CHAPTER - VI

FLOOD DAMAGES

6.1 General

Generally flood is defined as an unusually high stage in a river normally the level at which the river overflows its banks and inundates the adjoining area. In other way it is defined as the inundation of a normally dry area caused by high flow, or overflow of water in an established watercourse, such as a river, stream or drainage channel, or ponding of water near the point where the precipitation occurs and overtopping of the banks results in spreading of water in the plains. According to International Commission on Irrigation and Drainage (ICID)'s multilingual dictionary on irrigation and drainage, flood is defined as under :

"Flood is a relatively high flow or such in a river markedly higher than the usual, also the inundation of low land which may result from there. A body of water, rising, swelling and overflowing land not usually thus covered."

The report of Rashtriya Barh Ayog (1980) lists various situations related to flood as follows.

i) Streams carrying flows in excess of the transporting capacity within their banks, thus overflowing adjoining land.

ii) Backing up of water in tributaries at their outfalls into the main river with or without synchronization of peak floods in them.

iii) Heavy rainfall synchronization with the spills,

iv) Ice jams or landslides blocking streams course resulting in the back water overflowing river banks.

v) Synchronization of upland flood with high tides,

vi) Heavy local rainfall,

vii) Typhoons and cyclones

viii) Inadequate drainage to carry away surface water with the desired quickness.

Although man has had to live with floods since his very existence, the impact of floods was perhaps not felt to the same extent in the past as it is felt now a days. During earlier days comparatively much smaller number of people inhabiting the land and lesser pressure of industrial activities and other development works on flood plains. There is no doubt that with rapid increase in population and consequent increase in alround development activities of men, the flood plains are being gradually occupied to ever increasing extent to meet requirements of forest wealth of the country, for reclaiming areas for occupation and for obtaining fuel for domestic requirements have probably caused excessive siltation resulting in change in the river regime. All these have resulted in an anomalous siltation, where protective measures taken from time to time to train the flood flows in narrow restricted width have resulted in rise in the river beds of the course in few years. As the time passes, because of excessive siltation of bed, the drainage capacity of channels or rivers got upset and consequently making the existing flow equilibrium disturbed. This change in situation forces the river to find new course during the floods to accommodate the excess drainage.

6.2 Characteristics of flood

Intensity of flood is characterised by (i) Depth of Inundation (ii) Volume of inundation.

Frequency of floods represents the number of times an area is inundated during a particular time interval. Duration of flood represent the length of time interval during which a particular area is inundated. Due to siltation and erosions river changes its path which is known as meandering. Severity of flood is gauged by damages caused by flood. Flood typology depends on types and magnitude of damages caused.

Silt carrying capacity of a river stream is reduced considerably as and when the velocity of river stream becomes lower than critical velocity, consequently silt and sand are deposited in the river bed and height of the river bed is raised causing inundation of the surrounding areas. Such river stages are known as aggrading stage. River having velocity more than critical velocity erodes the river bed and known as eroding river.

6.3 Flood problem in the Burhi Gandak river system

The Burhi-Gandak river in its maiden journey from the Someshwar range of hills to its outfall into Ganga at Khagaria passes through three distinct phases with regard to its topography.

In the initial reach it crosses through hilly region with thick forest and more or less inhabititated areas, hardly any flood problem is experienced in this reach. The river slope in this part is very steep and the meander is also very less.

In the middle reach i.e. the reach upto Motihari town, this river debouches in the plains and it is still unembanked. Many tributaries which originate from the Himalayan foothills also join in this stretch. The river slope is moderate to flat and also the meander is pronounced specially in the end of this reach. The Masan meets this river at Basantpur (East Champaran) which is the

first major tributary and contributes sizable discharge. Subsequently the Balor, the Pandai, the Sikta, the Tilawe and the Tiur meet the Burhi Gandak at Baghlochana, the Tularamghat, the Murgiltola, Agarwa and Gularia respectively in the districts of East and West Champaran. During the monsoon period due to heavy rainfall in the catchment the Sikrahana spills and causes inundation in the area. Flood in the mainstream may also occur due to flood in its tributaries. The Flood situation in the area further aggravates due to inadequate waterway provided in some of the bridges/culverts in the roads and railways.

The areas generally affected by floods in West Champaran are the areas around Ramnagar, Narkatiaganj, Mainatand and Chanpatia etc. and in East champaran Sugauli, Motihari and Lalbegiaghat etc. Motihari town is frequently affected due to spill of Sikrahana river (Burhi Gandak is known as Sikrahana in its upper reaches).

Burhi Gandak is almost fully embanked in the lower reach i.e. the stretch from Motihari to its outfall in Ganga, except few gaps in the left embankment near Muzaffarpur town when the Bagmati spills meet the Burhi Gandak river. In this reach the main flood problem is not due to inundation of the area but the erosive action on the banks of the river which causes breaches in the embankments even in medium floods almost every year at number of places. This leads to flood fighting works at the corresponding sites for protection of the embankment. Erosion is more severe from downstream of Muzaffarpur town till its outfall, which when not contained appropriately causes breach of embankments at the eroded sites frequently.

The embankments on both banks of the river are very closely spaced i.e. the spacing between the embankments is even less than three Lacey’s width. Land in the area is quite fertile and hence valuable. The density of population is also quite high in this area. This naturally might have compelled to align these

embankments contrary to be prescribed design norms. The fluctuation in the maximum and minimum river discharge is also high in case of this river system and hence the river is unstable.

The course of the river is circuitous and meandering is more pronounced specially in this reach. The slope of the river is almost flat thereby causing sluggishness in the drainage of flood water. Over and above, as the Ganga remains high almost throughout the flood season and does not allow the Burhi Gandak flood water to drain down and therefore there is a back water effect in the main stream. This results in the rise in water level in the main channel of Burhi Gandak which bring allied problems like over topping of embankments, side erosion due to wave action, sloughing of the embankments. It requires preparedness and continuous vigil in the affected area till the situation eases out.

6.4 Past history of floods in Burhi Gandak river

The plains of Bihar, adjoining Nepal, are drained by a number of rivers and its tributaries that have their catchments in the steep and geologically nascent Himalayas. Gandak, Burhi Gandak, Bagmati, Kamla Balan, Adhwara group of rivers, Kosi and Mahananda originates in Nepal, carry high discharge and very high sediment load and drops it down in the plains of Bihar. About 65% of catchment areas of these rivers fall in Nepal/ Tibet and only 35% of catchment areas lie in Bihar. In the year 1978,1987,1998,2004 and 2007 Bihar witnessed high magnitudes of flood. The total area affected by floods has also increased during these years. Flood of 2004 demonstrates the severity of flood problem when a vast area of 23,490 sqkm was badly affected by the floods of Bagmati, Kamla Balan & Adhwara groups of rivers causing loss of about 800 human lives, even when Ganga, the master drain was flowing low.

At present, almost entire length of Burhi Gandak river is embanked on both sides below Motihari town in north Bihar. However, before the flood embankments were constructed, the Burhi Gandak used to spill more or less throughout its length. The great earthquake of 1934 had some effect on its regime. Construction of embankments were started during 1954. In between 1934 and 1954 the river had high floods in the years 1936, 1946, 1952, 1953 and 1954. These caused great damage to the area. The three floods of 1952, 1953 & 1954 coming in a row precipitated the proposal to build continuous embankments along both banks of the river. These embankments were practically completed in all the reaches by the end of 1957.

During the construction period of embankments and thereafter high flood are reported to have occurred in 1955, 1956, 1964, 1966, 1971, 1974, 1975, 1978, 1979, 1981, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1995, 1998, 2001 & 2004.

In some of the years, the embankments breached at many places and caused heavy damages to private as well as public properties. The causes of these breaches were different though failure through piping action is reported to have dominated as the most general cause of failure of embankments.

6.5 Flood details of recent past

Details of recent past floods occurred during last 16 years are given below:

1996 – Flood

The total maximum rainfall was 1841.8 mm recorded at Sikandarpur RG Station and the total minimum rainfall was 459.2 mm recorded at Lalbegiaghat RG Station. The river Burhi Gandak first crossed danger level at Samastipur on 22.7.96 and flowed above danger level for 16 days for the period from 22.7.96 to 28.7.96 and from 18.8.96 to 26.8.96. Its flow was above danger level at Rosera for 21 days and at Khagaria for 26 days.

1997 – Flood

The maximum rainfall of 2102.7 mm at Sikandarpur RG Station and minimum rainfall of 962.3 mm at Khagaria RG Station were reported. The river at Khagaria flowed above danger level for 2 days from 6.9.97 to 7.9.97.

1998 – Flood

The maximum rainfall of 1621.9 mm at Sikandarpur RG Station and minimum rainfall of 777.0 mm at Lalbegiaghat RG Station were recorded and the average rainfall was 1199.45 mm. The river was flowing above the danger level at 5 places on different dates during the monsoon season of year 1998. It flowed above the danger level for 14 days at Lalbegiaghat (i.e. 27.7.98 to 29.7.98, 31.7.98 to 3.8.98 & 20.8.98 to 26.8.98), 32 days at Sikandarpur (30.7.98 to 8.8.98 & 20.8.98 to 10.9.98), 46 days at Samastipur (29.7.98 to 23.8.98, 25.8.98, 27.8.98 to 14.9.98) 48 days at Rosera (29.7.98 to 25.8.98, 27.8.98 to 14.9.98 & 14.9.98 to 16.9.98), 41 days at Khagaria (4.8.98 to 23.8.98 & 25.8.98 to 14.9.98).

1999 – Flood

The maximum rainfall of 1664 mm at Samastipur RG Station and minimum rainfall of 780 mm at Chanpatia RG Station were recorded. The river Burhi Gandak remained above danger level at Sikandarpur, Samastipur, Rosera and Khagaria for 6, 18, 35 and 48 days respectively.

2000 – Flood

The maximum rainfall of 1285.3 mm at Samastipur RG Station and minimum rainfall of 817.3 mm at Ahirwalia RG Station were recorded. The river Burhi Gandak remained above danger level at Khagaria for the periods from 26.7.2000 to 31.7.2000, from 4.9.2000 to 18.9.2000 and from 21.9.2000 to 24.9.2000.

2001 – Flood

The maximum rainfall of 1582.6 mm at Sikandarpur RG Station and minimum rainfall of 945.8 mm at Rosera RG Station were recorded. The river Burhi Gandak remained above danger level at Lalbegiaghat for the periods from 5.8.01 to 7.8.01, from 5.9.01 to 18.9.01, at Sikandarpur on 9.8.01 and for the period from 7.9.01 to 21.9.01, at Samastipur for the periods from 7.8.01 to 14.8.01, from 4.9.01 to 26.9.01 and from 7.10.01 to 14.10.01, at Rosera for the periods from 6.8.01 to 14.8.01, on 28.8.01, from 2.9.01 to 26.9.01 and from 7.10.01 to 15.10.01 and at Khagaria for the periods from 31.7.01 to 9.8.01, from 23.8.01 to 28.8.01 and from 4.9.01 to 18.9.01. Breaching of Burhi Gandak left embankment was reported at 69-70 km of Mor Seal and at 98-99 km of Phulwaria Seal.

2003 – Flood

The maximum rainfall of 1753.4 mm at Sikandarpur RG Station and minimum rainfall of 840.6 mm at Rosera RG Station were recorded. The river Burhi Gandak remained above danger level at Lalbegiaghat for the periods from 6.7.03 to 13.7.03, at Sikandarpur for the period from 5.7.03 to 22.7.03, 4.8.03 to 14.8.03 and 21.8.03 to 3.9.03, at Rosera for the periods from 6.7.03 to 23.7.03, 3.8.03 to 16.8.03 and 21.8.03 to 3.9.03 and at Khagaria for the period from 22.8.03 to 5.10.03.

2004 – Flood

The maximum rainfall of 1514.3 mm at Lalbegiaghat RG Station and minimum rainfall of 694.6 mm at Rosera RG Station were recorded. The river Burhi Gandak remained above danger level at Lalbegiaghat for the period from 9.7.04 to 19.7.04, at Sikandarpur for the period from 12.7.04 to 28.7.04, at Samastipur for the period from 11.7.04 to 31.7.04 and at Rosera for the period from 11.7.04 to 2.8.04. The Burhi Gandak Left Embankment breached at 3-4

km at Harbolwa (East Champaran) on 12.7.04, at 22-23 km at Dardha Mohamadpur (Muzaffarpur), at 151-152 km at Pusa (Samastipur) on 15.7.04, at 155-156 km at Pusa (Samastipur) on 16.7.04. Sluice gate of the Burhi Gandak Left Embankment damaged at Kalua Pagamber (Muzaffarpur) and at Pusa (Samastipur).

2005 – Flood

The maximum rainfall of 948.0 mm at Sikandarpur RG Station and minimum rainfall of 584.4 mm at Samastipur RG Station were recorded. The river Burhi Gandak remained above danger level at Lalbegiaghat for the period from 27.8.05 to 3.9.05, at Sikandarpur for the period from 30.8.05 to 6.9.05, at Rosera for the period from 27.8.05 to 10.9.05 and at Khagaria for the period from 26.8.05 to 1.9.05. No damage to any structure was reported.

2006 – Flood

In the Burhi Gandak river system, no damage to live and property was reported.

2007 – Flood

In the year 2007 the flood situation was serious in north Bihar due to heavy rainfall in catchments of almost all rivers. There were 28 breaches at different locations of the embankments during 2007 flood season. Heavy spell of rainfall (average 82.70 mm) was observed in the begning of flood season. In Burhi Gandak there has been regular rainfall in July and August which kept the river water level continuously rising. Heavy losses and public property occurred. Hence huge damage was recorded.

2008 – Flood

An appreciable amount of rainfall was received on very first day of monsoon season i.e. 15th June (160 mm at Chanpatia RG Station, 141 mm at Sikandarpur RG Station and 92.2 mm at Khagaria RG Station). July was the wettest month having maximum rainy days followed by August-08. Minimal damage was recorded.

2009 – Flood

There was minimal flood in Burhi Gandak river basin. The rainfall was scanty in the year 2009. Minimal damage was recorded.

2010 – Flood

In year 2010 most of the rivers in North Bihar were flowing above the danger level at various places along their course in Bihar. Burhi Gandak was flowing 15 cm above the red mark at Khagaria. No damage was recorded.

2011 – Flood

The flood situation prevailed for almost all the river systems in North Bihar and rivers crossed the danger level during July, August and September, 2011. Afterwards the water level in different rivers began to fall. The river Burhi Gandak began to rise in the last week of August. The river crossed the danger level at Samastipur, Rosera and Khagaria sites. Maximum water levels attained by the river were at Sikandarpur 51.91 m on 29.09.2011, Samastipur 46.49 m on 01.10.2011, Rosera 42.90 m on 01.10.2011 and Khagaria 37.78 m on 18.08.2011 respectively. Huge damage was recorded.

2012 – Flood

Heavy rain in the catchment of Burhi Gandak resulted in overbank flow in smaller rivers and rivulets causing some flash flood in West Champaran, where overtopping on railway track was reported at Sikta railway station. The river Burhi Gandak began to rise in the last week of September, 2012. However, the river remained above the warning level at Samastipur, Rosera and Khagaria

for 6 days, 8 days and 38 days respectively. Maximum water level attained by the river at Lalbegiaghat 62.13 m on 21.09.12, at Sikandarpur 51.18 m on 22.09.12, at Samastipur 45.25 m on 24.09.12, at Rosera 42.41 m on 25.09.12 and at Khagaria 37.55 m on 23.09.12 respectively.

6.6 Causes of floods in the Burhi Gandak river system

Main causes of floods in the Burhi Gandak river system are enumerated below:

(i) Inundation due to overtopping of banks of the river in middle reaches.

(ii) Inundation in lower reaches where gaps are left in the embankment and also where spills/channel from the Bagmati meets the Burhi Gandak.

(iii) Bank erosion problem in the reach below Muzaffarpur (Sikandarpur).

(iv) Drainage congestion in the area due to inadequate waterways provided in the railway and road bridges especially in East Champaran district (upper reaches).

6.7 Flood Damage data

Burhi Gandak-Noon-Baya- Ganga link is planned for the flood problem of lower reaches of Burhi Gandak basin and is likely to provide relief to flood affected Samastipur, Begusarai and Khagaria districts of Bihar. Yearwise flood damage data and annual average flood damage in terms of money in respect of Samastipur, Begusarai and Khagaria have been shown in **Table 6.1, 6.2 & 6.3**. The average annual damages to crops, houses, human live, cattle live and to public utilities for the above three districts are worked out to Rs. 10706.66 lakh, Rs. 5485.25 lakh and Rs. 4280.62 lakh respectively **(shown in Bar Chart at Fig. 6.1)** at the Price Index 2012-13 considering escalation @ 8% per year for all damages except for human live and cattle live.

Table – 6.1

Flood damages in respect of Samastipur district

Year	Human lives lost & compensation		Cattle lives lost & compe-nsation		Damage to Crops		Damage to Houses		Damage to Public Utilities (Rs. in lakh	Total Damage (Rs. in lakh) (7+9+ 10)	Total damage Rs. in lakh at the price level 2012-13 (3+5+ escalate the value of column 11)
	No.	Amount (Rs. in lakh)	No.	Amount (Rs. in lakh)	Area in lakh ha.	Amount (Rs. in lakh)	No. of Houses	Amount (Rs. in lakh)			
1	2	3	4	5	6	7	8	9	10	11	12
1998	19	19.0	-	-	0.66	1124.41	22375	102.00	1.83	1228.24	3626.58
1999	11	11.0	-	-	0.05	281.34	669	33.70	-	315.04	867.79
2000	14	14.0	-	-	0.08	53.49	1052	18.59	1.00	73.08	198.03
2001	12	12.0	3	0.30	0.22	459.11	2902	266.70	88.01	813.82	1909.83
2002	86	86.0	671	67.10	0.63	4487.33	38676	1745.85	932.5	7165.68	15623.26
2003	23	23.0	8	0.8	0.55	1213.33	2652	620	233.5	2066.83	4155.4
2004	161	161.0	350	35.0	0.61	5510.35	70999	10613.75	27662.50	43786.60	81241.94
2005	11	11.0	-	-	0.02	100	0	0	-	100.0	182.38
2006	NO DAMAGE										
2007	157	157.0	75	7.5	1.25	16710.07	29391	775.00	17896.46	35381.53	52151.57
2008	NO DAMAGE										
2009	-	0.40	-	-	0.16	444.55	-	-	-	444.55	560.404
2010	NO DAMAGE										
2011	5	7.5	76	12.46	0.2	32	-	-	25.95	57.95	82.56
2012	NO DAMAGE										

Average annual flood damage is Rs. 10706.65lakh

Source:-Disaster Management Department, Govt. of Bihar.

Table – 6.2

Flood damages in respect of Begusarai district

Year	Human lives lost & compensation		Cattle lives lost & compe-nsation		Damage to Crops		Damage to Houses		Damage to Public Utilities (Rs. in lakh	Total Damage (Rs. in lakh) (7+9+ 10)	Total damage Rs. in lakh at the price level 2012-13 (3+5+ escalate the value of column 11)
	No.	Amount (Rs. in lakh)	No.	Amount (Rs. in lakh)	Area in lakh ha.	Amount (Rs. in lakh)	No. of Houses	Amount (Rs. in lakh)			
1	2	3	4	5	6	7	8	9	10	11	12
1998	5	5.0	-	-	0.73	2338.71	102	2.00	-	2340.71	6880.12
1999	13	13.0	-	-	0.04	240.00	15	2.30	-	242.30	671.96
2000	-	-	-	-	0.11	560.84	-	-	-	560.84	1412.29
2001	-	-	-	-	0.02	0.58	165	-	-	0.58	1.35
2002	10	10.0-	6	0.6	0.09	1031.90	1006	118.35	210.00	1360.25	2947.28
2003	9	9.0	-	-	0.32	346.48	309	9.59	-	356.07	720.78
2004	10	10.0	8	0.8	0.25	2516.00	27257	712.50	5591.60	8820.10	16336.18
2005	NO DAMAGE										
2006	NO DAMAGE										
2007	54	157.0	75	7.5	1.25	16710.07	29391	775.00	17896.46	35381.53	52151.57
2008	NO DAMAGE										
2009	NO DAMAGE										
2010	NO DAMAGE										
2011	11	16.5	2	0.33	0.31	881.92	193	49.05	-	930.97	1022.28
2012	-	-	-	-	0.08	135.00	-	-	-	135.00	135.00

Average annual flood damage is Rs. 5485.25 lakh

Source:-Disaster Management Department, Govt. of Bihar.

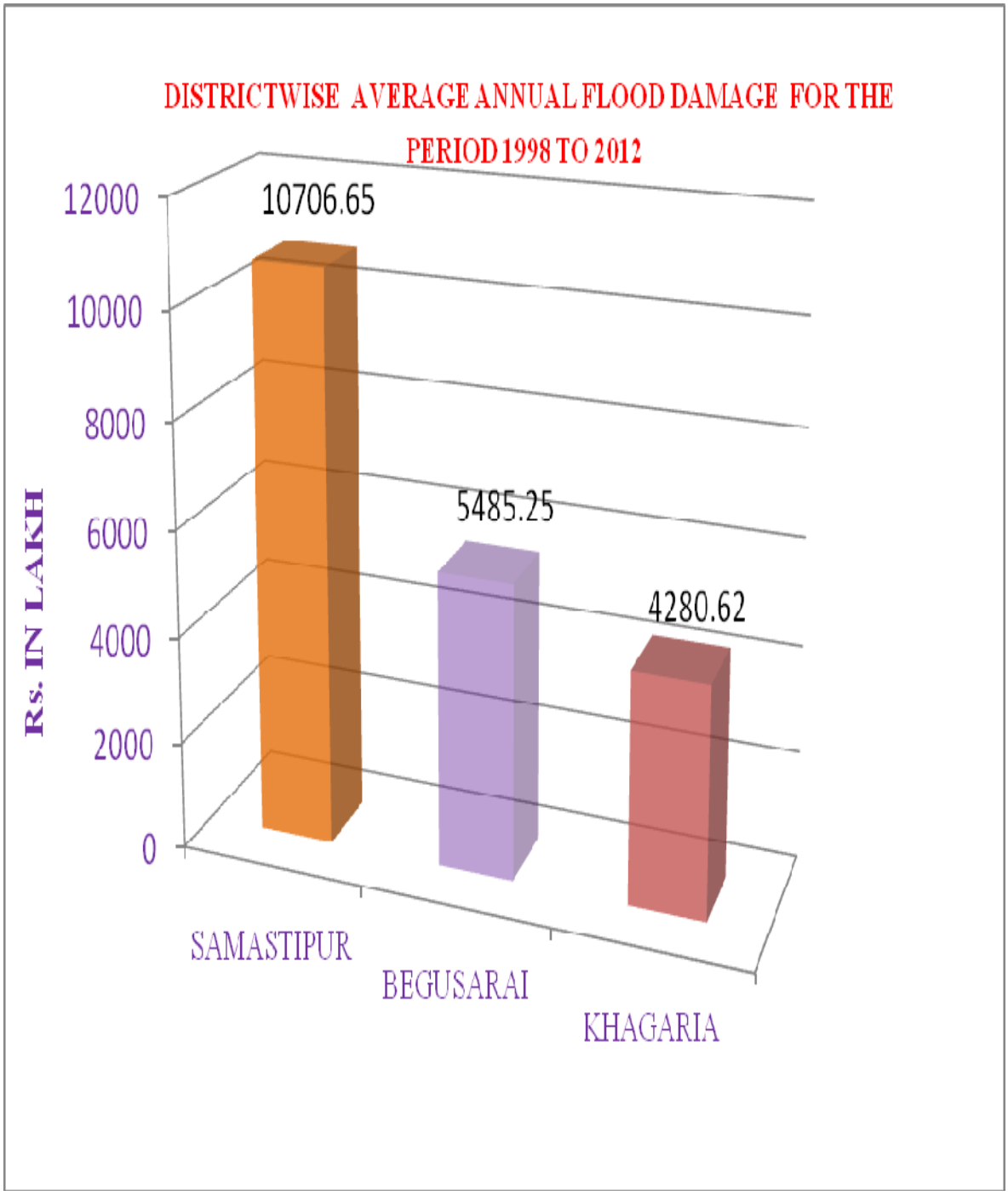
Table – 6.3

Flood damages in respect of Khagaria district

Year	Human lives lost & compensation		Cattle lives lost & compe-nsation		Damage to Crops		Damage to Houses		Damage to Public Utilities (Rs. in lakh	Total Damage (Rs. in lakh) (7+9+ 10)	Total damage Rs. in lakh at the price level 2012-13 (3+5+ escalated value of 11)
	No.	Am-ount (Rs. in lakh)	No.	Am-ount (Rs. in lakh)	Area in lakh ha.	Amount (Rs. in lakh)	No. of House-s	Amount (Rs. in lakh)			
1	2	3	4	5	6	7	8	9	10	11	12
1998	23	23.0	-	-	0.40	1145.55	3344	103.11	15.05	1263.71	3734.76
1999	6	6.00	-	-	0.39	2340.00	439	62.90	1.50	2404.40	6545.06
2000	3	3.00	-	-	0.09	80.20	688	27.36	84.00	191.56	485.38
2001	7	7.00	-	-	0.07	117.65	165	11.45	17.50	146.60	348.82
2002	47	47.00	4	0.40	0.30	752.00	7207	373.00	104.50	1229.50	2701.80
2003	5	5.0	-	-	0.07	265.10	118	102.05	12.30	379.45	763.522
2004	39	39.0	125	12.50	0.90	947.90	68500	9690.0	1341.55	11979.45	22224.63
2005	-	-	2.54	0.040	.040	62.50	0	0	0	62.50	107.15
2006	NO DAMAGE										
2007	101	101.0	71	7.1	0.50	8507.33	32500	8507.33	372.00	17386.66	25654.81
2008	5	1.99	9	0.4	0.06	335.94	3575	738.25	8.03	1082.22	149.74
2009	8	1.82	-	0.10	0.01	226.50	60	21.00	55.00	302.507	82.99
2010	NO DAMAGE										
2011	10	15	-	-	0.12	1291.8	16	0.51	-	1292.31	1410.69
2012	NO DAMAGE										

Average annual flood damage is Rs. 4280.62 lakh

Source:-Disaster Management Department, Govt. of Bihar.


DISTRICTWISE AVERAGE ANNUAL FLOOD DAMAGE FOR THE PERIOD 1998 TO 2012
Rs. IN LAKH
12000
10000
8000
6000
4000
2000
0
10706.65
5485.25
4280.62
SAMASTIPUR
BEGUSARAI
KHAGARIA

6.7.1 Overall damage of flood

Flood damage occurs in lower reaches of Burhi Gandak basin. Samastipur, Begusarai and Khagaria districts are prone to recurring floods. Flood moderation in Burhi Gandak by diversion through the proposed link canal would reduce the inundated area by about 50% as is evident from the simulation study of the worst flood of 2004 (226 sq km without proposed canal and 114 sq km with proposed canal) carried out for hydrological studies. The flood inundation scenarios inside the model area for the worst flood of 2004 and for the estimated flood of 50 years return period are shown in **Fig. 6.2(a), 6.2(b) and 6.3(a), 6.3(b)** respectively. The total damages to houses, crops and public utilities will be reduced to a great extent due to reduction of inundation. The damage to the extent indicated in **Table 6.1** of 2004 amounting to Rs. 81,242 lakh can be reduced to a great extent. If the flood magnitude is less than the worst flood of 2004, the losses can be minimal. Therefore, in totality, the reduction of damage in terms of reduction of inundation, damages to house, crop and public utilities would be much beyond 50%. Since the reduction of flood damages is directly proportional to annual flood peaks occured in Burhi Gandak river, the reduction in damages will vary from 50 to 90% on year to year basis. Hence, an average reduction in damages to the tune of 70% of the overall average annual damages in the districts of Samastipur, Begusarai and Khagaria has been considered to arrive at the benefits from flood control. The overall average annual damage of the three districts work out as Rs. 20472.53 lakh. Accordingly, 70% of the overall average annual damages i.e. Rs. 14330.73 lakh has been considered as annual benefit from the project.

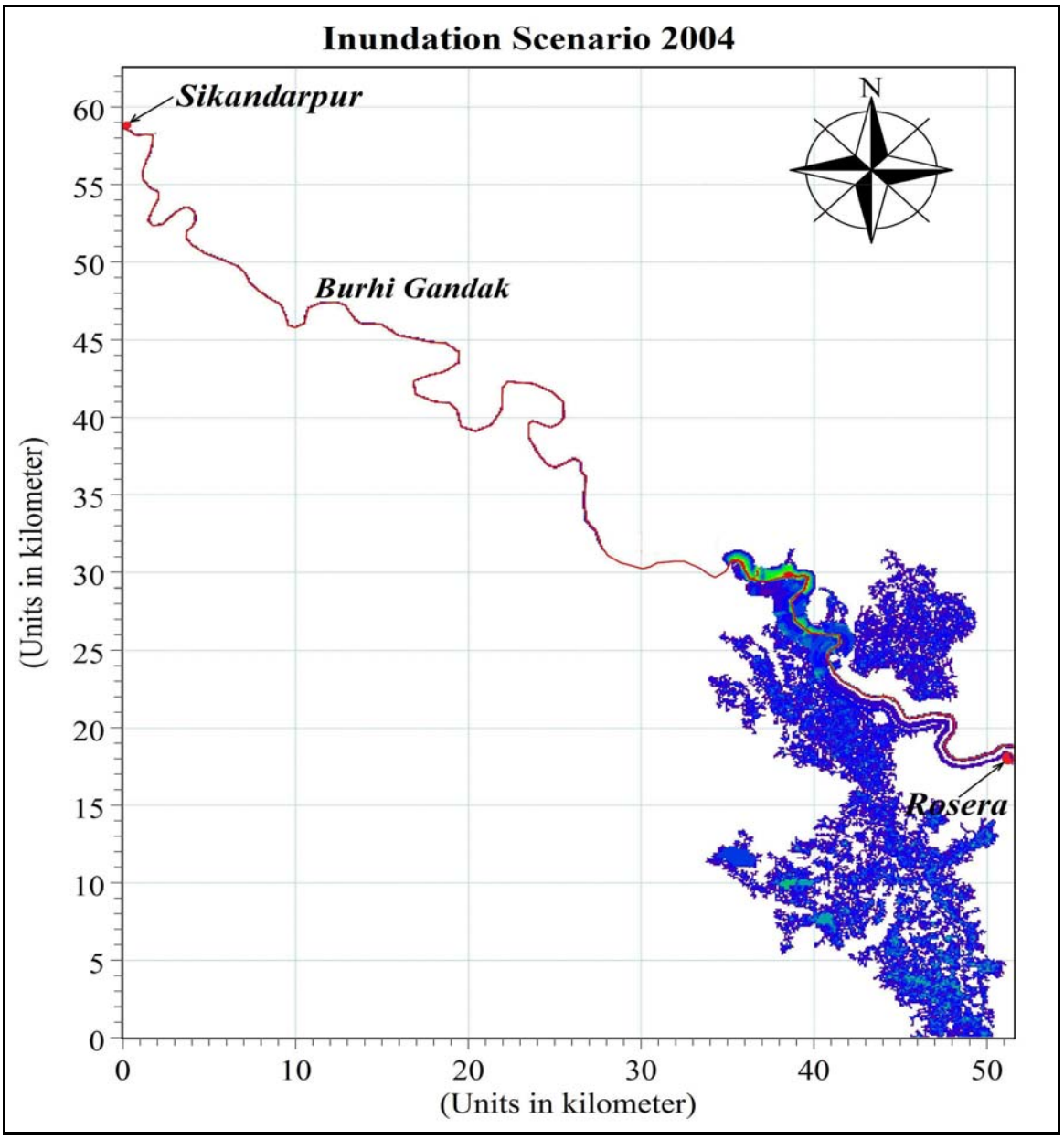


Fig. 6.2(a): Inundation scenario (226.40 sqkm) without canal for peak discharge of 3,041 cumec

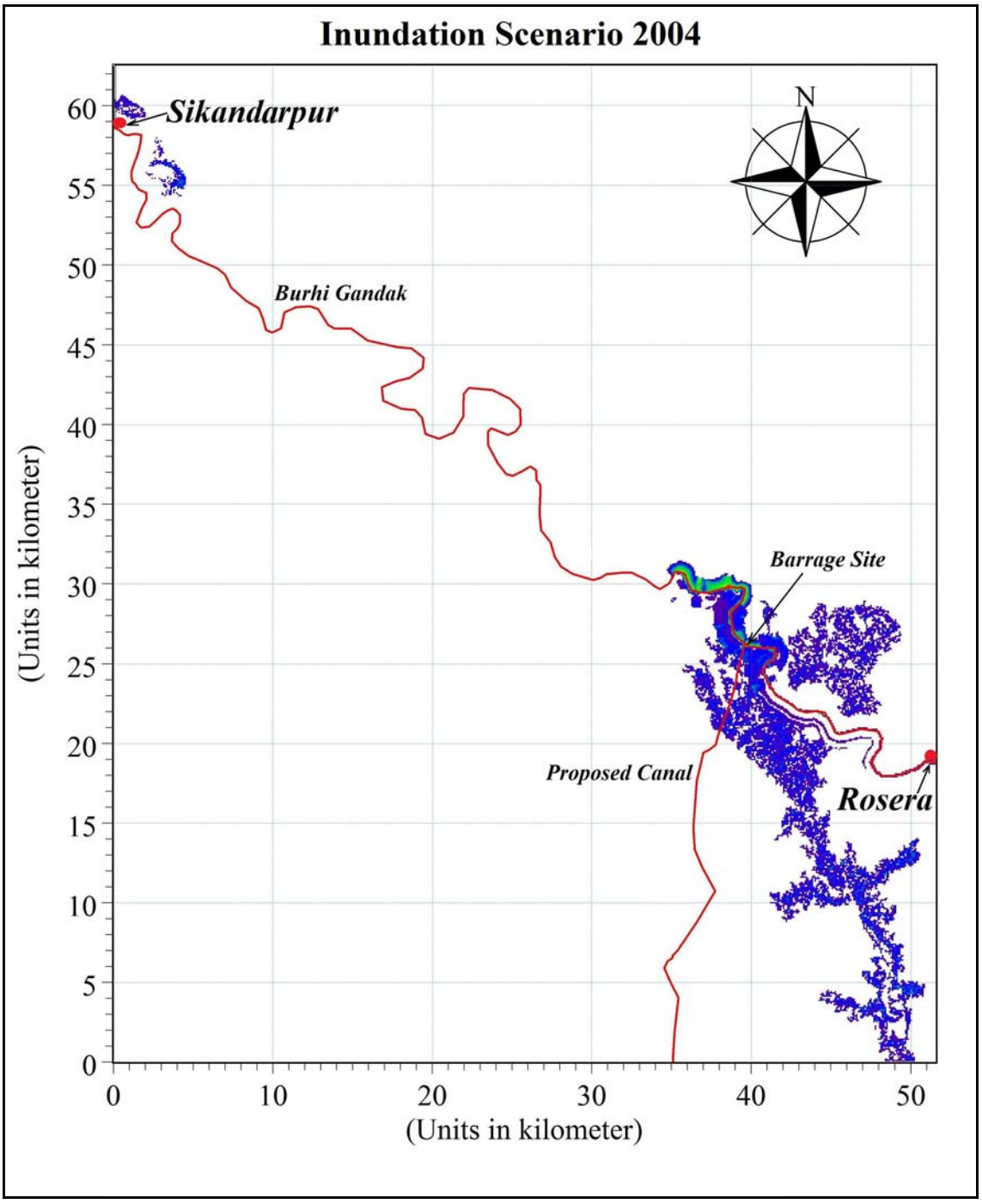


Fig. 6.2(b): Inundation scenario (114.17 sqkm) with canal for peak discharge of 3,041 cumec

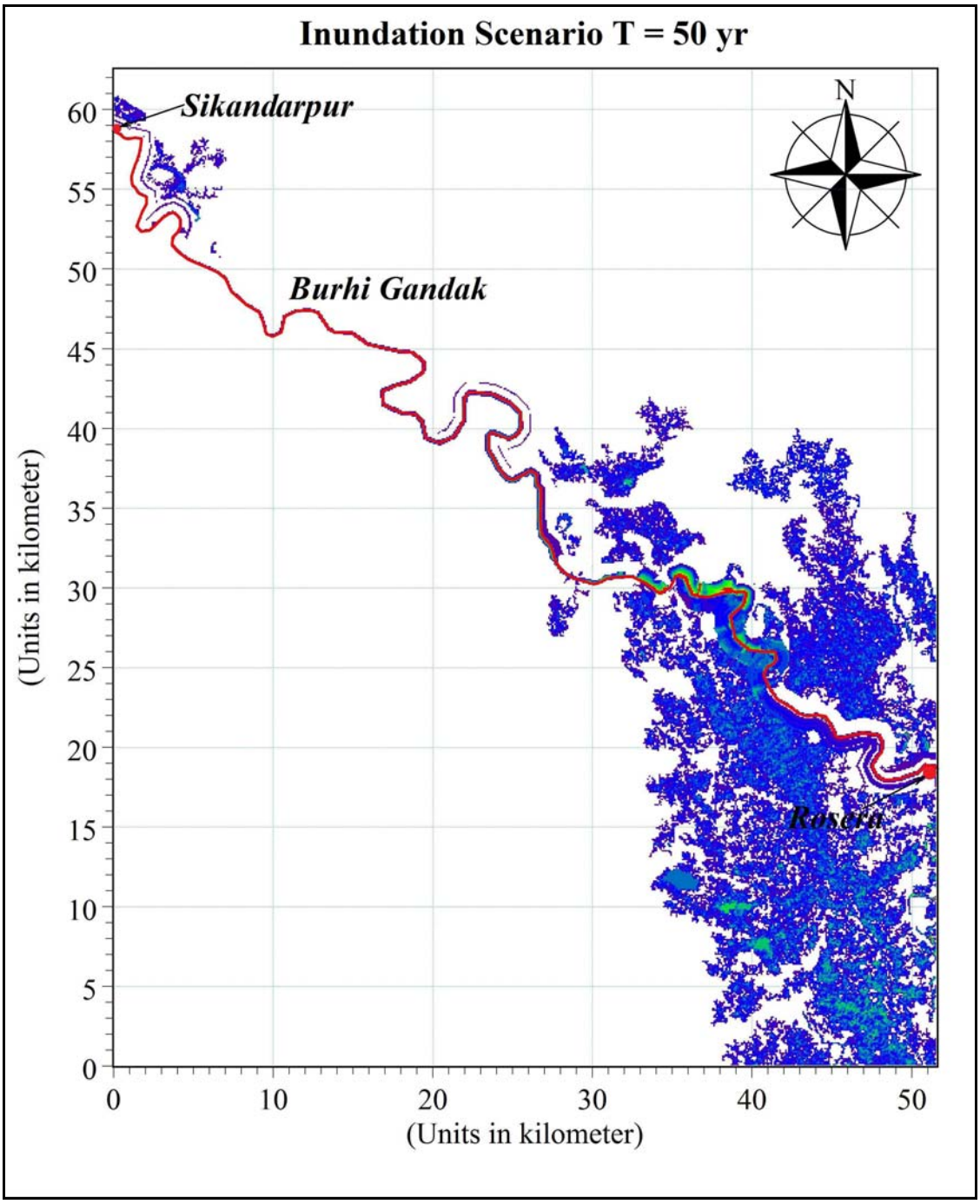


Fig. 6.3(a): Inundation of 455.53 sqkm (inside the modeled area) without canal for peak discharge of 4920 cumec.

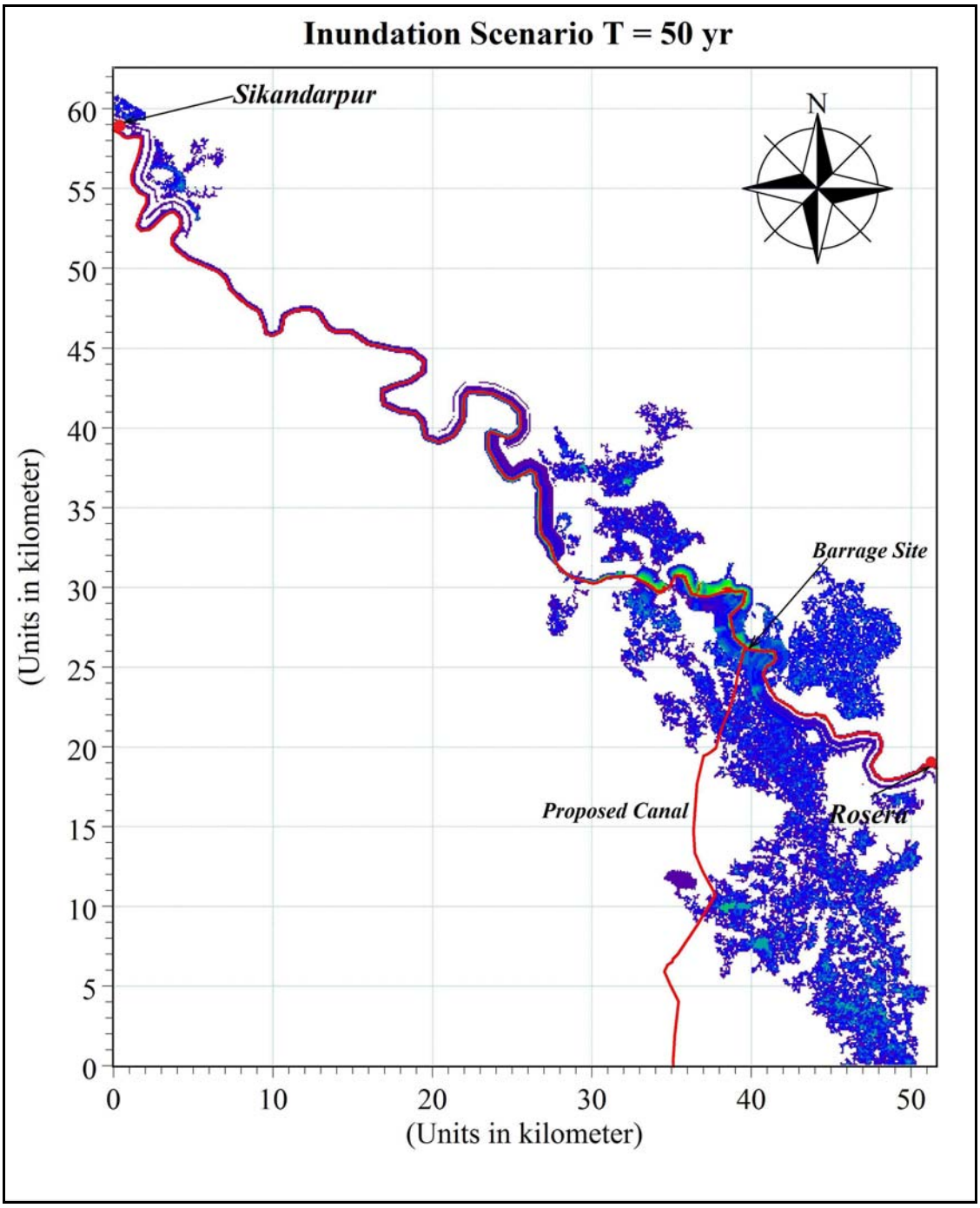


Fig. 6.3(b): Inundation of 313.75 sqkm with canal for peak discharge of 4920 cumec corresponding to 50 year return period.