredging there is great variation in river bed as compared to previous year.

The experimented study was conducted on the factors causing salinity intrusion like runoff, change in river bed, temperature and precipitation, to find the main cause of salinity intrusion

in Valapattanam river basin. From the study it is concluded that:

1. The runoff in Valapattanam River is decreasing annually and upstream runoff is a factor affecting salinity intrusion.
2. From the results of bathymetric survey it is found that there is a drastic change in river bed which is due to unsystematic dredging.
3. From the values of temperature and precipitation it is found that salinity intrusion increases with rise in temperature and decrease in precipitation.
4. The reduction of upstream runoff in recent years was caused by global drought, precipitation and large amount of water consumption at upstream which resulted due to both human and natural factors.
5. The only factor that can be controlled by humans is reduction of unsystematic dredging of sand from rivers.
6. If the factors causing salinity intrusion are not controlled then the effect of which will be high and may cause severe harm to aquatic life, mangroves, etc. resulting in imbalance of ecosystem of Valapattanam river.

REFERENCES

- [1] https://smartech.gatech.edu/bitstream/.../park_chan-hee_200412_phd.pdf
- [2] <http://www.mapsofindia.com/maps/kerala/rivers/>
- [3] <http://www.enchantedlearning.com/subjects/astronomy/moon/Tides.shtml>
- [4] Zhang Xinfeng and Deng Jiaquan(2010), "Affecting Factors of Salinity Intrusion in Pearl River Estuary and Sustainable Utilization of Water Resources in Pearl River Delta", Springer Science Business Media.
- [5] <http://water.usgs.gov/ogw/gwrp/saltwater/salt.html>
- [6] Manfred Koch(2013), "The Saltwater Intrusion Problem: Concepts, Challenges, Modeling, Experiments and Case Studies", Department of Geohydraulics and Engineering Hydrology, University of Kassel, Germany.
- [7] HuayangCai, Hubert H. G. Savenije, Qingshu Yang, Suying Ou, and YapingLei(2012), "Influence of River Discharge and Dredging on Tidal Wave Propagation: Modaomen Estuary Case". Journal Of Hydraulic Engineering, ASCE.
- [8] <http://kerala-rivers.blogspot.in/2013/01/valapattanam-river-largest-river-in.html>
- [9] <http://www.thehindu.com/todays-paper/tp-national/tp-kerala/islets-along-valapattanam-river-beckon-nature-lovers/article3130951.ece>
- [10] http://www.envirobiotechjournals.com/article_abstract.php?aid=2579&iid=91&d=3
- [11] H. H. G. Savenije(1989) influence of rain and evaporation on saltin intrusion in estuaries, Journal of Hydraulic Engineering, Vol. 114, ASCE
- [12] TilaiLi,XiangyuGao ,(2011), "Impact of runoff on salt intrusion of Yangtze Estuary", River and Harbor Engineering Department, Nanjing Hydraulic Research Institute (NHRI).
- [13] Dorothy F. Payne,(2010) "Effects of climate change on salt water intrusion at Hilton Head Island", SC. U.S.A. SWIM21 - 21st Salt Water Intrusion Meeting.