

Role of Multipurpose Projects on Distribution of Cropping Intensity and Canal Irrigation: A Study on DVC Projects of the Middle Damodar River Valley of West Bengal

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Abstract

The river valley projects with many objectives are called multipurpose project. Multipurpose project in the Damodar River played a major role not only as a flood controller but also as a source of canal irrigation. Middle and lower course of the river are the most prominent area where irrigation systems are largely controlled by DVC projects of Damodar River. Several canal systems has also developed after construction of dams in DVC project of Damodar River Valley. The study area falls under the area in between Panchet Dam and Burdwan Town. It is extended up to 23°28' N to 23°41'N latitude and 86 ° 44 'E to 87 ° 18' E longitudes. Total length of the area is approximately 70 km. the avg. height of this area is 110 m from the sea level. To show the increase of Agricultural Land in downstream section Damodar River Basin, block wise Cropping Intensity distribution has been calculated for showing locational and temporal. In this river valley, the area under Agricultural Land has been drastically increased (15%) from 1990 to 2010 but there are slightly increase in the Built up areas. The western side of the basin have the low cropping intensity in the Burdwan District. Upper reaches are less fertile that is why production is also low and reverse condition are found in the lower reaches of the river basin area. The downstream of the river valley are pure alluvial track of the Ganga River system and this region are more fertile than the upstream region. Whole basin area is bounded with agricultural and industrial activities. Irrigation also can put impetus on the agricultural output of this valley region especially in the downstream areas of the valley. Thus the dams are severally interlinked with the human settlement and landscapes of the Damodar Valley Region.

Keywords: Multipurpose DVC projects, Agriculture, Dam and Barrage, Land use/land cover change, Cropping Intensity, Damodar River Valley

1. Introduction

The river valley projects with many objectives are called multipurpose projects. These objectives include irrigation, generation of hydro-electricity, flood control, afforestation, drinking water, soil conservation, silt control, navigation, recreational facilities, preserving wild life 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. 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 in a river basin (ICOLD, 2013). Damodar River was one of the rivers that affect severely human life and properties in east India. But after the dam construction by DVC project, the magnitude of flood can be reduced and save lots of life and properties in the basin area of lower reaches. Its basin houses a densely populated, highly urbanised, highly industrialised and intensively cultivated area in that region (Lahiri et al., 1985). It is the Damodar basin with its canals that pioneered the so-called Green Revolution (Lahiri et al., 2003). Several canal systems also develop the after construction of dams in DVC project of Damodar River Valley. Variability of rainfall will affect river flow rates and flood runoff, which will in turn likely impact upon the amount of available irrigation water (Sakamoto et al, 2006). The study is concerned with the increase of agricultural land in lower section of the Damodar River and to analyse the role of multipurpose projects on distribution of agricultural field and Cropping Intensity in downstream section of Damodar River Basin.

2. Study Area

The study area falls under the area in between Panchet Dam and Burdwan Town. It is extended up to 23°28' N to 23°41'N latitude and 86 ° 44 'E to 87 ° 18' E longitudes (Figure 1). Total length of the area is approximately 70 km. the avg. height of this area is 110 m from the sea level. The study area covers the districts of Bokaro, Dhanbad district of Jharkhand and Bankura and Burdwan District of West Bengal. This region is very densely populated area as the major cities such as Asansol, Ranigang, Durgapur, and Burdwan are in this area. The study area includes the downstream river of Panchet Dam to Burdwan District. The agricultural land has been severely

modified in this region by the rapid urbanisation of the Asansol-Durgapur Industrial Belt, coalfield area of Ranigang and Burdwan town. In the Burdwan district, lower reaches of the Damodar River is highly fertile and rich in agricultural resources (Lahiri et al., 2003). The study area includes the plateau region of the Chotanagpur area in the upstream section and the downstream section is associated with alluvial characteristics with several bifurcation in the lower section of the Damodar River (Biswas, 2015).

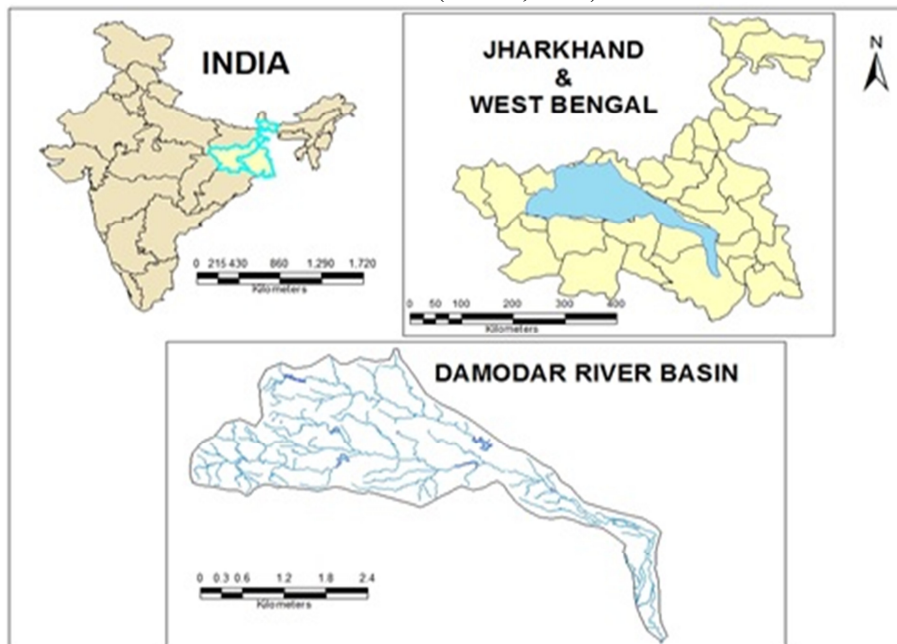


Figure 2. Location of the study area

3. Materials and methods:

For the analysis of the impacts of multipurpose projects on agriculture, the area under agricultural field and cropping intensity have been taken into consideration. To show the increase of area under agricultural field, satellite images have been collected from mentioned sources (Table 1). From two year images (1990 and 2010), basin has been extracted and these have been classified with Unsupervised classification using GIS tools to show the increase of agricultural field over the studied time. The increase of production has been evaluated using Cropping Intensity method (Saito et al., 2006). The Cropping Intensity have been calculated by dividing Gross Cropped Area (GCA) by Net Sown Area (NSA) (equation 1).

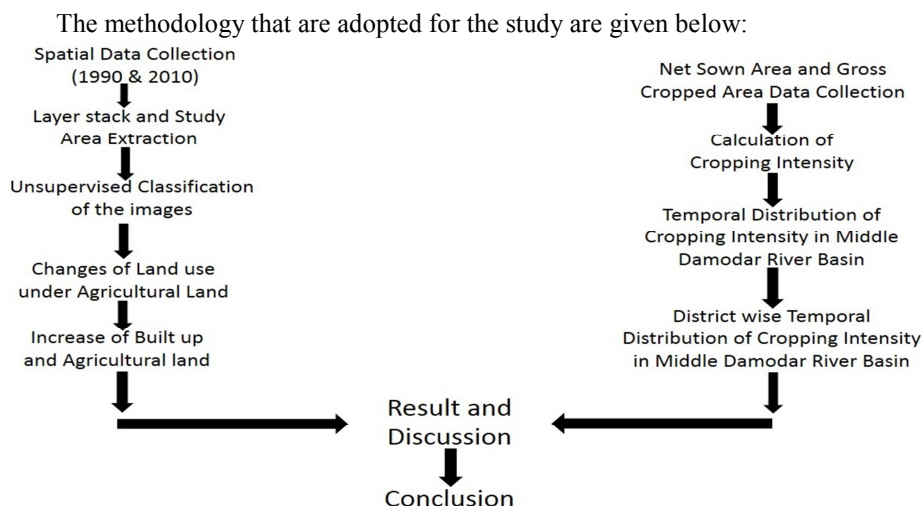
$$\text{Cropping Intensity} = \frac{\text{Gross Cropped Area}}{\text{Net Sown Area}} \times 100 \quad (1)$$

Block wise Cropping Intensity of three districts (Burdwan, Bankura and Purulia) has been calculated of the lower Damodar River basin. The districts that fall on the Damodar basin area have been taken into consideration for the study. 16 blocks of Burdwan district, 7 blocks of Bankura district and 6 blocks of Purulia districts have been considered. For the analysis of temporal changes, a decadal changes (1995-96 to 2005-06) of Cropping Intensity has been illustrated. To show the variety of Cropping Intensity, block wise cropping intensity distribution has been adopted. It is evaluated to show the spatial changes of Cropping Intensity from Damodar River surrounding to its periphery within the basin area. Block wise distribution shows the impacts of canal irrigation on the agricultural distribution.

For the fulfillment of objectives, the data have been collected from the following sources:

Table 1: Data source of the study

Agricultural data		Geospatial Data (Satellite Images)		Irrigation data
Net Sown Area	Gross Cropped Area	1990	2010	
Agricultural Census Division, Dept. of Agricultural and Cooperation, India	Agricultural Census Division, Dept. of Agricultural and Cooperation, India	Landsat 5 TM (30 m resolution) USGS Earth Explorer	Landsat 7 ETM (30 m resolution) USGS Earth Explorer	Damodar Valley Corporation, Kolkata, West Bengal



4. Role of dams and barrages in Canal irrigation:

Multipurpose project in the Damodar River played a major role not only as a flood controller (Biswas, 2015) but also as a source of canal irrigation (Table 2). Two key objectives behind the multi-purpose river valley development in Damodar were following:

- i. Excess water during the monsoon must be stored within the upland areas in large reservoirs, and released from dams to augment the lean season flow; and
- ii. High embankments must be constructed along river courses to prevent monsoon flows from reaching densely populated, intensively cultivated lowlands (Lahiri, 2003).

The older canals such as the Eden Canal and the Damodar Canal – merged later in the DVC irrigation network – are actually more efficient for economic sufficiency to the farmers of the region (Basu and Mukherjee, 1963). Middle and lower course of the river are the most prominent area where irrigation systems are largely controlled by DVC projects of Damodar River. Durgapur Barrage in Durgapur are mainly constructed to serve the agricultural land of the valley region through canal irrigation system.

Table 2: Role of Dams and Barrages in irrigation in Middle Damodar River Valley

Major Dams and Barrage on Damodar River	Tenughat, Panchet, Durgapur Barrage
Irrigation Command Area (gross)	5.69 lakh hectare
Irrigation Potential Created	3.64 lakh hectare
Flood Reserve Capacity	1292 million cusec
Canals	Pp 2494 kms

Source: Damodar Valley Corporation, Kolkata

Under the DVC project, total command irrigated area are 5.69 lakh hectare. Out of which 64 percent area that is 3.64 lakh hectare area are created with irrigation potential area. About 36 percent of the area are still under the command area. There are a length of 2494 km canal has been constructed with the help of several dams and barrage under the DVC projects. Of late, about 1.7 million acre feet of water are capable to provide for annual irrigation. The DVC claims that the two canal systems were supposed to provide irrigation water to the command area only during the kharif (main/monsoon cropping) season to supplement seasonal fluctuations in natural rains (Lahiri, 2012). But there was a counter argument that the objective of supplying irrigation water to the kharif crop was not very successful (Banerjee, 1991).

5. Increase of area covered by Agricultural lands:

Flood moderation can also improve the habitats in the Damodar Drainage Basin areas. After reduction in peak of the floods, the people of the basin areas can put reliability in agriculture. The irrigation system from the barrages can also accelerate the production yield in the basin areas. In the Damodar River Basin, there are sharply two zones are found. In the western part, Industrial activity is the major economic activity. On the contrary, in the eastern part of the basin Agricultural activity is predominant. In 1990, lower course of Damodar have occupied 62685.64 hectare of area in 1990. But it is drastically increase up to 137322.72 hectare in 2010 (Table 3). In the figure 2, changes of agricultural land have been shown. The distribution of agricultural lands is high surrounding the Damodar River. This is possible only for the flood moderation by the multipurpose projects of DVC. There are about 74637.08 Hectares (15%) increase in the Agricultural land in the valley. There is significant increase in the Build-up areas has also been noticed.

Table 3: Changes in Agricultural Land in Lower Damodar River (1990-2010)

Land use Land cover Categories	1990		2010		Area of Changes (Ha.)	Percentage of Changes (%)
	Area (Ha.)	Area (%)	Area (Ha.)	Area (%)		
Rivers and Water bodies	34239.34	6	23075.1	4	-11164.24	-2
Agricultural Land	62685.63	11	137322.72	26	74637.08	15
Build up Areas	73685.45	13	77305.41	14	3619.96	1

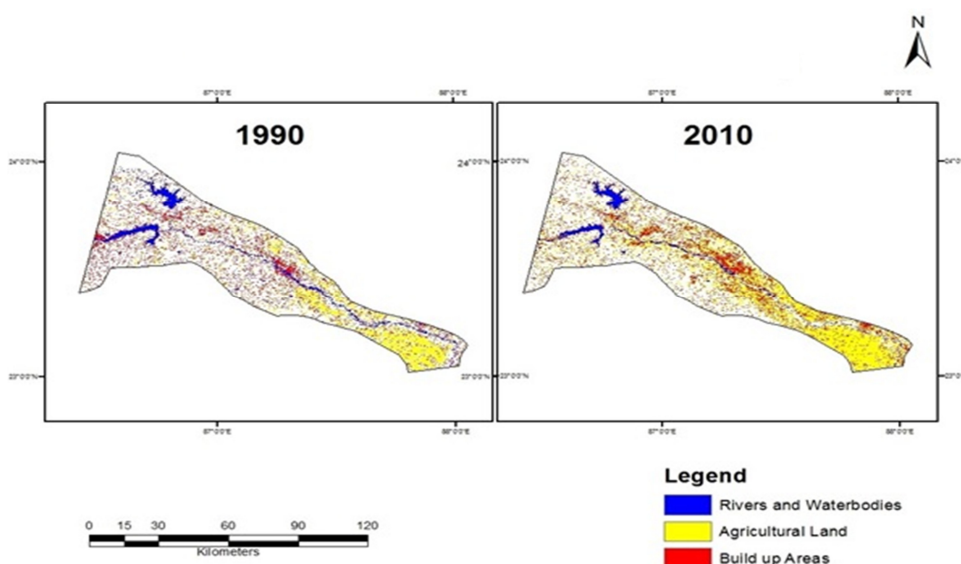


Figure 3. Distribution agricultural lands in the middle Damodar River (1990-2010)

6. Result and discussion

6.1. Locational-temporal Distribution of Cropping Intensity in Middle Damodar River Valley (1995-2006):

For the analysis of Agriculture in the Damodar River Valley, Cropping Intensity method is adopted. Cropping intensity is shown block wise in the three districts of West Bengal. These districts are Burdwan, Bankura, and Purulia. Those blocks are considered that have fallen under the Basin of Damodar. 16 blocks of Burdwan, 6 blocks of Purulia, 7 blocks of Bankura have been considered. In the figure 3.A, spatial distribution of Cropping Intensity of 1995-96 has been shown. Cropping Intensity of the lower reaches of the valley is higher than the upper reaches. This is simply because of agriculture is the main economic activity in lower reaches of the valley and in the upper reaches of the valley, industrial activity is going on. Among the blocks, Memari I, Jamalpur of Burdwan and Patrasayar of Bankura are those blocks that have cropping intensity above 160. However, in case of Memari I and Jamalpur block, cropping intensity is above 230. More or less same intensity is in year of 2000-01 (Figure 3.A). In upper reaches, the value of cropping intensity is low, on the other hand lower reaches have enjoyed with high values. It is noticed that Galsi I & II, Jamalpur, Memari I block of Burdwan and Patrasayar block of Bankura have the value of cropping intensity above 200. But overall throughout the valley Cropping intensity has been increased in the year of 2000-01 in comparison with 1995-96. There are slightly decreased amount of cropping intensity in the year of 2005-06. The reduction is mainly due to increasing tendency of build up areas and settlement. In 2005-06, (Figure 3.C) lower reaches of the valley have occupied high cropping intensity and upper reaches have the least. Again Jamalpur and Memari I of Burdwan and Patrasayar of Bankura block have enjoyed with higher value of cropping intensity in 2005-06. In some blocks the data is not available as most of the areas of these blocks are highly urbanised. Data throughout the three time period is not available in the blocks of Asansol, Durgapur, Kulti, Jamuria II. These area are highly industrialised area that is why most of the people of the areas are engaged with industrial activity rather than agricultural activity.

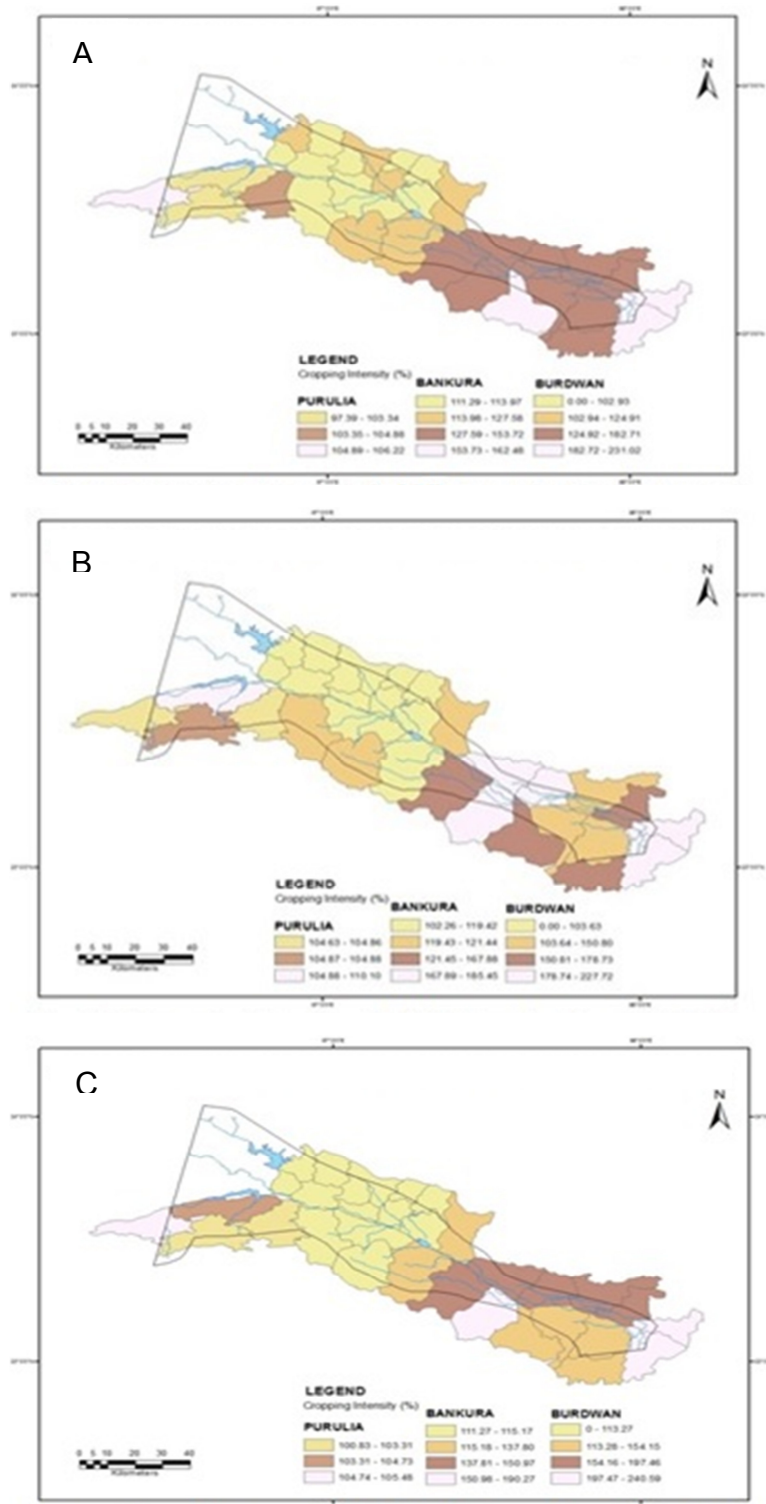


Figure 4. Cropping intensity of the middle Damodar River. A, B and C represents the cropping intensity in the year 1995-96, 2000-01 and 2005-06 respectively

6.2. Block wise distribution of Cropping Intensity in Middle Damodar River Valley:

In the block wise distribution of cropping intensity of Burdwan (Figure 4.A), variation of cropping intensity have been noticed. In one hand, Memari I and Jamalpur have the higher cropping intensity that is above 200. On the other hand, industrial areas like Jamuria, Asansol, Kulti block have the lower cropping intensity with near to 100. Rest of all block under the Damodar valley have the cropping intensity in between 100 to 200. In the temporal dimension of distribution, overall Burdwan districts have the higher cropping intensity in 2000-01 than in 2005-06.

In Bankura District (Figure 4.B), the cropping intensity does not fluctuated highly. Patrasayar is the block where throughout the time period, cropping intensity is high cropping intensity. On the contrary, Gangajalghati Block have the low value (100 to 120) of cropping intensity. But overall, Bankura district has cropping intensity low than Burdwan district.

In Purulia district (Figure 4.C), cropping intensity is very low. Highest cropping intensity is noticed in Neturia block (110) in 2000-01. Purulia is under the dry area where water availability is very low throughout the district. In the western side of the district is hilly region that is why agricultural practices and production is very low. This is the region for the low value of cropping intensity. In 1995, Raghunathpur 1 block have the low cropping intensity (<100). Most of the blocks of the districts have low fertile lands. Purulia is the only district of West Bengal that falls under the draught prone area.

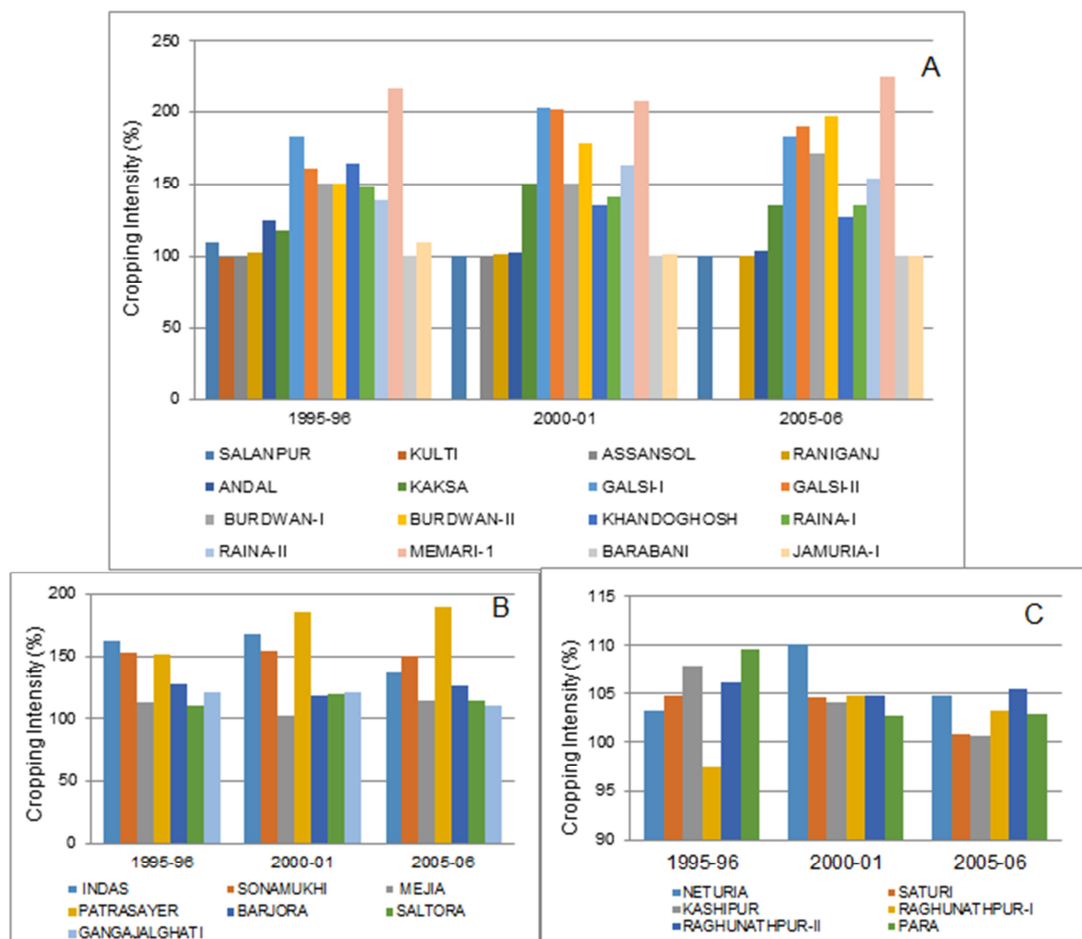


Figure 5. Block wise distribution of Cropping Intensity of three districts from 1995-96 to 2005-06. A, B and C represent blocks of Burdwan, Bankura and Purulia districts

Generally, the agricultural land that are close to the main canal or the barrage areas are more productive than the land that are far from the main canal or the barrage areas. But in the middle section of Damodar River this phenomena is reverse. In this river valley area, remote agricultural lands from the main canal are more productive than the agricultural land near to the rivers side areas. The whole basin area as well as the Southern Bengal face more precipitation than the Jharkhand. The western side of the basin have the low cropping intensity in the Burdwan district. This may because of the presence of several industries in the western side of the basin area. The industrial belts of Burnpur, Durgapur attract large amount of people in the industrial activity in this region. Most of the people are engaged with the secondary activities. That is why, the cropping intensity are less in the western side of the basin area. On the contrary, the economy of eastern side basin are depends on the agriculture. Most of the people of the area are not depends on the only canal irrigation, well irrigation is also well distributed in this region. The downstream of the river valley are pure alluvial track of the Ganga River system and this region are more fertile than the upstream region. These are the probable reason for the high cropping intensity in the downstream region rather than the upstream region.

So, in the overall study of cropping intensity in Damodar River Valley, it is concluded that upper reaches of the river have low cropping intensity in all of the districts of the river valley. Upper reaches are less fertile that is why production is also low and reverse condition are found in the lower reaches of the river basin

area. Whole basin area is bounded with agricultural and industrial activities.

7. Conclusion

The Damodar River was the one of the major that caused several life and property loss with the help of its magnitude of floods. It was called as “Sorrow of Bengal”. When the Damodar Valley Corporation (DVC) was first modelled after the Tennessee Valley Authority (TVA) of USA in 1948, the river was again controlled, 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. Embankments, canals, sluices, weirs, dykes, barrages, dams, and reservoirs are now integral components of a geomorphic landscape of Damodar river system. (Bhattacharya, 2008). After Dam construction by DVC project, peak of flood can be reduced. Flood moderation can put impacts on the agriculture in the downstream of the valley area. Amount of agricultural land is also increased after the modification and reduction of flood by the dams. Based on this river, a huge amount industrial and agricultural landscape has been developed through the ancient period. Huge amount electricity that is generated by the dams of DVC is supplied to the Durgapur-Asansol Industrial Region. Irrigation supply also can put impetus on the agricultural output of this valley region especially in the downstream areas of the valley. Thus the dams are severally interlinked with the people and landscapes of the Damodar Valley Region.

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