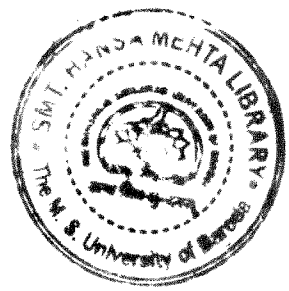
CHAPTER - VI

CHAPTER SIX

CONCLUSIONS



The Ganga river throughout its course shows major and minor riverine changes in terms of its fluvio-geomorphology, amount of erosion and deposition occurred as well as bank-line changes. The changes vary spatially as well as temporally in dimension, direction and magnitude. The important conclusions inferred are as under:

1. As discussed in the previous chapter, regarding the fluvio-geomorphological changes it has been seen that the entire river course has been under various fluvial changes at larger or smaller extent.

- Prominent presence of ox-bow lakes at various locations such as Rudrapur, Monghyr and Sahibganj as well as the presence of numerous small and large water-bodies near Ballia, Rudrapur, Patna, Sahri, Monghyr, Bhagalpur, Sahibganj as well as at many other locations suggest and indicate the remnants of the old Ganga river course. Presence of ox-bow lakes, palaeo channels and meander scars also strongly supports the shifting of the river course at various places.
- Near Patna a huge island has been formed over these years. This island has become wider and bigger in 2004 and 2006 than compared to 2000 as well as the historical data. This island has been formed as a result of the shifting of the main channel in the Southern direction which earlier used to flow in the Northern direction. Due to this a huge patch of land was gradually left behind in between the main channel and few smaller streams which are still active forming an island in between.
- At some places, if we compare the pre-monsoon and the post-monsoon data, we come across sudden increase in the island area during and after monsoon season. The reason behind this drastic increase during the post-monsoon season is that, after

monsoon season many small and minor connecting streams which are normally in dry state also gets activated because of seasonal rainfall. Due to this reactivation many smaller as well as larger streams get interconnected and merged leaving patches of land in between which gradually forms an island. This type of island formations is usually seen after monsoon. At many places it has been seen that even during the same year there is a considerable difference in the sedimentation area between the two seasons. The reason behind this may be the seasonal effect since after rainfall the sand-bars which are normally land exposed gets inundated in water and thus cannot be seen because of which also the visible area gets reduced. Many regions show sudden increase in the surface water area. This may be an indicative of heavy rainfall received in that region in a particular year.

- Apart from these, looking at the complete river course pattern it has been observed that the width of the river, the area of islands, area of sand-bars, flood-plain area and the surface water area show major or minor changes from one location to the other.

The type of channel pattern also varies with location. Throughout the river course we come across different channel patterns such as braided, straight or meandering. It has been observed that the river course near Rudrapur, Monghyr and Sahibganj show a typical asymmetrical meandering pattern which suggest that the here the river course may be controlled by some basement structures such as a fault, fracture or a lineament. Whereas certain places near Ballia, Chhapra which is towards the West of Ballia, Patna, Sahri and Bhagalpur we come across braided pattern. A braided pattern generally indicates the incapability of the stream in carrying further sediment load.

2. The river throughout its entire course has shown major or minor bank-line shifting at various locations. The amount of shifting varies in dimension and direction. As discussed in (chapter 5, table 5.12), the shifting at different locations from SOI to 2000 is as below

   - Near Ballia the river showed a shifting of around 2 km
   - Near Rudrapur the amount of shifting during SOI to 2000 was upto 3 km.
   - The regions near Patna have shown maximum changes in terms of bank-line shifting. From SOI to 2000 the shift was found upto 8 km which is a very major change throughout the river course in Bihar.
   - Near Sahri the change was upto 3 km during
   - The region near Monghyr, has also undergone major changes. It is noticed that this area like Patna has shown maximum changes as well as instability in context with river shifting and various other fluvial changes. The amount of shifting was around 7.5 km during SOI to 2000
   - Near Bhagalpur the change was observed upto 5.9 km and
   - The region near Sahibganj showed a shifting of around 4 km

- The comparison between the subsequent years 2000 and 2004 and 2004 and 2006 by taking 2000 as the reference year showed that the maximum change has been observed around Patna and Monghyr, whereas the minimum shifting has been observed around Ballia (ref table 6.1).

The shift direction and amount vary at different places but overall it has been observed that maximum shifting has occurred either towards the Northern or the Southern direction (ref table 5.12 and 6.1). The major reasons behind the bank-line shifting are tectonic activity, major flood events and erosion and deposition. Erosion

and deposition also play a major role in bringing about meandering and braiding which actively contribute towards river course shifting.

3. Erosion and deposition are also two main important factors responsible for the change in the river course. The river channel erodes the soft and fragile country rocks and when the load carrying capacity of the river decreases, this sediment material gets deposited. Since the deposition creates an obstacle for the river channel to flow further in the same direction, the channel in response to adjust with the new condition changes its course and starts flowing through a different path.

- As described in the previous chapter, the Ganga river at various locations throughout its course shows high rate of erosion as well as deposition. The regions near Ballia, Rudrapur, Sahri and Bhagalpur show higher rate of aggradation than compared to degradation. Dominance of aggradation indicates the shrinking of the river bed in these regions. The regions near Patna and Sahibganj have undergone much more rate of degradation than compared to aggradation which indicates the widening of the river bed. Near Patna, the river has undergone severe erosion since SOI to 2006.
- A complete assessment of the amount of erosion and deposition along both the bank-lines of the Ganga river from SOI till 2000 was also carried out. The comparative study showed that the amount of erosion and aggradation along the left and the right bank of the Ganga river from SOI to 2000 was 868 and 756 sq km respectively (ref fig 6.1).
- Similar estimation was also done between SOI to 2004 and the amount of erosion and aggradation was found to be 974 and 658 sq km respectively (ref fig 6.2).

Table 6.1: Overview of the bank-line shifting in different regions from SOI to 2000, 2000 to 2004 and 2004 to 2006

REGION	YEAR		
	From SOI - 2000	From 2000 - 2004	From 2004 - 2006
BALLIA	Upto 2 km	0.5 km	0.5 km
RUDRAPUR	Upto 3 km	1 km	1 km
PATNA	Upto 8 km	1.5 km	0.5 km
SAHRI	Upto 3 km	0.8 km	0.2 km
MONGHYR	Upto 7.5 km	1.5 km	0.7 km
BHAGALPUR	Upto 5.9	0.1 km	0.5 km
SAHIBGANJ	Upto 4 km	1 km	1.2 km

- From this assessment it was found that the amount of erosion had increased from SOI to 2004 than compared to SOI to 2000 whereas the amount of deposition (sedimentation) had decreased in SOI-2004 than compared to SOI to 2000.
- The amount of erosion and deposition between 2000 and 2004 thus amounts to be 106 sq km and 98 sq km respectively.
- The similar study was also carried out for the 2006 for specific locations under major riverine changes. The amount of erosion and deposition occurred near Ballia was 23.0 sq km and 56.0 sq km, near Rudrapur 29.0 sq km and 82.0 sq km, near Patna 171.0 sq km and 80.0 sq km, near Sahri 18.0 sq km and 40.0 sq km, near Monghyr 170.0 sq km and 176.0 sq km, near Bhagalpur, 60.0 sq km and 162.0 sq km and near Sahibganj 174.0 sq km and 80.0 sq km respectively for details (ref chapter 5)

The major reasons behind erosion and deposition are mainly the amount of rainfall received in a particular year, major flood events and various anthropogenic activities.

The use of various remote sensing techniques and satellites has proved to be of immense help in undertaking various geomorphological and geological studies. Remote sensing techniques have made remote areas easily accessible for understanding the dynamic riverine environment. The multitemporal, multispectral and multispatial capabilities have proved to be very useful in carrying out various geomorphological studies such as river migration, channel changes, various fluvio-geomorphological changes as well as in estimating the amount of land under sedimentation or degradation. Use of remote sensing studies also helps in understanding the causes behind these changes so that proper controlling measures can be taken. This study will be helpful in understanding the Ganga river behavior which in turn will be helpful for

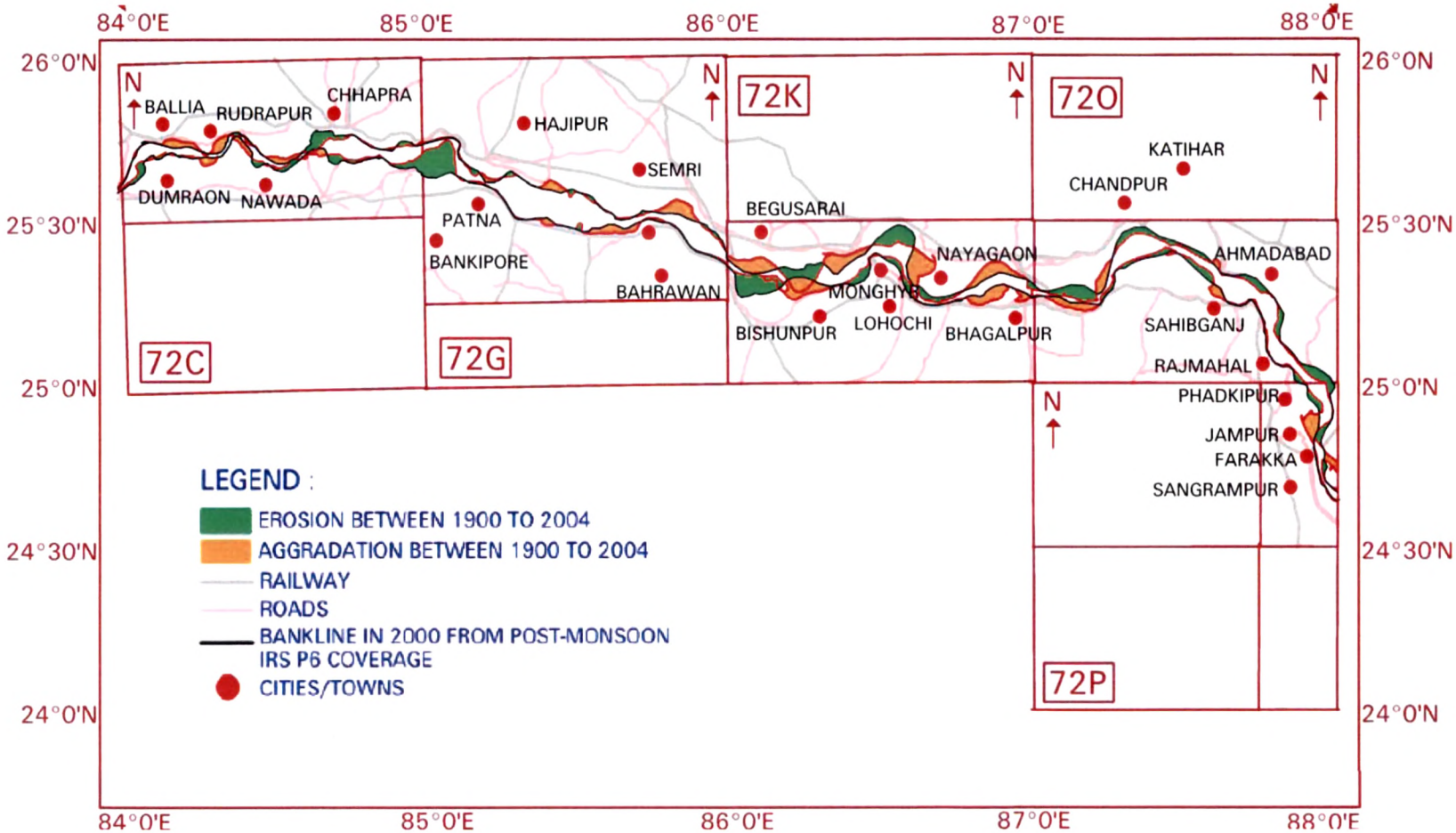


Fig 6.1: Erosion and deposition along both the banks of the Ganga river course from SOI to 2000

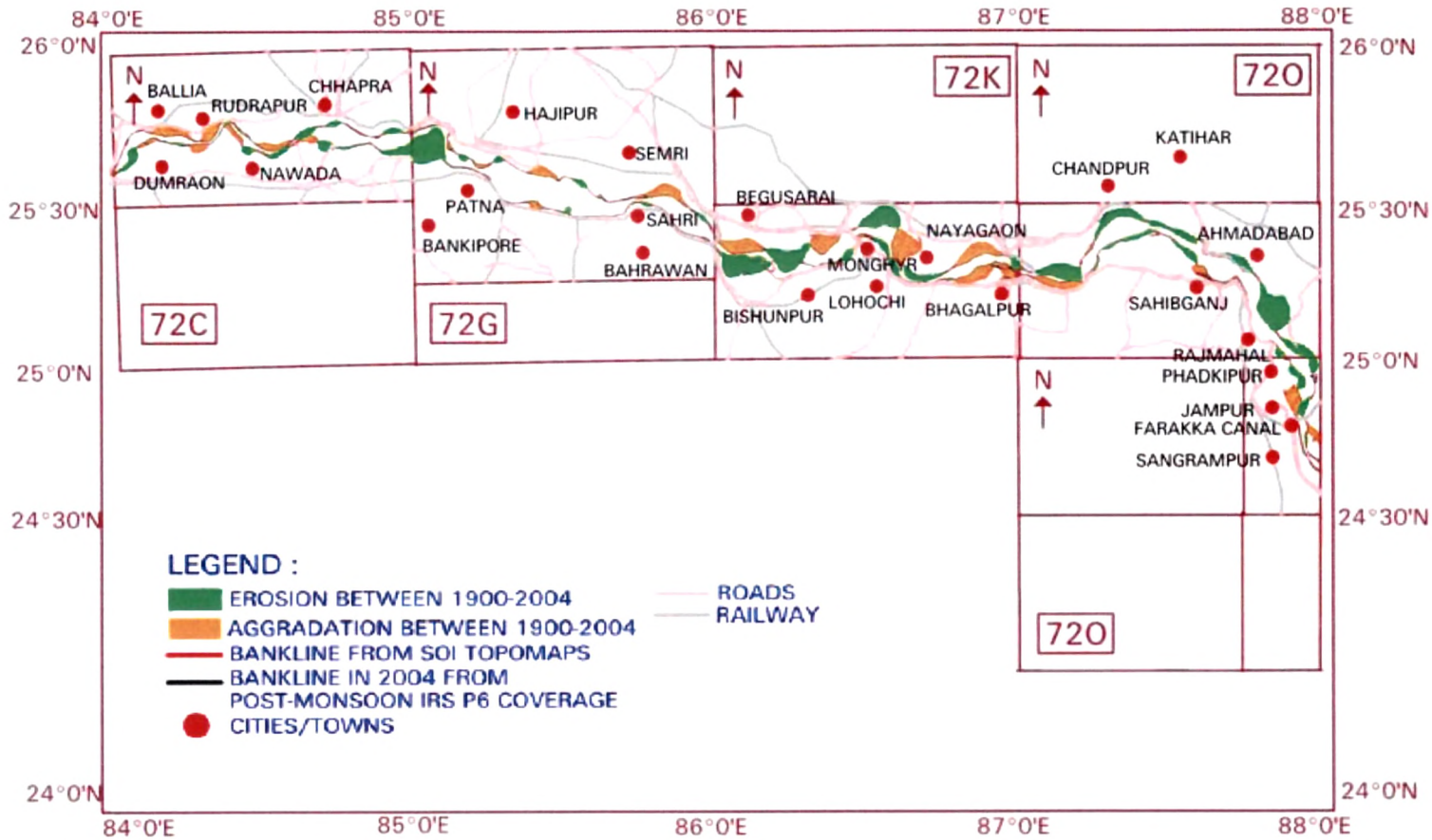


Fig 6.2: Erosion and deposition along both the banks of the Ganga river course from SOI to 2004

various developmental activities and agencies dealing with the planning and implementation of river valley projects, water-resource planning, various geo-engineering projects and to agencies such as Central Water Commission, Central Ground Water Board etc. The scientific database generated through this study will be of immense use in sound planning of various developmental activities of our country.