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Catastrophic floods in Kosi catchment during August 2008

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सार – 18 अगस्त 2008 को कोसी बाँध के पुश्ते में दरार का पता चला जिसके कारण इसकी जल धारा ने अपना मार्ग बदल लिया और इसके फलस्वरूप इसके पहले वाले जलमार्ग के पूर्व में 120 कि.मी. के ईर्द गिर्द एक नया जल मार्ग बन गया। पुश्ते में दरार पडने से लगभग 2832 मी.^{3} प्रति से. जल अत्याधिक तेजी से बहार निकल आया जिससे महेन्द्र राजमार्ग में दरारें आ गईं और इसके बाद इसने दक्षिण की ओर बढते हुए 1892 से 1921 के नदी के छोडें हुए मार्ग पर नदी का रूप ले लिया और इस प्रकार पहले वाली दरार ने सी-लूप बनाते हुए गंगा की तरफ सीधा मार्ग ले लिया। इस अध्ययन में अगस्त 2008 के दौरान कोसी नदी जलग्रहण में विनाशकारी बाढ़ से संबंधित मौसम वैज्ञानिक पहलुओं को विस्तार से बताया गया है। इससे यह जाहिर है कि विनाशकारी बाढ कोसी जलग्रहण में केवल वर्षा के कारण नही आती है यह दरार नदी प्रबंधन की गलत नीतियों, मानव की उपेक्षा और बाँध के चढ़ाव बंद के खराब रखरखाव के कारण पड़ती है (सिन्हा 2009)।

ABSTRACT. A breach in embankment of Kosi barrage was reported on 18 August, 2008 which has changed its course and resulted in a fresh channel around 120 km to the east of its previous channel. At the time of failure of the embankment, gushing out of about 2832 m^3/s water with great impact breaking into the Mahendra Rajmarg and then taking a southward route into the old 1892-1921 abandoned course of the river, thus leaving the pre-breach C-loop and following a straight route to the Ganga. In this study meteorological aspect are analysed in details in relation to the catastrophic flood in the Kosi river catchment during August 2008. It seems that this catastrophic flood may not be solely due to rainfall in the catchment of Kosi. The breach is due to incorrect strategies of river management, human negligence and poor maintenance of afflux bund of the barrage (Sinha, 2009).

Key words – Catchment, Areal Rainfall, Synoptic Situation, Flood, QPF.

1. Introduction

Kosi and floods in Bihar have inseparable history and some of the most devastating floods occurred in the years 1954, 1963, 1971, 1984, 1987, 1991, 1995 and 2008. The floods in Kosi catchment occurred due to breaches at upstream in 1963, 1971, 1984, 1991 and 2008. The Kosi river is known as the "Sorrow of Bihar" as it has caused widespread human suffering in the past through flooding and very frequent changes in its course. The Kosi Catchment is the largest river catchment in Nepal and one of the largest tributaries of the Ganga River. It has seven major tributaries namely Sun Kosi, Tama Kosi, Dhudh Kosi, Indravati, Likhu, Arun and Tamar. That is why it is known as 'Sapt Kosi' in Nepal. It originates from the Tibetan Plateau of China. The seven major tributaries of Kosi drain a total area of 69,300 sq. km. before the river falls into Ganga in India, 42.4% of this area is in China, 44.3% in Nepal and 13.3% is in India. The river travels a distance of 729 km from its source to the confluence with the Ganga.

On an average, it carries 70-80 million tons of silt every year and it is perhaps due to this feature, it tends to change its course after a definite period of time. Gole and Chitale (1996) described the Kosi system as an 'inland delta' built by large sediment flux which was also attributed to be the primary factor causing westward shifting of Kosi and extensive flooding. During the last two centuries, for which records are available, the river has changed its course in a westerly direction and it has laterally moved nearly 150 kilometres (Gole and Chitale, 1996; Wells and Dorr, 1987). The movement of the river has not been gradual but of avulsive nature (sudden change in river course) originating from a nodal point (Wells and Dorr, 1987; Slingerland and Smith, 2004). A number of paleo channels on the satellite image of the Kosi catchment testify the migratory behaviour of the

TABLE 1

Heavy rainfall events in July 2004

Date	Areal rainfall for Kosi catchment in India region (mm)
4 July 2004	30.5
5 July 2004	25.2
6 July 2004	35.4
7 July 2004	71.8
8 July 2004	50.4
9 July 2004	51.1
10 July 2004	49.2
11 July 2004	38.1

river (Sinha *et al*., 2008). Many experts are therefore, of the opinion that viability of high dams on any Himalayan river is very bleak, because the heavy siltation makes barrages useless after a period of time.

The Kosi Barrage, a multipurpose project in Nepal near the Indian border of Bihar state, was built in 1956. It is a multipurpose project for irrigation, flood control and hydropower generation. The Kosi Barrage has been designed for a peak flood of about 27,000 m^3/s.

Despite a long history of flood control management in the catchment for more than 5 decades, the river continues to bring a lot of misery through extensive flooding. Sinha *et al.* (2008) has studied the flooding problem in the Kosi river catchment and presents an in-depth analysis of flood hydrology. The flood risk map is validated with long-term inundation maps and offers a cost-effective solution for planning mitigation measures in flood-prone areas. During the last 60 years, after the construction of the barrage, 8 times breach had occurred on the embankment.

In 1954 the most devastating catastrophic floods occurred during 23-31 July and 19-26 August due to heavy rainfall (Ramaswamy, 1987). The maximum point rainfall observed was 174 mm at Supaul on 22nd August in Indian region and 222 mm at Ramechap on 23rd August in Nepal. During the storm of 19-26 August, 14 stations in India & 13 stations in Nepal and during 23-31 July storm 7 stations in India & 19 stations in Nepal reported 75 mm or more rainfall over the catchment. During 4th to 11th July, 2004 the areal rainfall received in the catchment was shown in Table 1.

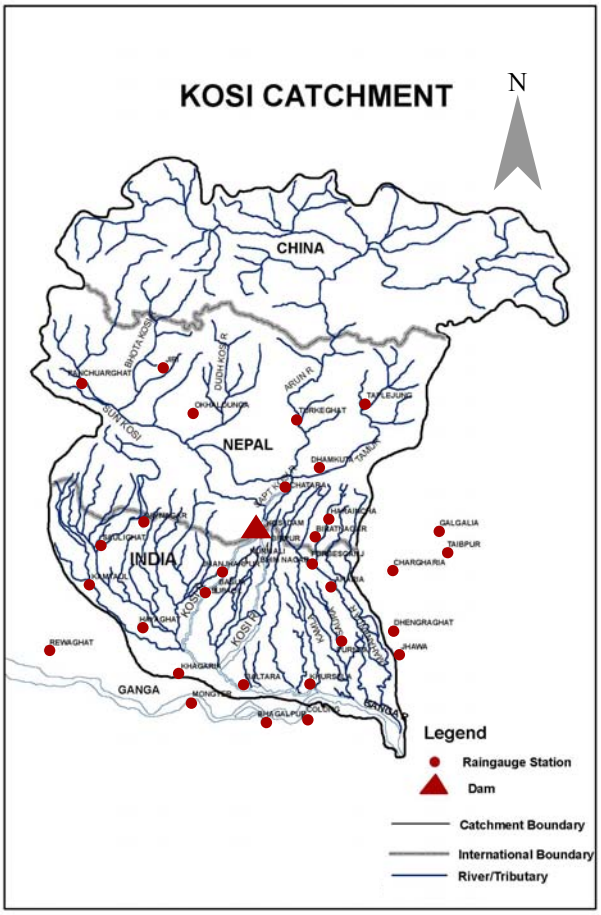


Fig. 1. Kosi river and raingauge network

A breach in embankment of Kosi barrage was reported on evening of 18 August, 2008 which has changed its course resulted in a fresh channel around 120 km to the east of its previous channel and catastrophic flood occurred which caused enormous loss of life and property. In this study meteorological aspect are analysed in details in relation to the catastrophic flood in the Kosi river catchment during August 2008 in the parts of Nepal and India.

2. Data and methodology

Detail synoptic situations has been studied during the period of flood and before it. Synoptic charts, satellite imageries [Kalpana I(VIS), IRS] and daily rainfall data of 37 stations in and around of Kosi catchment in India and Nepal region have been used for analysis. The catchment map of Kosi river along with the rainguage network is given in Fig. 1. The synoptic situations have been identified which gave rainfall over the catchment. The areal rainfall occurring in the catchment during the period

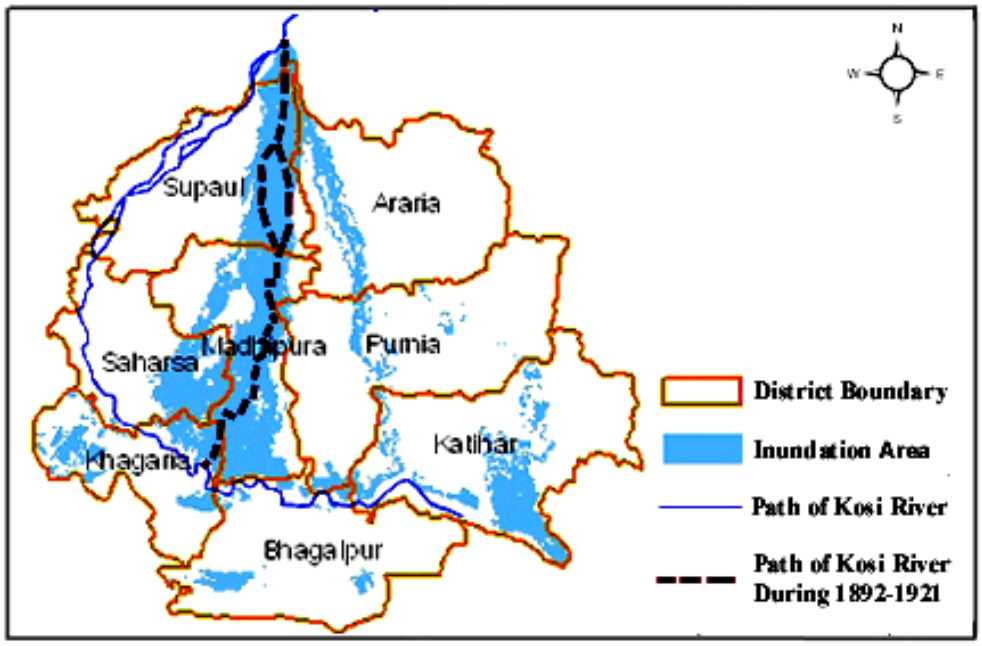


Fig. 2. Flood inundation extent on 27th August 2008 in Kosi river (Radarsat data)

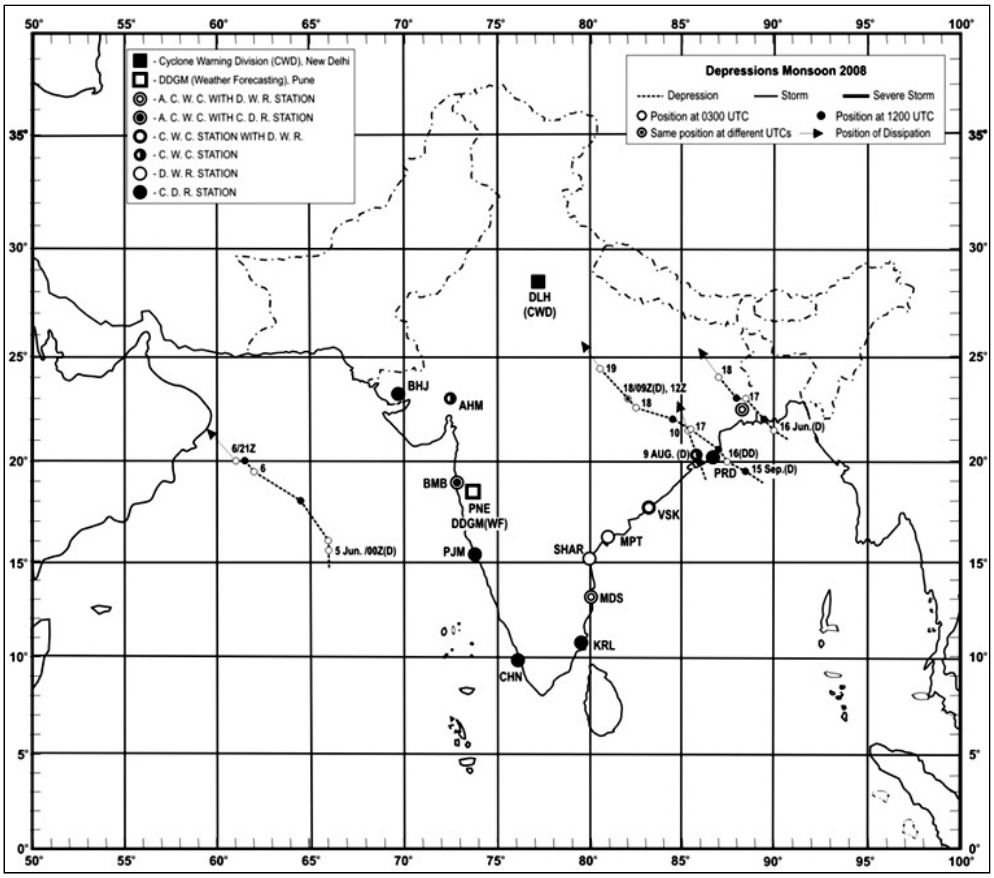
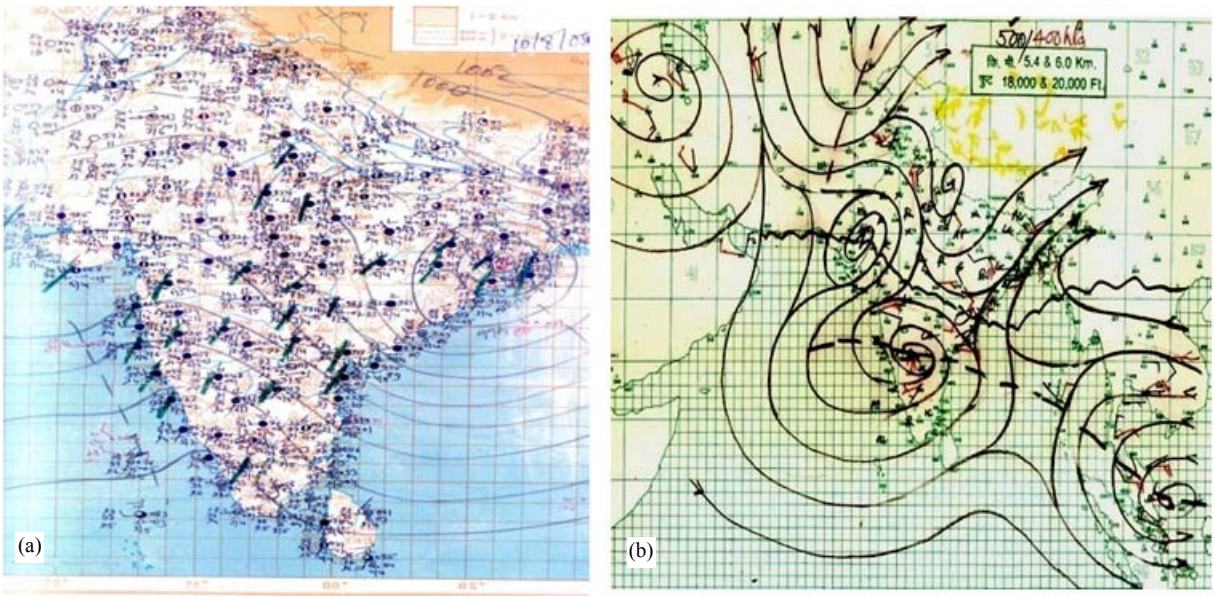


Fig. 3. Tracks of storms and depressions during southwest monsoon 2008



Figs. 4(a&b). (a) Analysis of surface chart on 10 August 2008 and (b) Analysis of 500 hPa level on 16 August 2008

TABLE 2

Areal rainfall over the Kosi catchment

Date	Areal rainfall for Kosi catchment in India region (mm)	Areal rainfall for Kosi catchment in India & Nepal region (mm)
16 August 2008	28.6	23.1
17 August 2008	37.0	27.9
18 August 2008	10.3	9.6
19 August 2008	32.2	25.9
20 August 2008	11.6	8.0

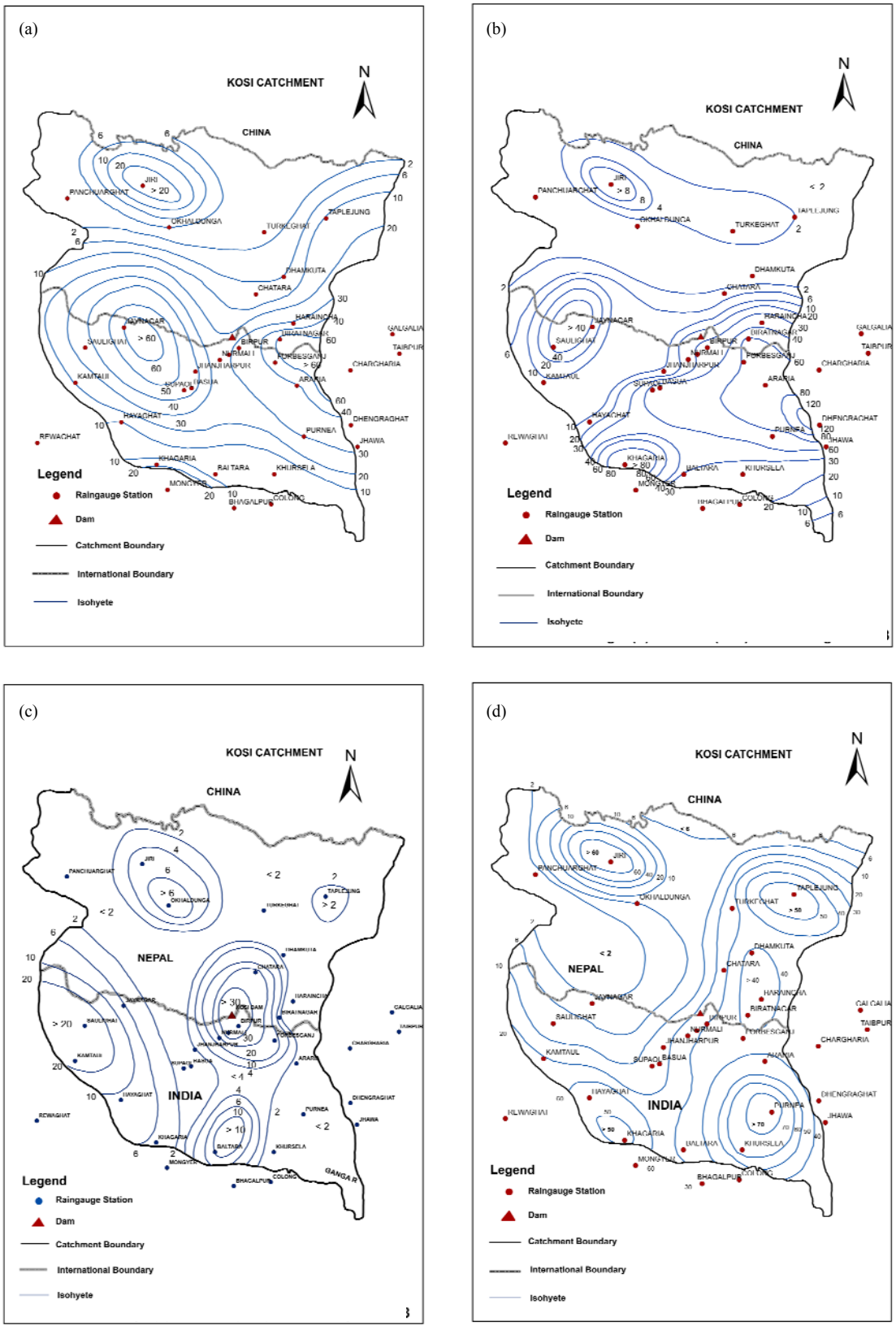
16th August 2008 to 20th August 2008 have been computed by isohyetal method and compared with earlier data during severe flood period.

3. Results and discussion

The breach in embankment of Kosi barrage can be visualized from the analysis of radar-satellite images from NRSA (Fig. 2). It had occurred at 11.9 km from the Kosi barrage and the length of the breach was 1735 m. Failure of the embankment resulted in gushing out of about 2832 m^3/s water with great impact breaking into the Mahendra Rajmarg and then taking a southward route into the old 1892-1921 abandoned course of the river, thus leaving the pre-breach C-loop and following a straight route to the Ganga. Interestingly there is not much variation in the Kursela situation where Kosi falls into the Ganga. Kosi has an average discharge of 1557 m^3/s of water that increases by as much as twenty times during the monsoon or flood season.

3.1. *Synoptic situation*

A Low Pressure Area (LOPAR) formed over NW and adjoining WC Bay of Bengal on 8th August. It concentrated into depression on 9th close to Puri and weakened into a LOPAR on 10th evening. It moved across Orissa, north Chhattisgarh, east Madhya Pradesh till 11th. An upper air cyclonic circulation existed near the catchment up to 15th. It then interacted with the mid-latitude westerly trough and re-curved northwards towards west Uttar Pradesh till 16th and then moved eastwards towards east Uttar Pradesh where it persisted till 20th. It then moved northwestwards and became less marked on25th over east Rajasthan and adjoining Madhya Pradesh. From 14th onwards the monsoon was active over Bihar



Figs. 5(a-d). Rainfall (mm) of (a) 16th August 2008, (b) 17th August 2008, (c) 18th August 2008 and (d) 19th August 2008

and the monsoon trough was lying near the foothills. Track of depression is shown in Fig. 3. An upper air cyclonic circulation exists near the catchment up to 15th [Figs. 4. (a&b)].

3.2. *Rainfall analysis*

The daily rainfall data of 37 stations are plotted on the catchment map of Kosi basin in the region of India and Nepal from 16th August to 20th August. The daily areal rainfall in the catchment is estimated using Isohyetal method [Figs. 5 (a-d)]. In association with upper air cyclonic circulation the catchment receives an areal rainfall between 20 to 25 mm (Catchment with in Indian region). The areal rainfall received in Indian region & Nepal region of Kosi catchment is given in Table 2. The maximum areal rainfall received on 17th August was 37 mm in Indian region and 27.9 mm in Indian and Nepal region of Kosi catchment respectively. On 17th August, 2008 the maximum point rainfall 90 mm occurred at station Khagaria in the catchment and 122 mm at Dengraghat which is close to the catchment. The breach in the embankment occurred on evening of 18th August 2008 and the rainfall recorded on 19 August 2008 is 77 mm past 24 hrs rainfall. In earlier occasions, the catchment received much more rainfall as seen from Tables 1 & 2 which indicates that the breach may not be only due to rainfall. The breach is due to incorrect strategies of river management, human negligence and poor maintenance of afflux bund of the barrage (Sinha, 2009).

3.3 *Damages*

The river took the new straight route from the breach location, during its journey it flooded vast areas on both sides of the new course affecting nearly four million people from their homes and destroyed 100,000 ha (250,000 acres) of farmlands, damaging huge property, resulting in unprecedented loss of cattle wealth and human lives. The worst affected districts included Supaul, Araria, Saharsa, Madhepura, Purnia, Katihar, parts of Khagaria and northern parts of Bhagalpur, as well as adjoining regions of Nepal. The entire affected area appeared like a lake 125 km long by 25 km wide. Whole towns and villages have drowned; railway stations, roads, bridges, government buildings, the entire administrative apparatus of places have been wiped out. The water was stagnant for a long period because the flood was not from a proper river channel as can be seen from NRSA radarsat picture of 27 August 2008 (Fig. 2).

Centre/State government had taken highest level relief measure to help people and Prime Minister of India is termed the devastation as a National Calamity. IMD also gave daily special forecast of Kosi catchment for rehabilitation work. To facilitate construction activities for the construction of embankment along with its protection there were three channels in the main stream of the river Kosi which were closed by earthen dam and the water reaching to cofferdam from upstream was diverted through a dug diversion channel/pilot channel to main Kosi river upstream of the barrage (Ghani, 2009). The breach of embankment is restored in 2009.

4. Conclusion

The catastrophic flood occurred in Kosi catchment in August, 2008 due to the breach in the embankment of Kosi barrage and may not be only due to rainfall. The water flows directly in the southern direction, not following river channel and remained stagnant for few days, caused flood. The rainfall in the catchment before and after the breach period accelerate the flood situation. It also made the situation a little difficult for work of safety measures.

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