Multipurpose Projects Serve as a Flood Controller- Is this the Reality? A Study of DVC Projects of the Damodar River of West Bengal, India

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Abstract
The river valley projects with many objectives are called multipurpose project. Among the single purpose dams, dams serves as follows: irrigation, hydropower, water supply, flood control, recreation, navigation and fish farming. Most of the cases, flood control is becoming the sole factor for which the multipurpose projects or dams can be constructed. The Damodar River was renowned as the "River of Sorrow" for its high magnitude and frequency of flood. The Damodar Valley Corporation (DVC) was modelled to play a major role in reducing the magnitude of flood by constructing several Multipurpose Projects in this river valley on this river itself and its tributaries also. To find out whether dams are able to control the floods or not in Damodar River basin, recurrence interval has been calculated through flood frequency analysis in two different periods: the Pre-Dam (1934-1957) and the Post-Dam (1958-2007) Period. Annual stream flow has been reduced in the post dam period. Discharge of the Damodar River has also been reduced in different Recurrence Interval years (5, 10, 20, 30, 40, 50 years) in the post-dam period. The ranges of flood moderation between the pre and post-dam period is high in the high recurrence interval years and vice versa. The major achievement of the DVC dams is these can moderate the flood up to 64% in the post-dam period. Flood moderation can reduce high magnitude of flood in the peak flow season. The major dams of the Damodar River valley of the DVC project can able to moderate or reduce high magnitude of flood of the river valley, but this can lead to increase in the frequency of low level flood. Dams are interlinked with the people and landscapes of the Damodar Valley region and the people can adopt and sustain with the vulnerable nature of the river.
Keywords: Multipurpose Project, Flood Controller, Flood Frequency Analysis, Recurrence Interval, Damodar Valley Corporation (DVC), Pre-dam, Post-dam, Flood Moderation

1. Introduction

A river valley projects with numerous objectives is known as multipurpose project. These include several objectives such as: irrigation, hydroelectricity generation, flood control, afforestation, drinking water, soil conservation, silt control, navigation, recreational facilities, preserving wildlife etc. Among the single purpose dams, dams serves as follows: 48 % for irrigation, 17% for hydropower (production of electricity), 13% for water supply, 10% for flood control, 5% for recreation and less than 1% for navigation and fish farming. Often it has been observed that flood control has become the sole factor for which the multipurpose projects or dams have been constructed (Singh, 1990). The most effective method of flood control is accomplished by an integrated water management plan for regulating the storage and discharges of each of the main dams located on a river basin (ICOLD, 2013). Hydrological alteration (reduction of flood magnitude, seasonal flow distribution) (Batalla et al., 2004; Lajoie et al. 2007) such as: Reduction of flow (Petts and Gurnell, 2005) leads to a reduction in stream power and sediment carrying capacity of a river, as a result of which reservoir storage and evaporation from water surface takes place (Brandt, 2000; Gregory, 2006). Peak flow reduction during the maximum inflow discharge is the major aims of these dams in order to achieve the goal of flood moderation. Dams do have the ability to reduce about 50-70 percent maximum discharge of the rivers (Graf 2005; 2006). Flood, the major natural disaster of West Bengal (Chakraborty, 2010; Mukhopadhyay, 2010), victimizes several people every year, and that these floods are not only a result of over-flowing of the Damodar River but other rivers also (Chapman and Rudra, 2004). The Damodar River is a sub-system of the Ganges River system of India. It is one of those rivers that has continuously affected human life and properties in east India. From the headword hilly area, sudden huge amounts of water through several channel are poured into the downstream areas, appearing like a huge wall of water, known as '*harpaban*' (flash flood), resulting to severe damage to the downstream areas (Bhattacharya, 2011). The first recorded high magnitude flood was in 1730 (Voorduin, 1947). The problems of flood and bank side erosion had been a typically chronic problem in the lower Damodar basin in West Bengal (Ghosh, 2012; Sen, 1991). The high magnitude flood was frequent in the pre-dam period. Embankment construction was the first control structure in the lower Damodar region that was undertaken to reduce the effect of the flood and bank erosion. N. K. Bose (1943), Chief of Damodar Flood Investigation Committee, had mentioned that the problem of Damodar is not only for surplus of water, but also surplus of sand (Rudra, 2008). After the dam construction by DVC project, the magnitude of flood has reduced (Ghosh and

Mistri, 2013; Ghosh and Guchhait, 2014) and has thus saved a higher amount of life and property, and also increased the irrigation facility and agriculture in the lower reaches of the basin (Lahiri, 2003; 2012). The multiple objectives of Voorduin's Plan of flood control, irrigation, power, etc. in the valley had been sought to be achieved principally through a set of reservoirs at 8 sites on. In the first, only 4 dams such as: Tilaiya (1953), Konar (1955), Maithon (1957) and Panchet (1959) were constructed by DVC (Chandra, 2003) and later the Tenughat Dam on the Damodar River (Sen, 1991) and Durgapur Barrage facilitating controlled processes of flow and flood mitigation. These plays a significant role in the natural fluvial geomorphic processes and forms (Sen and Prasad, 2002). Damodar Valley Reservoirs in Damodar and its tributaries has achieved flood moderation of about 75 percentage in the case of high floods (Sinha and Srivastava). In some areas, water discharge from the dams is dependent on the rainfall. Often water is released from the dams at the time of high rainfall. The downstream areas are then worst affected. Thus, it may be stated still floods still do exist in the Damodar river valley as quasi-natural phenomena.

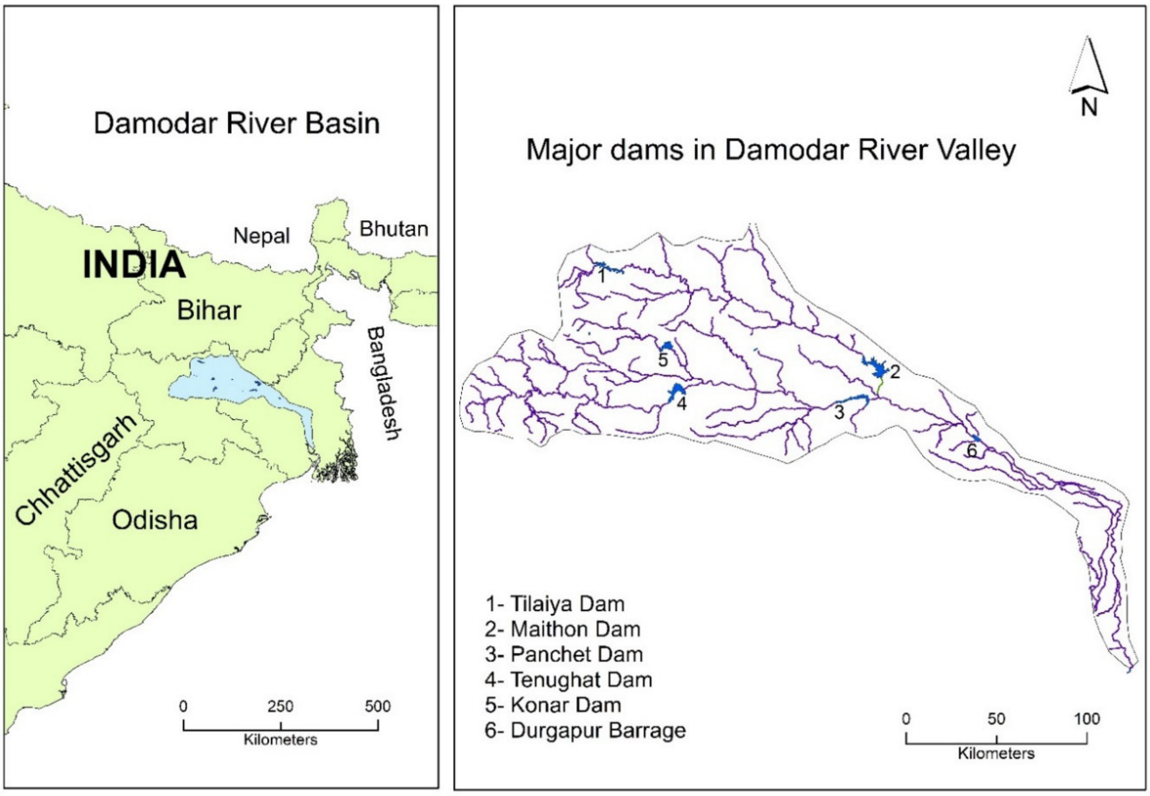


Figure 1: Location map of the Damodar River basin and major dams on the Damodar and its tributaries

The present study is an attempt to focus on whether dams in reality are actually able to control the floods of lower regime of the Damodar River in the post dam period.

2. Location of the Study Area

The Damodar River, originating in the hills of Palamau district of Jharkhand, is a major river in the Eastern Gangetic Plain (CICFRI, 1998). The entire river basin is shared by the two neighbouring states: Jharkhand and West Bengal. The present study is related with the multipurpose projects that had been set up in Jharkhand and West Bengal. All of the dams had been established at Tilaiya, Maithon, Konar, Tenughat, and Panchet in Jharkhand. Except the first three dams, rest of the dams are on the Damodar River itself (Figure 1). The catchment area has the major 2 dams at Tilaiya and Maithon on the Barakar River, Konar on the Konar River and Panchet on the Damodar River. Only Durgapur Barrage and Anderson Weir had been set up at Durgapur and Rhondia of West Bengal. The study area covers the districts of Bokaro, Dhanbad district of Jharkhand and two districts of West Bengal namely, Bankura and Burdwan District. This region is very densely populated area as some of the major industrial towns such as Asansol, Ranigang, Durgapur, and Burdwan are located in this area. The study area also includes the plateau region of the Chotanagpur area in the upstream section and the downstream section is associated with the alluvial characteristics with several bifurcation in the lower section of the Damodar River.

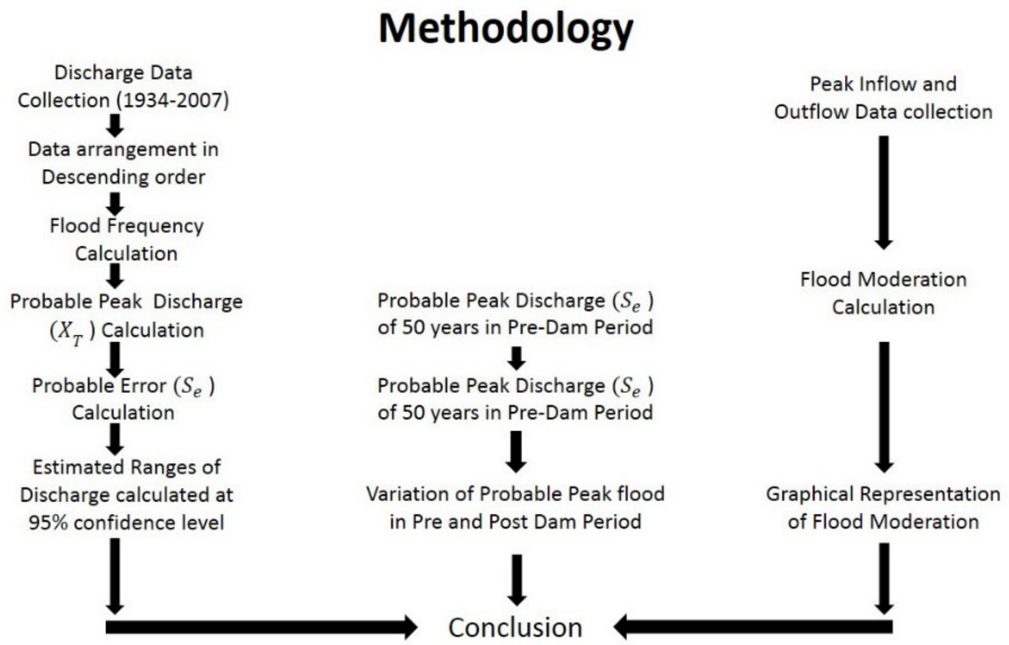
3. Materials and Methods

For the fulfilment of the earlier mentioned objectives data has been collected from the following sources:

Table 1: Data source of the study

Discharge Data	District Information
Hydraulic Data Division, Damodar Valley Corporation, Maithon; River Discharge Database, Centre for Sustainability and the Global Environment; Damodar Valley Corporation, Kolkata DVC Data Book (1995)	District Statistical Handbook

For the analysis of the dam as a flood controller to the Damodar River Basin, two periods have been considered. Such as: The Pre-Dam (1934-1957) and the Post-Dam (1958-2007) Period (Batalla et al., 2004). Two major dams of the river basin (Maithon and Panchet) have had been constructed in between 1957-1959. The long term discharge data are available at Maithon and Panchet gauzing station. The long term Peak discharge data have been collected from the above mentioned gauging station and sources from 1934 to 2007. From the collected data trends of flood have been calculated before and after the dam construction. To prove whether the dams are able to control the flood in Damodar River Basin, flood frequency analysis and recurrence interval have been calculated for both the pre and post dam period (Davie, 2003). The annual peak water discharge has been used for the flood frequency analysis and calculation of recurrence interval in both pre and post dam period. In order to calculate the flood frequency in the river valley, Gumble's method of flood frequency analysis has been adopted. Flood frequency (Jha and Bairagya, 2011; 2012) and Recurrence Interval is calculated differently in two periods (Pre and Post Dam). The Flood Peak Moderation has been shown graphically with the help of peak inflow and outflow discharge data. With the help of flood data at two stations, temporal change of highest peak flood magnitude and frequency of moderate flood has been shown to show effect of dams on the magnitude of floods. Methodology has been represented in the following figure graphically. The present study is restricted to the flood peak reduction measurable form the gauging record from the gauging station.



3.1. Calculation Flood Frequency and Recurrence Interval in both pre and post dam periods

Gumble defined a flood as the largest of the 365 daily flows and the peak annual series of flood flows (Subramanya, 2008).

$$\text{Average Discharge } (\bar{Q}) = \sum \frac{Q}{N}$$

$$\text{Flood Frequency (T)} = N + {}^{1}\!/_{m}$$

Where, N = No. of Observation, m = Order number of the event

$$\text{Max Probable Flood (P)} = 100/T$$

Where, T = Flood Frequency

Standard Deviation $(SD_{n-1}) = \sqrt{\frac{(Q^{-}-Q)^2}{N-1}}$

The general formula for the prediction of extreme flood values and its probability of occurrence is given by Gumble as below:

$$Q_p = Q^{-} + K.\sigma_{n-1} \quad (1)$$

Where,
Q_p = Probable Peak Discharge,
σ_{n-1} = Standard Deviation of the sample size $N = \sqrt{\frac{\Sigma(Q-Q^{-})^2}{N-1}}$
Q^{-} = Average Flood discharge,
K = Gumble's Frequency factor expressed as

$$K = \frac{Y_t - Y_n}{S_n} \quad (2)$$

In which Y_t= reduced variate, a function of T and is given by

$$y_T = -\left[In.In\frac{T}{T-1}\right] \quad (3)$$

Or,

$$y_T = -\left[0.834 + 2.303loglog\frac{T}{T-1}\right]$$

Y_n = Reduced mean, a function of sample size N.
S_n = Reduced standard deviation, a function of sample size N.
Y_n and S_n are expected mean and standard deviation collected from Gumble's extreme value distribution table (table 2 and 3) respectively.

Table 2: Reduced Mean Yn in Gumble's extreme value distribution (Sample Size N)

N	0	1	2	3	4	5	6	7	8	9
10	.4952	.4996	.5053	.5070	.5100	.5128	.5157	.5181	.5202	.5520
20	.5236	.5252	.5268	.5283	.5296	.5309	.5320	.5332	.5343	.5353
30	.5362	.5371	.5380	.5388	.5396	.5402	.5410	.5418	.5424	.5430
40	.5436	.5442	.5448	.5453	.5458	.5463	.5468	.5473	.5477	.5481
50	.5485	.5489	.5493	.5497	.5510	.5504	.5508	.5511	.5515	5518

Table 3: Reduced Standard Deviation Sn in Gumble's extreme value distribution

N	0	1	2	3	4	5	6	7	8	9
10	.9496	.9676	.9833	.9971	1.0095	1.0206	1.0316	1.0411	1.0493	1.0565
20	1.0628	1.0696	1.0754	1.0811	1.0864	1.0915	1.0961	1.1004	1.1047	1.1086
30	1.1124	1.1159	1.1193	1.1226	1.1255	1.1285	1.1313	1.1339	1.1363	1.1388
40	1.1413	1.1436	1.1458	1.1480	1.1499	1.1519	1.1538	1.1557	1.1574	1.1590
50	1.1607	1.1623	1.1638	1.1658	1.1667	1.1681	1.1696	1.1708	1.1721	1.1734

Source: K. Subramanya (2008), p. 257

The value of variate x with a recurrence interval of T is as follows:

$$X_T = Q^{-}K(SD_{n-1}) \quad (4)$$

An estimation of confidence limit has been derived. It gives the limit of the calculated value. The value of x_T is bounded by the value of x_1 and x_2

$$x_{1/2} = x_T \mp f(c)S_e \quad (5)$$

Where, $S_e$is the probable errors, $f(c)$ is function of confidence probability c determined by using following Table 4:

C in percent	50	68	80	90	95	99
f(c)	0.674	1.00	1.282	1.645	1.96	2.58

$$(\text{Probable error})S_e = b\frac{\sigma_{n-1}}{\sqrt{N}} \quad (6)$$

$$b = \sqrt{1 + 1.3k + 1.1k^2}$$

Where, k is the frequency factor mentioned in the eq.2, σ_{n-1}= standard deviation of the sample and N is the sample size.

4. Result

4.1. Flood Frequency Analysis in the Pre-dam Period:

The amount of the highest peak flood discharge is 18112 in 1935 and the average discharge in Pre-dam period is 8,378 cumec.

In table 5, the probable peak flood has been calculated in the intervals of 5, 10, 20, 30, 40 and 50 years. This implies that a particular amount of discharge will occur after a particular time period. There are positive relations between the probable peak flood and the recurrence interval year. Higher the recurrence interval, the higher is the probable peak flood that has occurred. There are 12458.16 cumec amount of discharge that has occurred in the interval of 5 years.

Table 5: Calculation of Probable Peak Discharge of the Damodar River at Raniganj and Rhondia in Pre dam Period

Recurrence Interval Year	$Y_T = -\left(In.In\frac{T}{T-1}\right)$	Y_n	S_n	K= $\frac{Yr-Yn}{Sn}$	(SD_{n-1})	Q¯	X_T = Q¯K(SD_{n-1})	Probable Error(S_e)	The estimated discharge lying in between (95% Confidence Probability)
5	1.500	0.5296	1.0864	0.893	4569.05	8378	12458.16	1625.63	15644.39 9271.92
10	2.251	0.5296	1.0864	1.584	4569.05	8378	15615.38	2249.56	20024.52 11206.24
20	2.971	0.5296	1.0864	2.250	4569.05	8378	18658.36	2873.92	24291.24 13025.48
30	3.385	0.5296	1.0864	2.628	4569.05	8378	20385.46	3213.92	26684.74 10486.18
40	3,677	0.5296	1.0864	2.897	4569.05	8378	25178.40	3589.06	32016.96 18339.84
50	3.903	0.5296	1.0864	3.105	4569.05	8378	26211.00	3689.58	33442.58 18979.42

In table 5, the magnitude of peak flood having a frequency of 5, 10, 20, 30, 40, 50 years has been calculated as 12458.16, 15615.38, 18658.36, 20385.46, 25178.40, 26211.00 cumec respectively. From this analysis, it is calculated that the magnitude of peak flood peak discharge should be less than 26211.00 cumec in an interval of 50 years. This is the scenario in the Damodar River Valley before the multipurpose projects have been constructed by DVC authority.

4.2. Flood Frequency Analysis in the Post-dam Period:

In Damodar River itself and its tributaries, several dams have been constructed in the upper and middle stream regime in an effort to 'tame the river'. The annual peak discharge data at Rhondia have been collected, as this site has faced the high modifications in its discharge after construction of the Panchet Dam, the Tenughat Dam and the Durgapur Barrage. Rhondia barrage has also modified the discharge of the downstream of the river as this site is under the agricultural region of the valley area.

It is noted that the discharge has been reduced by the dams and totally depends on the reduction of water from the dams in the upstream areas. Average discharge in the post-dam period is 3,933 cumec whereas it was 8,378 cumec in the pre-dam period. The amount of highest flood peak discharge is 18590 cumec in 2001.

In table 6, the magnitude of peak flood having frequency of 5, 10, 20, 30, 40, 50 years have been calculated as 6418.68, 8379.95, 3645.61, 4607.60, 5355.67, 5977.70 cumec respectively. It is calculated that the magnitude of peak flood peak discharge should be less than 12693.51 cumec in an interval of 50 years. Though these ceases to exist any strict as in 2001, this station has faced a peak flood discharge of about 18000 cumec. When one takes into consideration the magnitudes of floods of different recurrence intervals before and after the dam construction, it is clear that dams have much less control on rare events of high magnitudes.

Table 6: Calculation of probable peak discharge of the Lower Damodar River at Raniganj and Rhondia in Post dam Period

Recurrence Interval Year	$Y_{T} = -\left(In.In\frac{T}{T-1}\right)$	Y_n	S_n	K= $\frac{Yr - Yn}{Sn}$	(SD_{n-1})	Q⁻	X_T = Q⁻K(SD_{n-1})	Probable Error(S_e)	Estimated discharge lying in between (95% Confidence Probability)
5	1.500	.5485	1.1607	0.820	3031.32	3933	6418.68	1202.48	8775.54 4061.42
10	2.251	.5485	1.1607	1.467	3031.32	3933	8379.95	2260.93	12811.37 3948.53
20	2.971	.5485	1.1607	2.087	3031.32	3933	10259.36	3645.61	17407.76 3113.96
30	3.385	.5485	1.1607	2.444	3031.32	3933	11341.55	4607.60	20371.45 2310.65
40	3,677	.5485	1.1607	2.695	3031.32	3933	12102.41	5355.67	22599.52 1605.30
50	3.903	.5485	1.1607	2.890	3031.32	3933	12693.51	5977.70	24409.80 977.22

In Table 5 and 6, it has been observed that there is a reduction of peak flood discharge from pre-dam to post-dam period. In the case of 5 year Recurrence Interval, the peak flood discharge is reduced from 12458.16 to 6418.68 cumec that is about a reduction of about 6039.48 cumec (48.478%). There are about 6039.48 (48.478%), 7235.43 (46.335%), 8399 (45.015%), 9043.91 (44.365%), 13075.99 (51.933%), 13517.49 (51.572%) cumec reduction of peak flood discharge in post-dam period in the recurrence interval year of 5, 10, 20, 30, 40, 50 respectively.

Table 7: Difference of Probable Peak discharge in Pre and Post dam period

Recurrence Interval (Years)	**Discharge (X_T in m^3/s)**			
	Pre Dam	Post Dam	Difference	
			Cumec	Percentage (%)
5	12458.16	6418.68	6039.48	48.478
10	15615.38	8379.95	7235.43	46.335
20	18658.36	10259.36	8399	45.015
30	20385.46	11341.55	9043.91	44.365
40	25178.4	12102.41	13075.99	51.933
50	26211	12693.51	13517.49	51.572

5. Discussion:

5.1. Reduction of Annual Stream flow in Post-Dam Period:

For the analysis of average stream flow in two different periods, data are available from 1934-1956 in the pre-dam periods and from 1959 -2007 in the post-dam periods. In figure. 2, the two different periods have been shown. In the left hand side of the figure, in pre-dam period, the trends of annual stream flows has increased. On the other hand, in post-dam period, the trend is more or less homogeneous or slightly decreasing (Ghosh and Mistri, 2013; Ghosh and Guchhait, 2014). The annual stream flows in post the dam periods are totally under control. In the pre-dam period, average annual stream flow was 4,061 cumec, on the contrary, average annual stream flow is 2760.25 cumec in the post-dam period.

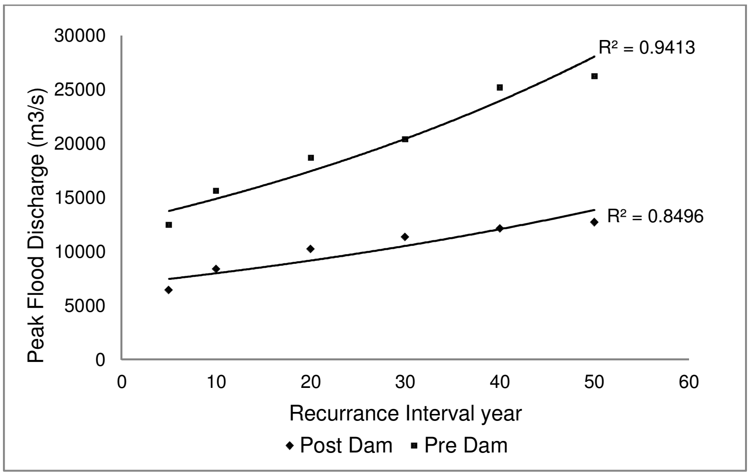


Figure 2: Annual stream flow of pre and post-dam period at Rhondia on the Damodar River

This demonstrates that there is a reduction of 1301 cumec (32%) water discharge in the post-dam period from the pre-dam period. The peak flow of the river has been reduced by the dams. Similarly, figure 3 represents the differences of peak discharge in the pre and post dam period. The trend of the peak flood discharge is also higher in the pre dam period than the post dam period. Though the peak flood discharge has been reduced by the dam construction but in 1978 and 2001 the discharge has gone above 10000 cumec. Albeit, DVC have found the success in flood moderation of the Damodar river valley with the help of DVC dams, but floods have been occurred in 1959, 1978, 1999, 2000, 2006 and 2007. This reveals that the lower valley is still vulnerable to sudden low magnitude floods (Bhattacharya, 2011). From the figure 3, it has been found that the amount of reduction is more in the recurrence interval of 40 and 50 years than the year of 5,10,20 etc. This demonstrates that the dams are able to arrest the high peak flood discharge rather than the moderate discharge. The range of discharge of water between the pre and the post–dam period is higher in the high Recurrence Interval year (30-50 years) and vice versa (Figure 3). The range of moderation is low in the low peak discharge of 0 to 30 years. The dams are able to cope the high peak discharge and has achieved success in the reduction of high peak flood in the high Recurrence Interval year such as 50 years. So the DVC dams are able to reduce the high peak flood in the Damodar river basin.

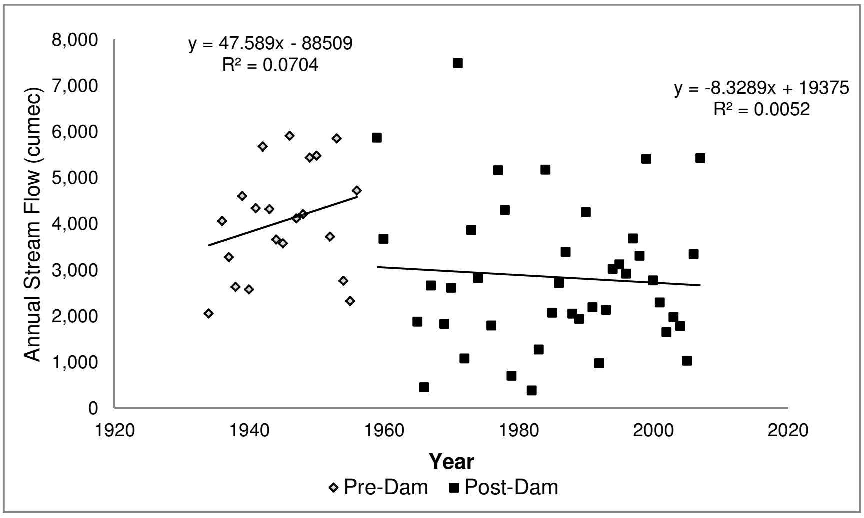


Figure 3: Peak flood probability in pre and post- dam period at Maithon and Panchet station

5.2. Flood Peak Moderation by Dams construction in the Lower Damodar River:

In case of flood moderation in the overall post dam period (Chandra, 2003), dams have been able to moderate the floods in the downstream areas of the Damodar River (Brandt, 2000). Flood moderation is the difference between inflow to the dams and outflow from the dams. Peak inflow and moderated out flow data of Panchet and Maithon have been collected. Dams of DVC have the ability to moderate flood from 32% to 80%. The amount of average flood moderation is 64 %. In 1978, a high magnitude devastating flood had occurred and the dams can able to moderate up to 78%. This thus saved a greater loss of life and properties in the downstream areas. It has been reported that the magnitude of the design flood from the Panchet reservoir would be reduced by 80% subsequent to dam closure (Jain et al., 1973). The highest amount of flood moderation has been achieved in 1963 (Figure 4). Flood magnitude reduction has been possible in major the flood period in the post dam period of the Maithon and the Panchet combined. In the major flood of 1961, 1995 and 1973, more than 10000 cumec water inflow can be moderated with the dams. Major achievement of the dams has been in the flood of 1978, which was the devastating flood in the Damodar River basin area. In this year, over 15000 cumec water inflow were moderated by the Maithon and the Panchet Dams combined. It has thus been observed that reduction in the occurrence of major high peak floods is an achievement in the post dam period of Damodar River basin.

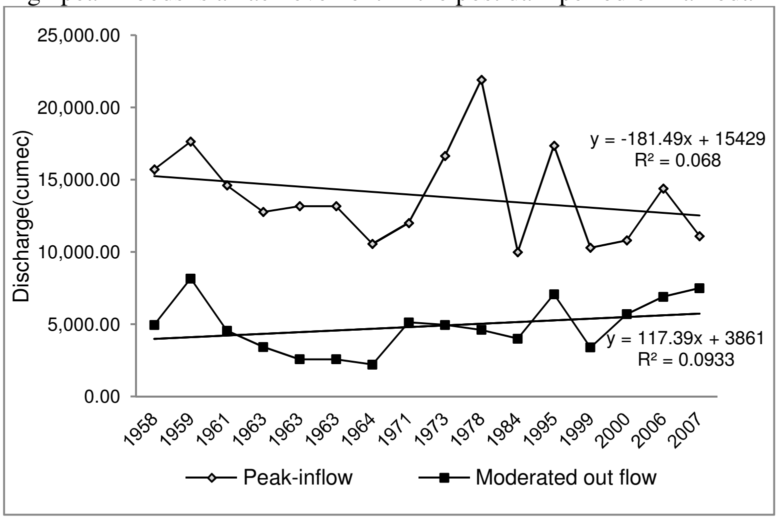


Figure 4: Flood moderation due to dam construction in post -dam period of the Damodar River

5.3. Flood magnitude analysis in post-dam period:

If one tries to undertake flood magnitude analysis in the post dam period, then one would observed that the dams have been able to control the peak flow of flood in the river valley. The data are available in Raniganj (1857-1917) and Rhondia (1933-2007). In figure 5, the frequencies and magnitude of flood have been shown in the pre and post dam periods. It is noticed that there has been hardly any occurrences of extremely abnormal floods in the post dam period (Figure 5). But in the pre dam period, the same station have experienced with numerous extremely abnormal floods twice. Thus an inverse relationship has been observed between magnitude of flood and frequencies of flood in post-dam period at Rhondia station.

The frequencies of low magnitude flood has however increased after dam construction. But in the pre-dam period, frequencies of low magnitude floods were few and vice-versa. This simply implies that dams are able to controls high magnitude severe floods with mass water storage in the reservoirs and flood moderation but are hardly effective in case of low magnitude flood that occurs in the Damodar river valley.

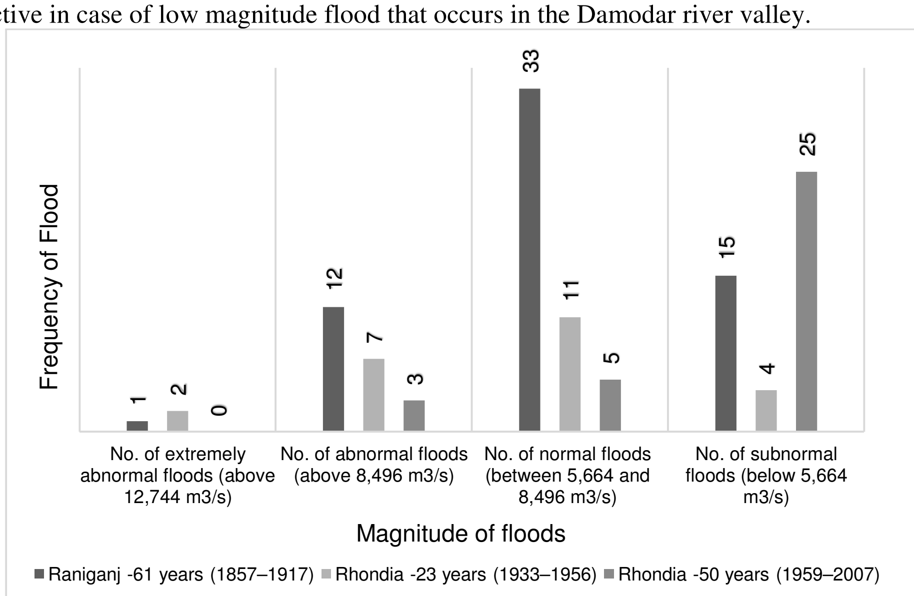


Figure 5: History of flood magnitude and frequency at Raniganj and Rhondia of the Damodar River

6. Summary and Conclusion:

So it may be concluded from the above discussion that the multipurpose projects or dams can control the floods in the Damodar river basin. But, that only happens in the case of high magnitude peak flood where and reduction or moderation of the peak flood occurs. But it hardly an effective control measure for reduction of the frequencies of low magnitude or low peak floods.

It cannot be said that the lower Damodar basin are still under the vulnerable area. But it is true that it lesser vulnerable in the post-dam period than it was the pre-dam periods. The DVC dams have been able to reduce the vulnerability of flood in the lower reaches of the drainage basin. But the release of excess water from the dam during high low pressure storm rain still continue to cause inundation of the downstream regime of the river.

The Damodar river was the one of the major river that caused several life and property loss with its high magnitude of floods. It was thus called as the "Sorrow of Bengal". But the Damodar Valley Corporation (DVC) was modelled after the Tennessee Valley Authority (TVA) of USA in 1948, has been able to gain control over the river and its floods, and this time through the construction of sophisticated engineering structures and heavy embankments were used in its lower sector to reduce flood hazard in the Rarh plain. Several anthropogenic activities such as: Embankments, canals, sluices, weirs, dykes, barrages, dams, and reservoirs are now integral components of the geomorphic landscape of the Damodar river system for moderating the flood. After the completion of dam constructions by the DVC, the peak of floods can further be reduced, but it can hardly be able to reduce the frequency of low magnitude floods. Several distributaries are affected or characterised with low water flow as an after effect of the DVC dams in the Damodar River. The flood moderation have benefited the agriculture in the downstream of the valley area. The amount of agricultural land has also been increased after the modification and reduction of flood by the dams. The industrial belt of Asansol-Durgapur region has totally depended on the Damodar River for water supply. The people in the downstream area can sustain their lives smoothly after the flood moderation. Huge amount electricity that is generated by the dams is supplied to the Durgapur-Asansol Industrial Region. Irrigation supply has also gain impetus on the agricultural output of this valley region. Of late, the DVC has been focusing more on Power Generation rather than the flood control and other objectives. Albeit, most of the low level flood (flood in Burdwan and Hooghly district on Oct, 2013) (Anandabazar Patrika, 2013) has been artificially generated through the release of excess water from the reservoirs storage of the dams at the time of high storm rainfall in the upstream and the hilly areas. This needs to be taken seriously into consideration by the DVC authority. Thus the dams are severally interlinked with the people and landscapes of the Damodar Valley Region and the people have expressed their thanks to the DVC Authority for giving them an opportunity to sustain a smoother life with the water resources of the Damodar River.

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