# STUDY OF VARIATION OF SUSPENDED SEDIMENT DISCHARGE MEASURED AT BURHANPUR GAUGING SITE OF UPPER TAPI BASIN

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***Abstract: Sediment is a natural component of riverine environments and its presence in river systems is essential. Sediment load and sediment concentration are therefore highly important variables that may play a key role in environment quality assessment and help to evaluate the extent of potential adverse impacts. The river flow rate also affects the transport pattern in any river. Changes in the stream flow variability can impact the aquatic ecology of river system by lowering the frequency of disturbances and reducing the diversity of riverine habitats. The present work will study the behaviour of the variation of flow and sediment discharge of Tapi River measured at Burhanpur gauging site. Monthly, seasonal and annual trends of suspended sediment load and flow will be studied.Sediment concentration varies largely with time and a major bulk of the annual sediment load may be transported within a few days and may go unmeasured at gauging site if the sampling frequency is poor.The monsoon months have both high sediment concentration and flow. About 88 % of the sediment load is transported within the monsoon month of June to September at Burhanpur.***

***Keywords: Tapi River, Flow discharge, Suspended sediment rate, Seasonal variation***

## 1. INTRODUCTION

Sediment is a material formed naturally by the process of breaking down of rock due to erosion and weathering, and is subsequently transported by action of wind, water, ice, and by the force of gravity acting on the particles. For examples, river water carries sand and silt particles in suspension and deposit them on the sea due to processes of sedimentation and become sedimentary rock such as become sandstone and siltstone if buried as stated in water.usgs.gov.

Sediment is a natural component of riverine environments and its presence in river systems is essential. However, in many ways and many places river systems and the landscape have been strongly affected by human activities which have destroyed naturally balanced sediment supply and sediment transport within catchments. As a consequence a number of severe environmental problems and failures have been identified, in particular the link between sediments and chemicals is crucial and has become a subject of major scientific interest. Sediment load and sediment concentration are therefore highly important variables that may play a key role in environment quality assessment and help to evaluate the extent of potential adverse impacts.

The U.S.Geological Survey (USGS)across the country has done lots of work in measuring how much sediment are transported by streams .for this, measurement of both the amount of water flowing past a site (stream flow or flow)and the amount of sediment in that water (sediment concentration )is done because, both stream flow and sediment concentration are changing continuously.

Stream flow is measured by taking a discharge measurement. Suspended sediments are the sediment which are itself moved in the water and water is collected in bottles and are send to a lab to determine the sediment concentration .As the amount of sediment transported by a river changes over a time, hydrologist take measurements and samples when stream flow goes up and down during storm. Once the amount of water flowing and the amount of sediment in the water at different flow condition is found ,we can compute the tonnage of sediment that moves past the measurement site during a day, during storm and even during the whole year.

## 2. STUDY AREA

The present study was undertaken for Burhanpur gauging station of Madhya pradesh, India. The latitude, longitude and altitude of the gauging station are 21° 17’58” N, 76° 14’ 07” E and 213 m above the mean sea level, respectively. Fig. 1 represent the location map of the study area. The catchment area of gauging station is 8487 km$^2$.


Figure 1 Map of Upper Tapi Basin

## 3. DATA COLLECTION

CWC Gandhi agar is conducting the G & D observations in the Catchments of Tapi river and on its tributaries by locating twenty one Hydrometer logical Stations in Tapi zone. These stations carry out observations about various hydrological parameters as gauge (river water level), discharge (amount of water released from a cross section in the river in a given time period), sediment (concentration of solid particles in water) and river water quality pertaining to different quality parameters. The discharge data and sediment data were collected for the stream gauging stations namely, Burhanpur, for 35years (1980-2015), from Central Water Commission (CWC), Government of India

## 4. METHODOLOGY

**Annually, Monthly & Daily Variations**

Annual variation shows the variation in Discharge and suspended sediment load annually by calculating average of annual data Monthly variation shows the variation in Discharge and suspended sediment load monthly by calculating average of monthly data and find the correlation between data, Plot the trend line and also find the $R^2$ value.

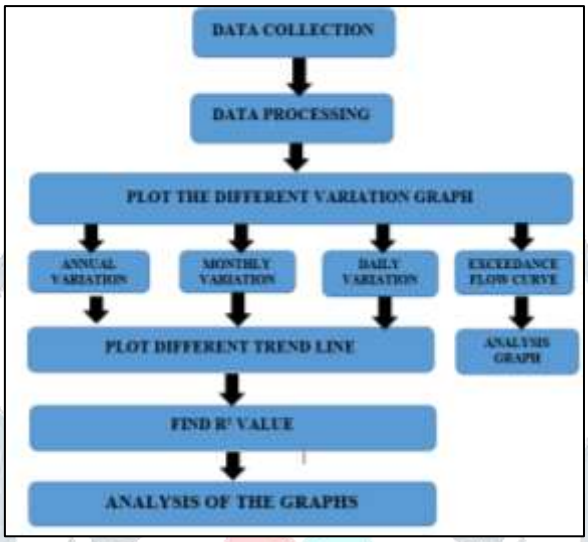


Figure 2 Methodology

**Exceedance flow curve**

"Exceedance" is a way to describe the percentage of time for which an observed stream-flow is greater than or equal to a defined stream-flow. Exceedance is used when stream-flow data are not normally distributed (i.e. on a bell-shaped curve). Most streams flows are not normally distributed because high flow events can skew the data making the mean flow greater than the median flow.

Low-flow events have high exceedance percentages, and high-flow events have low exceedance percentages. Low-flow events have a high exceedance percentage because most of the time, observed flows exceed the low flow. Similarly, high-flow events have low exceedance percentages because most observed flows are lower than the high-flow levels.

## 5. RESULTS

To find variation in discharge and suspended sediment for Tapi River data at Burhanpur gauging station, river data for a period of 35 years (1980-2015) river data are collected. Total 6641 data were recorded for river flow and 6283 data were recorded for sediment data.

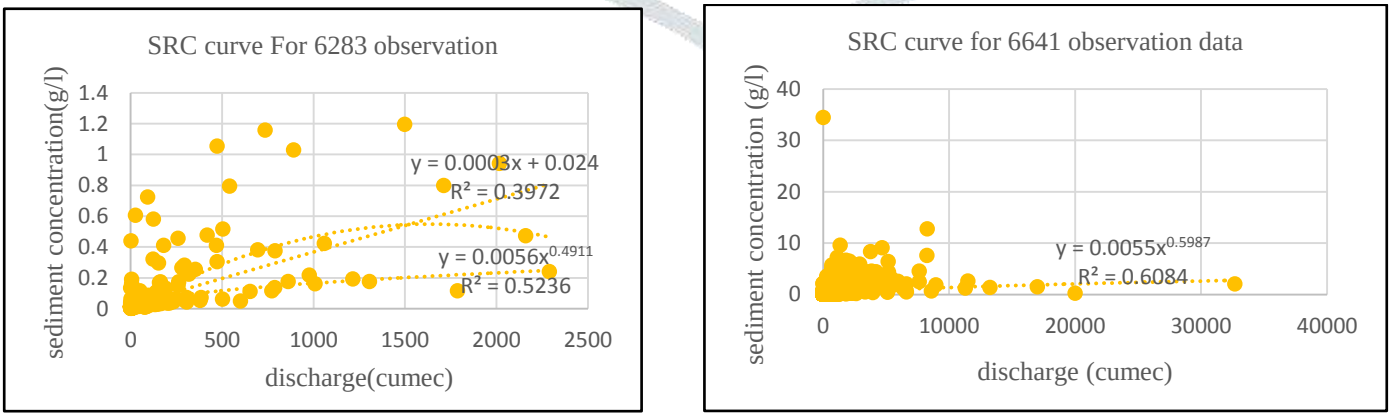


**Figure 3: Daily values of sediment concentration and flow of Burhanpur.**

Figure 3 shows different trend line with R² value & equation of trend line. The linear trend line gives $R^2$ value is 0.3972.For the Power trend line gives $R^2$ value is 0.5236.From fig 3, it can be said that discharge and sediment concentration has strong correlation in power function .Considerable scatter observed and this may be reason that there are other variables besides river flow influencing the sediment concentration. This could be because of the irregular sampling at the gauging stations. From fig 3,we observed that after finding missing data and plotting the trend line graph $R^2$ value is increased.

**Table 1 : Power function and $R^2$ for Burhanpur gauging Station for each year**

| Year | Power Equation | Correlation Coefficient |
|---|---|---|
| 1980 | $Y= 0.0059X^{0.6357}$ | $R^2 = 0.5713$ |
| 1981 | $Y= 0.0073X^{0.4242}$ | $R^2 = 0.6798$ |
| 1982 | $Y= 0.0047X^{0.0832}$ | $R^2 = 0.0127$ |
| 1983 | $Y= 0.0051X^{0.6584}$ | $R^2 = 0.4749$ |
| 1984 | $Y= 0.004X^{0.5096}$ | $R^2 = 0.5636$ |
| 1985 | $Y= 0.0033X^{0.6019}$ | $R^2 = 0.7495$ |
| 1986 | $Y= 0.0028X^{0.6786}$ | $R^2 = 0.6768$ |
| 1987 | $Y= 0.0055X^{0.7573}$ | $R^2 = 0.6431$ |
| 1988 | $Y= 0.002X^{0.8291}$ | $R^2 = 0.6412$ |
| 1989 | $Y= 0.0056X^{0.665}$ | $R^2 = 0.5984$ |
| 1990 | $Y= 0.0043X^{0.6333}$ | $R^2 = 0.5417$ |
| 1991 | $Y= 0.0010X^{0.3409}$ | $R^2 = 0.4578$ |
| 1992 | $Y= 0.0073X^{0.5627}$ | $R^2 = 0.5048$ |
| 1993 | $Y= 0.0029X^{0.6901}$ | $R^2 = 0.4753$ |
| 1994 | $Y= 0.0247X^{0.2843}$ | $R^2 = 0.299$ |
| 1995 | $Y= 0.006X^{0.5683}$ | $R^2 = 0.3835$ |
| 1996 | $Y= 0.0126X^{0.4725}$ | $R^2 = 0.4585$ |
| 1997 | $Y= 0.0071X^{0.4488}$ | $R^2 = 0.2588$ |
| 1998 | $Y= 0.0256X^{0.3607}$ | $R^2 = 0.2407$ |
| 1999 | $Y= 0.0095X^{0.4832}$ | $R^2 = 0.4094$ |
| 2000 | $Y= 0.0075X^{0.6655}$ | $R^2 = 0.5806$ |
| 2001 | $Y= 0.0726X^{0.2516}$ | $R^2 = 0.1261$ |
| 2002 | $Y= 0.0067X^{0.507}$ | $R^2 = 0.3599$ |
| 2003 | $Y= 0.0152X^{0.4088}$ | $R^2 = 0.1987$ |
| 2004 | $Y= 0.0261X^{0.3619}$ | $R^2 = 0.3862$ |
| 2005 | $Y= 0.0098X^{0.4408}$ | $R^2 = 0.3787$ |
| 2006 | $Y= 0.0102X^{0.4422}$ | $R^2 = 0.4208$ |
| 2007 | $Y= 0.0095X^{0.4332}$ | $R^2 = 0.4534$ |
| 2008 | $Y= 0.0088X^{0.5364}$ | $R^2 = 0.5046$ |
| 2009 | $Y= 0.0076X^{0.4885}$ | $R^2 = 0.2885$ |
| 2010 | $Y= 0.0027X^{0.7144}$ | $R^2 = 0.4027$ |
| 2011 | $Y= 0.0073X^{0.5988}$ | $R^2 = 0.32$ |
| 2012 | $Y= 0.0046X^{0.6039}$ | $R^2 = 0.2416$ |
| 2013 | $Y= 0.0006X^{0.4242}$ | $R^2 = 0.7767$ |
| 2014 | $Y= 0.0029X^{0.678}$ | $R^2 = 0.3715$ |
| 2015 | $Y= 0.0042X^{0.6346}$ | $R^2 = 0.3706$ |

From the Table 1, we observed that the $R^2$ values are not very high and the correlation between river flow and sediment concentration is poor. It is interesting to see that the $R^2$ values are good for some years; for instance, the $R^2$ value for the year 1984 is about 0.5636 and for 1985 it is about 0.7495 which shows a good correlation between the flow and concentration. The discharge and sediment concentration were plotted for the year 1985 and the plot shows same trend in the sediment concentration and the discharge as shown in Figure 5.3. For this year, the correlation is very good.

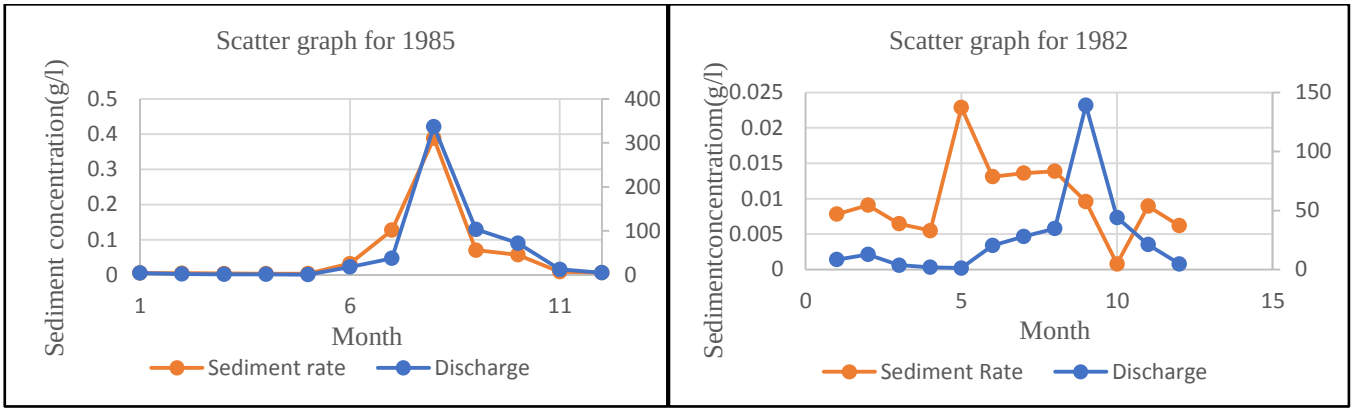


**Figure 4 Average Monthly variations of sediment concentration and discharge in 1985 & 1982 of Burhanpur**

But there are other years where the correlation is very poor; the correlation for the year 1982 is very poor with an R2 value of 0.0127.The discharge and sediment concentration were plotted for the year 1982 and the plot shows poor trend in the sediment concentration and the discharge as shown in Figure 4. For this year, the correlation is very poor. Figure 5 shows the maximum flow occurs in the monsoon months; i.e. June, July, August and September.The sediment concentration is also highest in these months.This trend is followed in all the years of the record period. From the data, it is observed that 88% of the sediment load is transported during the monsoon month of June to September. In the months from February to May only 4 % of the total yearly load was transported.The 8 % is transported during the months October to January. The river discharge follows a similar trend. Flow in the monsoon months contribute to 85% of the total flow while 9% is contributed by the months of October to January and the remaining 6% from February to May.Maximum peak Discharge in monsoon months is 512.1257 cumec and Maximum Sediment rate in monsoon months is 0.359208 g/l.

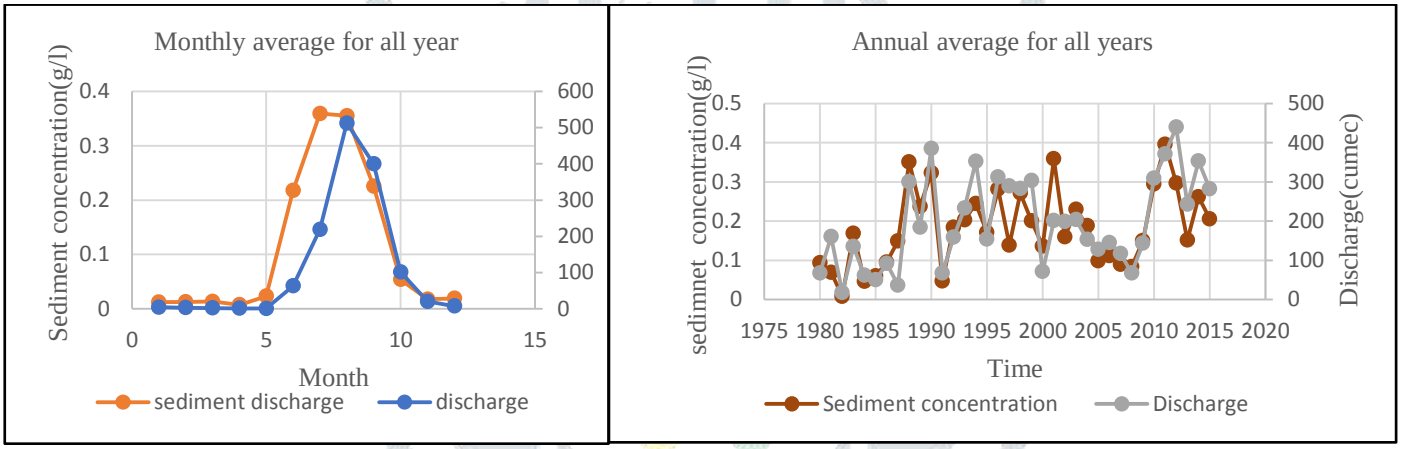


**Figure 5 Average Monthly variations & Average Annual variation of sediment concentration and discharge of Burhanpur**

Fig 5 shows average annual variation of sediment concentration and flow of Burhanpur in which the highest SSC was observed in 2011 with an average SSC of 0.39575 g/l. The minimum SSC was observed in 1982 with an average SSC of 0.007822 g/l.The highest discharge was observed in 2012 with an average value of 439.912 cumec. The Minimum discharge was observed in 1982 with an average value of 17.30636 cumec. Increase in sediment concentration was observed in the year 1983,1987,1988,2000, as compare to discharge flow.In the year 1996 to 1999,less variation in flow is observed. however, but sediment concentration decrease effectively.

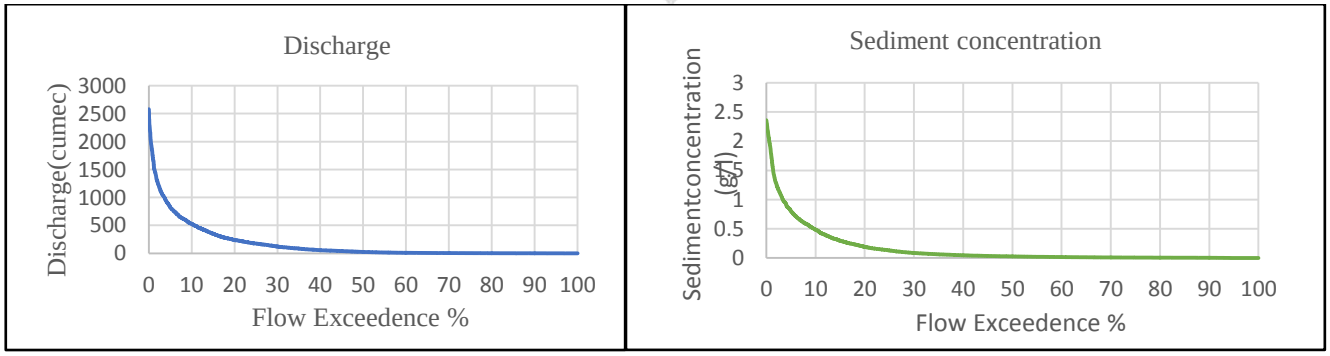


**Figure 6 Exceedance Flow Curve of Burhanpur**

From fig 6 for 30 % of flow Exceedance we get the 150.25 cumec flow in above means that average 150.25 cumec or exceed Discharge flow are flowing for the 30 % of total time period. Average flow at Burhanpur is 167.66 cumec so,from fig 6 we get 24% means 167.66 cumec or exceed flow are flowing the 24 % of total time Period.

## 6. CONCLUSION

Sediment concentration varies largely with time and a major bulk of the annual sediment load may be transported within a few days and may go unmeasured at gauging site if the sampling frequency is poor. The correlation between sediment concentration and river discharge at Burhanpur gauging station for the year 1985 was found to be very good with an R2 value of 0.7495. The correlation of average discharge and concentration over the record period of 1984 was found to be 0.53. For some years the correlation was very poor with an R2 value of 0.0127. On a daily basis, the correlation is poor but for average monthly values, the correlation is very good. There are rapid and unpredictable changes in the water flow and suspended sediment concentration. Hence, river flow is not a reliable key for monitoring the suspended sediment concentration in the river. The monsoon months have both high sediment concentration and flow. About 88 % of the sediment load is transported within the monsoon month of June to September. Exceedance flow curve showed that maximum flow occurred within the small time period of the year.

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