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Forecasting Model of Flood Inundated Areas along *Sharda* River in U.P.

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Abstract: *Paper has illuminated the satellite data of previous flood and hydrological data to estimate the inundated areas near Sharda River. Modeling of flood inundated areas predicted 10 cm rises in water level in affected areas by flood. IRS-P6/AWiFS and RADARSAT data were used. The RADARSAT satellite data have shown the flood water, water in low lying areas and real time flood data. The geo referenced IRS-P6/AWiFS, IRS-P6/LISS-III and PAN satellite data were useful for preparation of various thematic maps. Results revealed that most heavily flood affected villages at three gauge stations on Sharda River during year 2009 were: 13 villages of Puranpur Block of Pilibhit District downstream to Banbasa gauge station at 220.35m water level; 22 villages of Nighasan Block of Lakhimpur-khiri District downstream to Paliyakala gauge station at 154.62m water level and 26 villages of Behta Block of Sitapur District downstream to Sharda Nagar gauge station at 136.10m water level.*

I. Introduction

Meteorological and hydrological data are the main requirement for forecasting of flood inundated areas, besides the availability of information for making decisions and actions. Therefore it is required to integrate water level at different gauge stations with flood data of all places as on different dates. The modeling and forecasting of floods and their consequences require extensive spatial information of catchments and flood risk areas. The information required for forecasting of flood inundation is based on the extent of the area affected, location specific details, population affected during previous floods (Sunita, 2010; Singh and Prabhat, 2014). This has been reported along *Sharda* River in Uttar Pradesh in the paper.

Studies have been reported on the use of passive remote sensing and flood inundation (Horritt et al., 2003; Horritt and Bates, 2001). It is important to consider more developed active sensors, such as microwave and laser techniques as they have the ability to penetrate tree canopies and cloud cover. Active sensors generate their own energy and are extensively used now (Campbell, 2002). Such as *Landsat Thematic Mapper* (TM) are limited by atmospheric conditions, as well as the inability to detect standing water beneath obstructions i.e. as forest canopies (Townsend and Walsh, 1998). Radar systems are capable of determining sharp land-water boundaries, and are capable of higher spatial resolutions than passive systems under similar situations (Engman and Gurney, 1991). Radar can penetrate clouds, darkness and tree canopies (Smith, 1997). It is well demonstrated the ability of Synthetic Aperture Radar (SAR) for providing all weather flood area delineation (Lowry et al. 1981) and similar studies are reviewed the use of radar detection for flood studies (Hess *et al*. 1990). Besides studies have been reported on the forecasting the different aspects in our country (Chaturvedi and Mohan 1983; Ghani, 2009; Srivastava, Sharma and Sharan, 1983; Murthy and Rao, 2007; Sinha *et al*. 2008; Srivastava,2009; Veeranna *et al*. 2009).

Townsend and Walsh (1998) modeled floodplain inundation through the integration of SAR, Geographical Information Systems (GIS) and optical remote sensing. It was highlighted in the study that Landsat TM data is less appropriate for mapping flood inundation than the tested radar data, as in times of monsoon their use is severely restricted and best avoided if suitable radar images are available. The synergistic use of radar and optical remote sensing in conjunction with GIS modeling was therefore argued as an effective method for delineating flood inundated areas. Smith (1997) proposed a synergistic approach towards flood inundation mapping as fixed frequency SAR was found insufficient for the mapping processes and it required to be combined with visible infrared data (VNIR). Further, it was found that although SAR is not limited by atmospheric conditions, it was most effective for mapping smooth open water bodies, river flow and flood stages. It was also concluded that SAR provides excellent temporal coverage in certain situations. Therefore, it can be used to determine the flood extent.

Horrit *et al.* (2003) also recognized the potential of SAR systems for mapping flooded vegetation in the Wrangle Flats on the eastern coast of the UK. The approach was found to be reasonable and required further work to be undertaken. Radar data has also been used for indirect flood studies. Tholey (1995) used ERS-1 imagery along with GIS to assess the affect that land use has on flood events in northern and southern France.

Such studies are useful for forecasting of flood inundated areas that require urgent flood management. The flood forecasting is one of the most effective non- structural measures for flood management. For formulating the flood forecast, the observed hydrological data (water level) and satellite data of different dates are collected, integrated, manipulated and analyzed through GIS software and transmitted to the forecasting station through the different means of data communication (Aggarwal, 2004; 2006, 2007, 2009).Flood maps were prepared showing the flood inundated areas in 5km buffer of *Sharda* Rivers. These maps were found to be very useful for planners/decision making to make a scientific assessment and for batter management of relief activities (Aggarwal, 2010a; 2010b).

The flood inundation layer extracted from the satellite data of 5 km. buffer around Sharda rivers is integrated with the base data layers such as district boundary, block boundary, village boundary for estimation of district wise flood inundated area, number of villages affected during flood (Tangri,1986).Based on the duration of the flooding, magnitude of the flood and flood affected areas are estimated. The hydrological data (water level) is useful for flood inundation studies (Tangri and Sharma, 1985). The geo referenced IRS-P6/AWiFS satellite data are useful for preparation of catchment area of Sharda Rivers in Nepal region. Drainage map is required to measure and assessment of the runoff water and how much water input in the main river from different tributaries (Tangri, Mathur and Chaturvedi, 1986).

Flood Forecasting: Application of Remote Sensing & GIS

Geographical Information System (GIS) and remote sensing offer valuable tools to contribute to the required information about flood forecasting. Satellite remote sensing is the best source of mapping this information (Gupta and Bodechtel, 1982; Bhavaskar, 1984; Choudhary, 1989, 1991; Parihar, 1995).Main problems respect to floods is inundation, drainage congestion due to urbanization and bank erosion in our Country. Further it also depends on the river system, topography and pattern of flow in the area. The basic data requirements for forecasting of flood inundated areas are meteorological and hydrological data. The other most important element is the availability of timely information for taking decisions and actions. For this purpose we have to integrate water level at different gauge stations with flood data of that places as on different dates. The modeling and forecasting of floods and their consequences require extensive spatial information of catchments and flood risk areas. The information required for forecasting of flood inundation is based on the extent of the area affected, location specific details, population affected during previous floods.

This paper aims to estimate the inundated areas near *Sharda* Rivers based on satellite data of previous flood and hydrological data that is water level. Modeling of flood inundated areas is required to predict how much area will be affected by flood with respect to 10 cm. rise in water level through IRS-P6/AWiFS and RADARSAT data. The RADARSAT satellite data show the flood water, water in low lying areas and real time flood data. The geo referenced IRS-P6/AWiFS, IRS-P6/LISS-III and PAN satellite data are useful for preparation of various thematic maps (Sunita, 2010).

It also forecast modeling using the geo-informatics of floods inundated areas near Sharda River in downstream of different gauge stations. We report the modeling of flood inundated areas estimated on satellite data of previous flood and hydrological data of inundated areas near *Sharda* River. It shall be useful in forecasting of flood inundated areas that require urgent flood management. It had following objectives.

II. Objectives

i. Mapping of catchment areas of Sharda rivers in Nepal region using satellite data of IRS-P6/AWiFS as on December, 2009 and IRS-P6/LISS-III as on October, 2009 and IRS-P6/PAN as on March,2002 and Feb-March,2004.
ii. Mapping of flood inundated areas near Sharda River in downstream of different gauge stations in year 2007, 2008 and 2009 using satellite data of IRS-P6/AWiFS and RADARSAT.
iii. Comparison of water level with flood inundated areas near Sharda River in downstream of different gauge stations using satellite data of IRS-P6/AWiFS and RADARSAT as on 2007 to 2009.
iv. Modeling of forecasting of flood inundated areas with respect to 10 cm rise in water level in year 2007, 2008 and 2009 using IRS-P6/AWiFS and RADARSAT data.

v. GIS Integration of flood layer with village boundary layer for the calculation of area of inundation in each village using 5km. buffer around *Sharda* River in year 2007, 2008 and 2009.

III. Material and Methods

The datasets used for mapping catchment area of *Sharda* River in the present study were: i.IRS-P6/AWiFS satellite data as on 10th Dec, 2009; ii. IRS-P6/LISS-III satellite data as on 9th Jan, 2001; and 9th Oct, 2009 and iii. IRS-P6/PAN satellite data as on 28th March, 2002; 26th Feb, 2004 and 22nd March, 2004. District, Block and Village Boundary Layer of Uttar Pradesh were used as Base Data. Data were used for flood inundation mapping is given in Table-1.

Table-1: List of used data three Gauge stations on Sharada River.

Satellite Name	Gauge Stations		
	Banbasa	Paliyakala	Sharda Nagar
Radarsat	23.08.08	23.08.08	27.07. 08
		20.08. 09	21.08. 08
		12 .10. 09	23.08.08
			06.09.08
			25.09.08
			20.08.09
			25.08.09
			27.08. 09
			12.10. 09
IRS-P6/AWiFS	09.10.09	09.10.09	09.10.09
	14.10.09	14.10.09	14.10.09

IV. Results and Discussion

The Results of Mapping of catchment area of *Sharda* River in Nepal Region, GIS Integration for flood inundated villages and Mapping and Modeling of forecasting of flood inundated areas are summarized as below

1 Mapping of catchment area of *Sharda* River in Nepal Region

Mapping of catchment area of *Sharda* River were used to delineate the various water channels of the rivers covering the Nepal region. IRS-P6/AWiFS satellite data was used for mapping of both the rivers in Nepal Region. The watershed area of *Sharda* River in Nepal region has covered an area of 16.49 lakh hectares. Drainage maps were generated which were used to measure and assessment of the runoff water and water input in the main river from different tributaries. Map of catchment area of *Sharda* River is shown in following (Fig.-1 and Fig.-2).

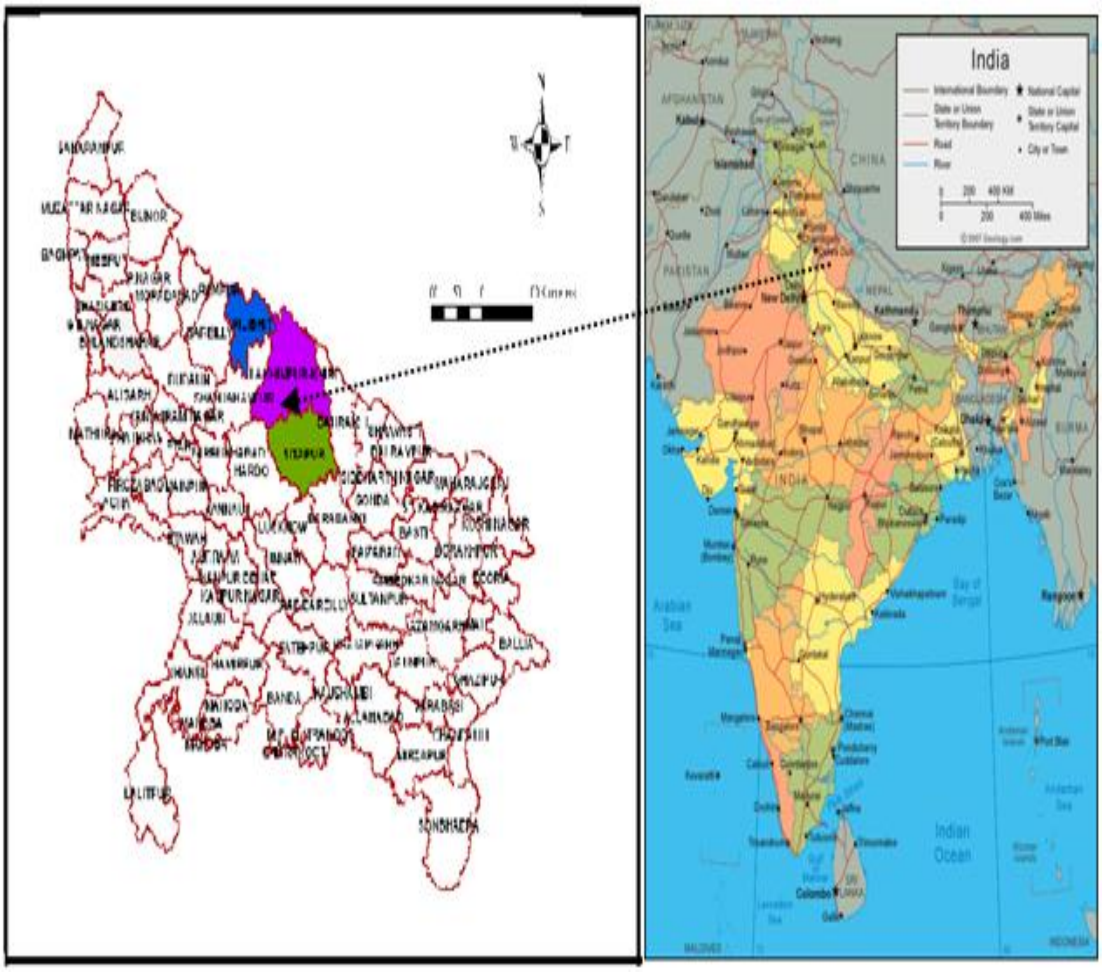

Fig.-1: Map of study area in Uttar Pradesh.

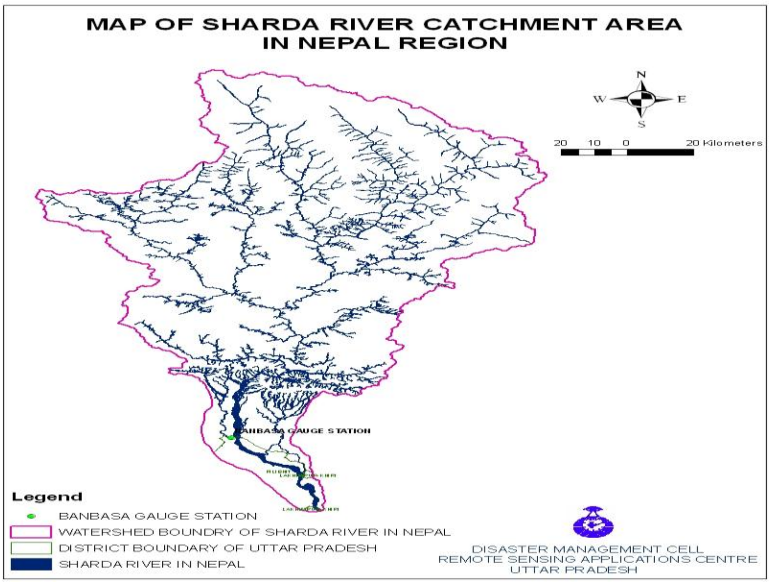

Fig.-2: Map of *Sharda* River catchment area in Nepal region.

2. GIS Integration for flood inundated villages

The maximum flood was observed with respect to rise in water level at three gauge stations of *Sharda* River during year 2009 from the observation of all the graphs based on flood inundated areas and water level and inundation maps and their corresponding information about area of the districts, blocks and villages:

i. The water level at Banbasa gauge station was 220.35m, the maximum flood was observed and 2394.70ha area was affected due to flood. List of flood inundated villages along *Sharda* River in downstream of Banbasa is shown in Table-2.(As on 9th Oct, 2009).
ii. The water level at Paliyakala gauge station was 154.62m., the maximum flood was observed and 6248.57ha area was affected due to flood. List of flood inundated villages along *Sharda* River in downstream of Paliyakala is shown Table-3.(As on 9th Oct, 2009).
iii. The water level at Sharda Nagar gauge station was 136.10m., the maximum flood was observed and 10589.97ha area was affected due to flood. List of flood inundated villages along *Sharda* River in downstream of Sharda Nagar is shown in Table-4(As on 9th Oct, 2009).
iv. Based on satellite data of previous flood and hydrological data, the flood inundated areas along *Sharda* River were estimated**.** The area of flood inundation in downstream of each gauge station of *Sharda* River during year 2007 to 2009 is shown inFig.-3 and Fig.-4.

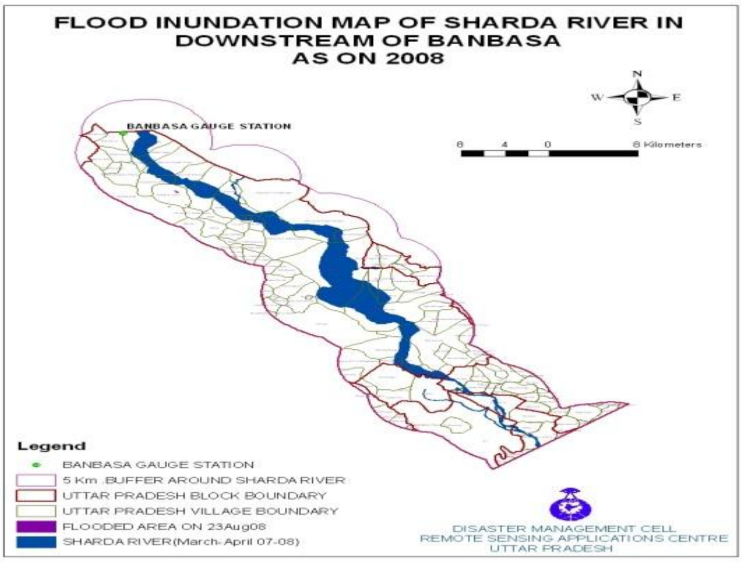

Fig.-3: Flood inundation map for downstream of Banbasa as on 2008

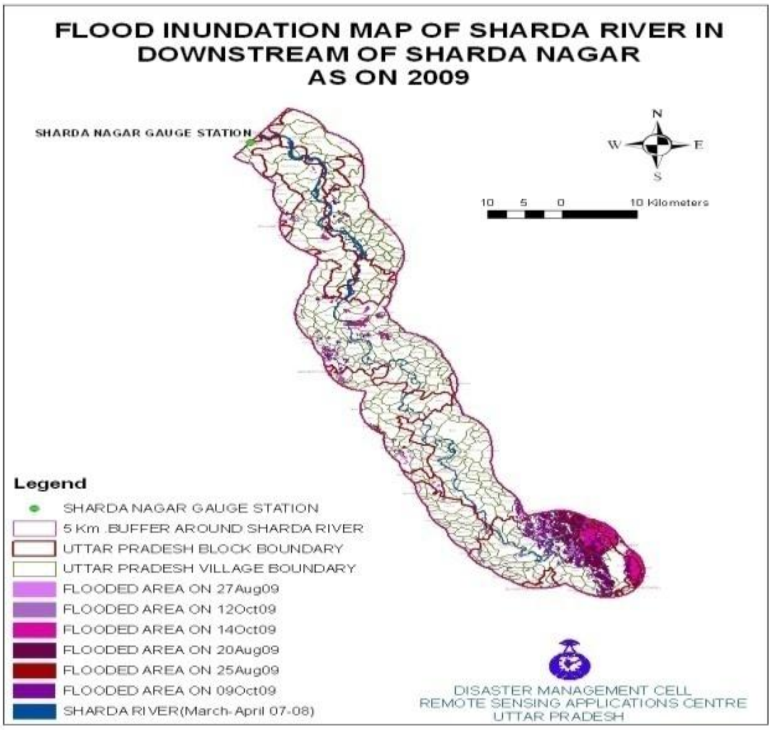

Fig-.4: Flood inundation map for downstream of Sharda Nagar as on 2009.

1. Mapping and Modeling of forecasting of flood inundated areas :

A trend was observed between changes in area of inundation with respect to change in water level by using water level at various gauge stations of *Sharda* River as on different dates and flood layers of various dates derived from RADARSAT satellite data and AWiFS data from 2007 to 2009.(Fig-5 to Fig.-7).

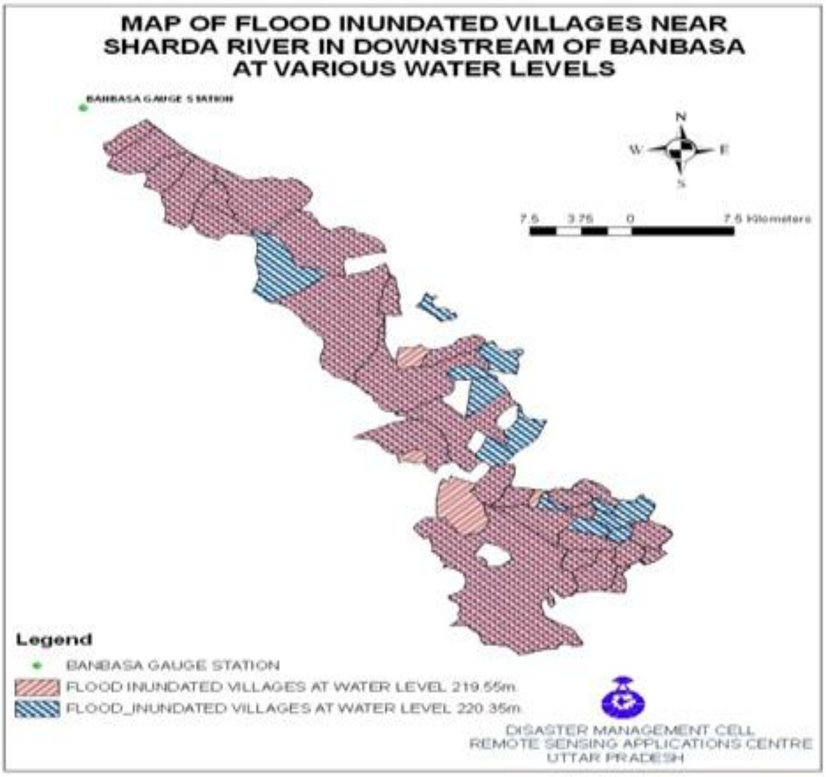

Fig.-5: Map of flood inundated villages near *Sharda* River in downstream of Banbasa at various water levels.

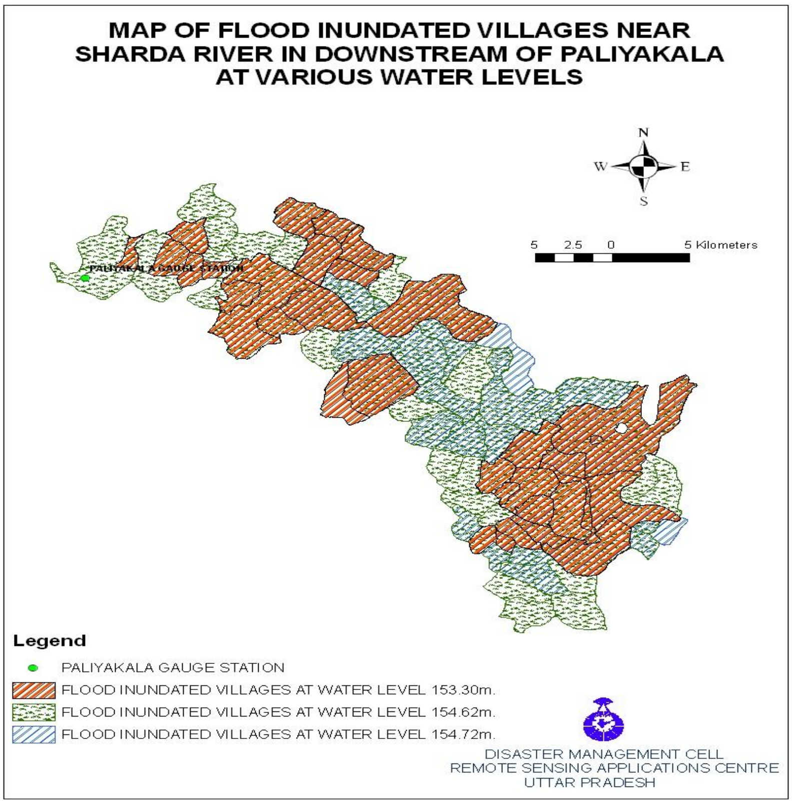

Fig.-6: Map of flood inundated villages near *Sharda* River in downstream of Paliyakala at various water levels.

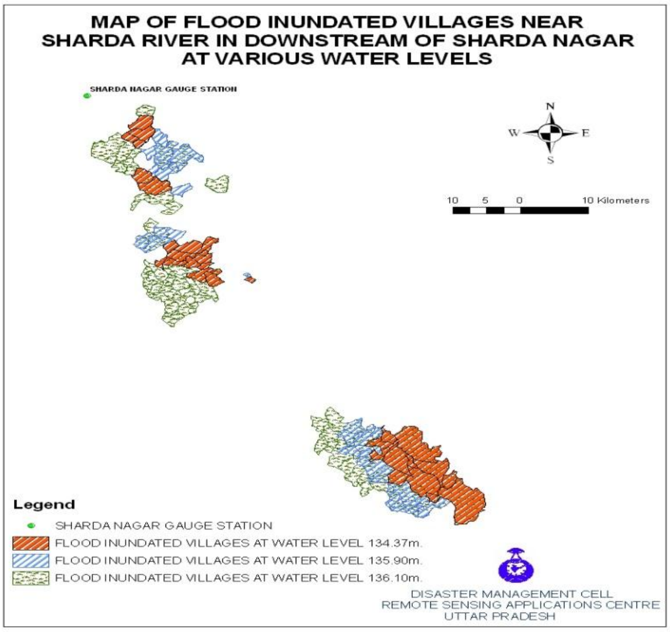

Fig.-7: Map of flood inundated villages near *Sharda* River in downstream of Sharda Nagar at various water levels.

The following results were summarized through forecasting model of flood inundated areas using geoinformatics and it was also concluded that with 10cm rise in water level at each gauge station of *Sharda* River was observed.

i. In Banbasa gauge station, the rise in water level from 220.35 to 220.45m that is, 10cm will affect an area of 105.30hain addition with the affected area at water level 220.35m. (Fig.-8)

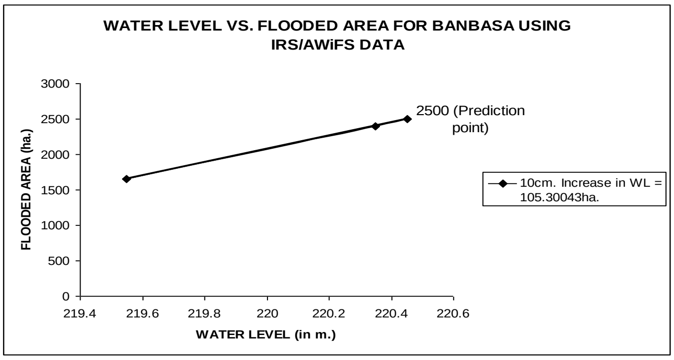

Fig.-8: Graph showing prediction point of flood inundated areas with 10cm. rise in water level using trend analysis for Banbasa gauge station.

ii. At Paliyakala gauge station, the rise in water level from 154.62m to 154.72m that is, 10cm will affect an area of 551.43ha in addition with the affected area at water level 154.62m. (Fig.-9)

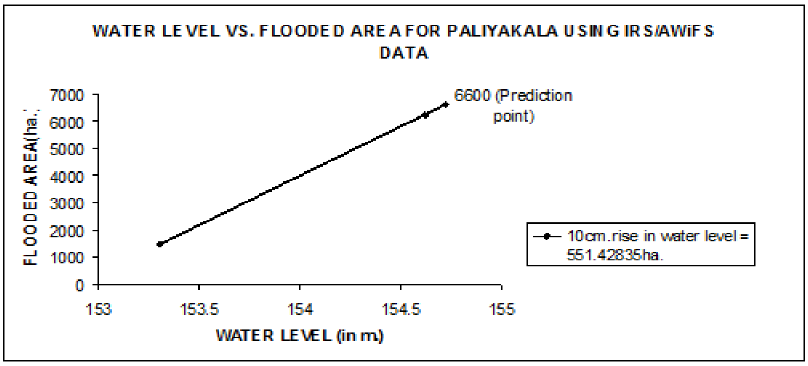

Fig.-9: Graph showing prediction point of flood inundated areas with 10cm. rise in water level using trend analysis for Paliyakala gauge station.

iii. At Sharda Nagar gauge station, the rise in water level from 136.10m to 136.20m that is, 10cm. will affect an area of 510.03ha.in addition with the affected area at water level 136.10m.(Fig.-10)

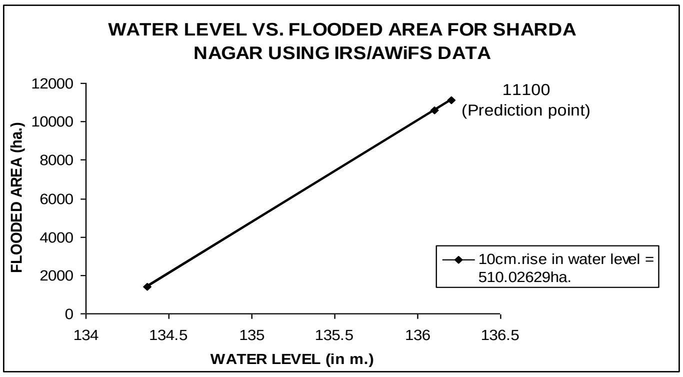

Fig.-10: Graph showing prediction point of flood inundated areas with10cm rise in water level using trend analysis for Sharda Nagar gauge station.

Table-5: Water level and flooded areas as on different dates in year 2009 usingIRS/AWiFS data for Banbasa gauge station.

Stations	Dates	Water Level (In M.)	Flooded Area (Ha.)
Banbasa	14.10.09	219.55	1648.54089
Danger Water Level (221.70 M.)	09.01.09	220.35	2394.69957
Prediction Point		220.45	2500

Table-6: Water level and flooded areas as on different dates in year 2009 usingRADARSAT Satellite data for Sharda Nagar gauge station.

Stations	Dates	Water Level (In M.)	Flooded Area (Ha.)
Sharda Nagar	20.08.09	135.9	4662.42521
Danger Water Level(135.49)			

The IRS/AWiFS and RADARSAT Satellite data were used as flood layer for mapping of flood inundated areas. Since, RADARSAT satellite data has low spatial resolution than AWiFS data. Therefore small water bodies in the image could not be interpreted and the actual area of inundation could not be calculated accurately. Hence, the modeling of forecasting of flood inundated areas was mainly based on flood layer of AWiFS data. All the flood layers were mainly from RADARSAT satellite data but only the flood layer as on 9th Oct, 2009 and 14th Oct, 2009 were of AWiFS data. Water level and flooded areas as on different dates in year 2009 using IRS/AWiFS and RADARSAT Satellite data for each gauge station of *Sharda* Riveris shown inTable- 5 and Table- 6.

V. Conclusion

We have exclusively focused on forecasting model of flood inundated area along *Sharda* River in Uttar Pradesh. The satellite data of IRS-P6/AWiFS, IRS-P6/LISS-III and IRS-P6/PAN were used for mapping of catchment area of *Sharda* River in Nepal Region. The watershed boundary was also created around the river using editing tools by considering the direction of water flow. Three gauge stations of *Sharda* River were included in the study area. Flood inundation maps for three gauge stations of *Sharda* River were generated with the help of ArcGIS ver. 9.2. The flood inundation maps were prepared by spatial intersection of flood layers with district, block and village boundary layers and then integrated with water level at all gauge stations of *Sharda* river in Uttar Pradesh. Water levels at all gauge stations as on different dates from years 2007 to 2009 were used for predicting the area of flood inundation due to 10cm rise in water level. In downstream of Banbasa, Paliyakala, Sharda Nagar gauge stations, with 10cm rise in water level 105.30, 551.43, 510.03 hectares area will be affected, respectively.

The present study implies the application of GIS technologies to develop a model for forecasting of flood inundated areas. The importance of forecasting of flood inundated areas is widely recognized as a vital non structural measure to alert the people living near the banks of *Sharda* River about the coming flood. Flood forecasting systems are formulated for issuing the flood warning in order to prepare the evacuation plan during the flood. Loss of human life and property etc. can be reduced to a considerable extent by giving reliable advance information about the coming floods. The people could be moved to safer places in an organized manner as soon as the flood warnings are received. We conclude that the most heavily flood affected villagesat three gauge stations of *Sharda* River during year 2009 are: 13 villages of Puranpur Block of Pilibhit District downstream to Banbasa gauge station at 220.35m water level.22 villages of Nighasan Block of Lakhimpur-khiri District downstream to Paliyakala gauge station at 154.62m water level.26 villages of Behta Block of Sitapur District downstream to Sharda Nagar gauge station at 136.10m water level.

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Table-2: List of flood inundated villages along *Sharda* River in downstream of Banbasa at various water levels.

LIST OF FLOOD INUNDATED VILLAGES NEAR SHARDA RIVER IN DOWNSTREAM OF BANBASA AT VARIOUS WATER LEVELS

District Name	Block Name	Village Name	Village Area (ha	Flood Inundated area (ha.)	
				At water level 220.35m. (09th oct' 09)	At water level 219.55m. (14th oct' 09)
Pilibhit	Puranpur	Lagabhaga	5868116.51	0.80218	0.46556
		Bhoora Gorakh Dibbi	14209039.81	72.70576	82.96687
		Dhakia T. Maharajpur	8618803.08	92.04509	52.81463
		Ramnagra	16130129.69	121.95503	62.56779
		Singhara Urf Tatarganj	27523639.49	24.90431	17.65344
		Gunhan	5358130.05	65.27227	42.29237
		Bijauri Khurd Kalan	9998647.17	3.46757	17.70081
		Sampurna Nagar Range	30517552.88	101.40978	37.46527
		Birkhera T. Maharajpur	21191256.47	5.69557	No Flood Data
		Bailaha	54764331.76	176.10628	374.39955
		Chandia Hajara	35151730.70	189.08765	150.73243
		Ashok Nagar	6545434.88	27.54614	4.98548
		Shanti Nagar	3676307.29	0.13738	No Flood Data
		Murainia Gandhi Nagar	7188329.59	23.89587	No Flood Data
		Kabeerganj	25908613.19	113.66231	66.07193
		Rana Pratap Nagar	7358194.18	14.79707	No Flood Data
		Khirkia Bargadia	18667813.51	47.25818	107.48122
		Shree Nagar	5373418.06	9.77925	No Flood Data
		Bharatpur	4392104.70	No Flood Data	24.29863
		Binaura T.Gajraula	2381099.39	No Flood Data	19.59938
Lakhimpur-khiri	Palia	Govind Naga Colony	4771163.62	13.64592	7.55668
		Kamala Puri Colony	3085903.87	0.10327	No Flood Data
		Singahi Khurd	6675331.81	3.47336	No Flood Data
		Pallia Range	8332139.30	15.59355	22.29574
		Paduwa	4358116.91	6.76969	0.23259
		Niranjan Pur	4263440.50	69.11668	50.43153
		Pallia Range	4578061.14	131.19696	56.13725
		Pateda	1966614.14	4.15682	No Flood Data
		Dhaka	6012229.98	5.44450	No Flood Data
		Badaiya Khera	1530264.25	39.19324	No Flood Data
		Suhela	2374448.39	69.96409	4.39360
		Bagauwa	3177746.38	5.63775	No Flood Data
		Pakareya	3872528.86	42.15344	No Flood Data
		Maraucha	6584173.11	18.77989	0.76661
		Pallia Range	2324584.70	5.37277	No Flood Data
		Khairahana	4722812.73	43.62164	17.32481
		Nevadiya	2038667.73	33.75399	10.77907
		Madan Pur	1434504.07	No Flood Data	8.50757
	Bijua	Khamaria	12022313.27	117.37952	17.86530
		Newasi	7186030.69	194.39603	119.48866
		Girda	4620081.51	171.70831	84.78630
		Bebaha Ramuapur	9643574.74	94.75640	0.51351
		Nagaria	2508238.39	7.75177	0.33745
	Bankeyganj	F-1	101126155.93	210.20231	110.93933
	Bijua	Canp	16448582.67	No Flood Data	74.68953

Table-3: List of flood inundated villages along *Sharda* River in downstream of Paliyakala at various water levels.

LIST OF FLOOD INUNDATED VILLAGES NEAR SHARDA RIVER IN DOWNSTREAM OF PALIYAKALA AT VARIOUS WATER LEVELS						
District Name	**Block Name**	**Village Name**	**Village Area (ha.)**	**Flood Inundated area (ha.)**		
				At water level 154.72m. (20th aug' 09)	**At water level 154.62m. (09th oct' 09)**	**At water level 153.30m. (14th oct' 09)**
Lakhimpur-khiri	Palia	Maruwa Pasichim	7418238.41	24.38663	19.77849	7.49501
		Maleneya	4590036.11	7.44373	9.33561	2.41781
		Bela	7023577.43	14.09273	103.78049	67.01576
		Bejaureya	8283740.07	24.75075	90.11811	32.84070
		Babaura	4553885.52	14.16595	93.44881	27.42674
		F-11(P-1)	1483774.89	5.17953	11.89233	No Flood Data
		Maghagai	25487936.58	69.53058	176.05277	12.92364
		F-11(P-2)	4878438.64	23.60071	70.15576	No Flood Data
		Chauri	1703305.79	18.47475	41.39491	No Flood Data
		Nagla	7064791.89	No Flood Data	36.85212	No Flood Data
		Atareya	4765533.19	No Flood Data	54.11828	No Flood Data
		Shrinagar	5087675.82	No Flood Data	151.72871	47.54053
		Sarkhana Purab	4924469.56	No Flood Data	15.86468	No Flood Data
		Patwara	5916973.92	No Flood Data	19.56991	No Flood Data
		Gori Fanta	2033998.92	No Flood Data	1.99582	No Flood Data
		Trilok Pur	5887432.25	No Flood Data	4.39156	No Flood Data
	Nighasan	Ballipur	6649039.84	0.15393	3.44653	No Flood Data
		Ganga Behad	9281931.32	1.16024	No Flood Data	No Flood Data
		Murgaha	10044313.55	158.14241	335.55349	No Flood Data
		Daulat Pur	17574212.46	65.29566	126.21794	No Flood Data
		F-11(P-6)	1740425.42	56.58140	82.85102	No Flood Data
		Lodhauri	39784166.74	187.85308	466.01380	162.98889
		F-11(P-5)	7048397.18	105.24728	246.69710	No Flood Data
		Dubha	12335296.81	6.31515	22.91556	No Flood Data
		Lalboghi	5774052.85	31.01037	120.69649	No Flood Data
		Madan Pur	8614368.06	8.96659	43.67581	18.85140
		Dakshini Nighasan	460876.82	8.17083	19.17606	11.80140
		Khamereya	4726243.71	4.03915	0.71344	22.97030
		Bailaha	14877067.96	47.45726	148.88805	21.16705
		Lauki	4764041.16	4.28516	74.82819	74.46211
		Dhundhela	4131474.17	27.54553	152.78380	81.01857
		Garnt No12	14733171.89	75.58859	277.59382	42.82952
		Adalabad	3127896.11	3.08927	No Flood Data	No Flood Data
		Dakshini Nighasan	1278756.33	5.49713	1.02596	No Flood Data
		Sauna Kalan	3067075.56	11.07328	20.73499	No Flood Data
		Chedui Pateya	9604884.61	No Flood Data	13.82391	No Flood Data
		Lalpur	8604475.95	No Flood Data	118.85678	No Flood Data
		Ambari	5265488.82	No Flood Data	43.06596	43.67890
		Sonaripur	3934317.09	No Flood Data	71.74084	No Flood Data
		Dakshini Nighasan	3941965.43	No Flood Data	21.72964	18.34296
		Pahar Pur	7793518.63	No Flood Data	239.25707	160.62323
		Mahadev Muriya	9890027.01	No Flood Data	183.20627	189.76167
		Tegnaheya	1782799.20	No Flood Data	36.46907	14.69407
	Phulbehar	Baragaon	7039165.84	19.20189	234.28524	No Flood Data
		Basha Bhoor	4261842.48	No Flood Data	36.24788	No Flood Data
		Sisoura	5895956.11	No Flood Data	30.77544	No Flood Data
		Shrinagar	8583865.20	No Flood Data	13.71439	No Flood Data
		Baroula	6809718.26	No Flood Data	14.92895	No Flood Data
	Bijua	Kunwar,Pur Kalan	13138560.44	69.93789	427.87695	95.86531
		Khaira	8599790.89	62.69417	97.59051	No Flood Data
		Ramnagar Kalan	17646233.35	18.47579	22.17375	0.26045
		Chandpura	7357988.13	2.98899	56.22330	No Flood Data
		Benipur	7019643.34	60.75774	130.60572	No Flood Data
		Karsaur	3721104.33	7.71976	14.43854	No Flood Data
		Jungle No9	3568565.61	46.42559	82.17954	10.87417
		Rurasultanpur	2980380.87	27.27463	42.85298	5.32744
		Seghia	1556458.58	56.98161	108.38357	0.79297
		Gujara	2639410.84	18.38845	36.18391	No Flood Data
		Mehdi	3419145.66	43.38018	144.16811	No Flood Data
		Bebaha Ramuapur	9643574.74	No Flood Data	38.14308	No Flood Data
		Baruwa Kalan	4609200.34	No Flood Data	56.38288	No Flood Data
		Nagaria	2508238.39	No Flood Data	95.66115	0.17117
		Daulat Pur	5520633.01	No Flood Data	185.67272	120.35829
		Majhoura	3437871.43	No Flood Data	17.75667	7.69828
		Shahpur	25786265.64	No Flood Data	342.15000	113.71467
		Jungle No6	2124361.04	No Flood Data	30.23910	0.17117
		Jungle No5	4448013.79	No Flood Data	16.30811	No Flood Data
		Pipariya Bhoor	9310335.52	No Flood Data	0.19317	No Flood Data
		Mataihiya	5598172.20	No Flood Data	2.97915	No Flood Data
		Jumgle No7	5007221.46	No Flood Data	26.42663	26.93901
		Kunwarpur Khurd	4881835.48	No Flood Data	0.02732	13.01007
		Gonha	6875744.16	No Flood Data	27.44496	No Flood Data
		Rameshara Pur	7141488.32	No Flood Data	No Flood Data	10.73733
		Jungle No 8	5172696.496	No Flood Data	7.06972	No Flood Data
		Musaypur	4764851.215	No Flood Data	32.5453	No Flood Data
		Belwa Sikatiya	5103181.418	No Flood Data	25.07285	No Flood Data
		Jamhora	5496333.055	No Flood Data	5.19663	No Flood Data
		Bharguda	2612642.77	No Flood Data	74.23354	No Flood Data

Table -4: List of flood inundated villages along *Sharda* River in downstream of Sharda Nagar at various water levels.

	Rampur Mathura	Dahaldhaurara	3144013.55	77.33285	109.34425	No Flood Data
		Bagasti	4617138.68	188.97678	222.79027	21.11574
		Bariyarpur	5682966.17	59.98639	265.12521	No Flood Data
		Terwamanikapur	4658676.17	134.31243	279.75420	No Flood Data
		Afsarya Husainpur	5549715.12	309.85089	468.27834	24.13235
		Shukulauporwa	15101253.52	849.03255	1290.92957	285.38954
		Mathura	4723875.73	38.20621	285.18501	No Flood Data
		Nausera	1705605.30	53.99935	101.69255	No Flood Data
		Pararamnagar	2559602.87	64.28140	174.88447	No Flood Data
		Keora	4391723.40	228.26092	365.10018	14.91295
		Basantpur	2347342.48	81.96329	170.08093	No Flood Data
		Puraina	2481565.08	97.51305	126.87102	54.93577
		Jankinagar	3142438.61	5.62895	107.38132	No Flood Data
		Khanewa Mitaura	7425088.50	206.93751	409.16889	No Flood Data
		Sonarakhi	20613773.42	436.27152	671.37407	228.66169
		Soharia	4801512.46	172.30726	371.67069	No Flood Data
		Kanarkhi	6712122.38	316.34345	514.41668	0.71896
		Rampur	3137469.49	11.36181	142.44146	No Flood Data
		Angaraura	10616766.12	219.54376	562.90955	No Flood Data
		Ataura	3796743.82	2.01516	34.46145	No Flood Data
		Akhari	4378462.46	51.31211	142.19866	No Flood Data
		Tulsipur Banjar	4109352.13	4.00332	66.13697	No Flood Data
		Goahdih	3098782.10	22.94224	62.63984	No Flood Data
		Kaluwapur	2154582.65	13.89407	33.52777	No Flood Data
		Rajapur Israuli	3266200.55	No Flood Data	150.90556	No Flood Data
		Dhamaura	4241035.20	No Flood Data	0.15680	No Flood Data
		Bela	1896266.79	No Flood Data	47.63350	No Flood Data
		Kodahi	1292326.05	No Flood Data	20.08288	No Flood Data
		Chhatauni	8017742.59	No Flood Data	214.35627	No Flood Data
		Deshilaukiya	6170820.22	No Flood Data	154.05842	No Flood Data
		Jairampur	6671035.30	No Flood Data	108.09759	No Flood Data
		Tulsipur Kharika	2958500.50	No Flood Data	34.17544	No Flood Data
		Surjanpur	3695672.99	No Flood Data	0.10817	No Flood Data
		Tikatha	3999421.94	No Flood Data	3.28275	No Flood Data
		Tulapur	29189773.46	453.11267	541.30825	241.78651
	Suratganj	Khujhi	2527621.77	83.55990	108.64211	13.60458
Barabanki		Jamka	3337583.67	0.17310	0.24504	No Flood Data
		Sarkanda	4603465.48	0.42211	0.02151	No Flood Data
		Kanchnapur	919779.18	No Flood Data	1.58340	No Flood Data
	Phakharpur	Bhauri	13941184.61	210.91544	305.94518	143.29396
Bahraich		Sipahiya Hulas	5663890.36	2.42241	6.24271	1.09964
		Majhara Tawkali	37643091.14	32.10812	94.23830	16.66622
	Isanagar	Hardaspur	4624515.64	0.80224	No Flood Data	No Flood Data
		Gaur Chaukhdia	4677742.16	No Flood Data	2.81899	4.90525
		Bareti	6264604.36	No Flood Data	51.17880	39.86739
		Harkhee Behar	974321.03	No Flood Data	39.35956	13.92165
		Belwa Gauhaniya	4452866.48	No Flood Data	9.87855	1.13872
		Chandi	3703171.34	No Flood Data	60.78246	59.15839
		Ahirori Semariya	3827399.30	No Flood Data	74.52094	71.77297
		Mahasi	2195131.31	No Flood Data	3.45499	No Flood Data
		Ramuwapur	1974217.44	No Flood Data	11.45856	0.00301
		Budhnapur	2072949.61	No Flood Data	3.27756	No Flood Data
		Parvatpur	4577798.63	No Flood Data	10.20656	No Flood Data
		Salarpur	1377905.20	No Flood Data	25.26580	No Flood Data
		Mugalpur	4080283.98	No Flood Data	34.95147	No Flood Data
		Kodri	2134024.86	No Flood Data	54.07834	No Flood Data
		Pinduria	3868338.40	No Flood Data	13.00058	No Flood Data
		Samolia	2370673.07	No Flood Data	42.79868	No Flood Data
		Muri Khera	1556555.26	No Flood Data	9.99947	No Flood Data
		Gadausa	5540066.34	No Flood Data	13.16977	No Flood Data
		Rihar	6779619.71	No Flood Data	5.88723	No Flood Data
		Matua Saraia	2846186.13	No Flood Data	69.01686	No Flood Data
		Ram Rura	3131993.20	No Flood Data	132.24762	No Flood Data
		Saraiya	619170.43	No Flood Data	12.81341	No Flood Data
		Supauli	2234254.68	No Flood Data	0.52095	No Flood Data
		Kadbada	2087008.84	No Flood Data	36.87619	No Flood Data
		Kaima Klan	1548181.28	No Flood Data	14.88430	No Flood Data
		Dhanpuria	1867068.77	No Flood Data	20.99908	No Flood Data
		Karmoodih	1179955.51	No Flood Data	18.35796	No Flood Data
		Patauli	4314855.61	No Flood Data	70.20968	No Flood Data
		Lakhanapur	4066261.18	No Flood Data	1.68935	No Flood Data
		Sidkira	1961597.71	No Flood Data	2.67713	No Flood Data
		Samaudi Dih	7351453.91	No Flood Data	No Flood Data	35.71480
		Gurela	3202171.49	No Flood Data	No Flood Data	9.65364
		Sonsari	2044130.68	No Flood Data	No Flood Data	0.12306
	Reusa	Shankarpur Jhishni	6042778.75	1.30603	3.12941	No Flood Data
		Thora	9058971.24	No Flood Data	9.80640	No Flood Data
		Thangaon	5210476.64	No Flood Data	22.67570	No Flood Data
		Naseerpur Dewariya	6256984.65	No Flood Data	227.50922	No Flood Data
		Manpur	2680283.60	33.67627	98.70375	No Flood Data
		Eteya Bhatpura	357818.95	25.31047	27.38651	No Flood Data
	Sakran	Khajura	3520047.22	No Flood Data	64.89601	No Flood Data
		Dugana	4761882.59	No Flood Data	0.11754	No Flood Data
		Gagalapur	609783.38	No Flood Data	6.91543	No Flood Data
		Kalli	3934000.53	No Flood Data	15.03702	No Flood Data
		Chiliha	1604999.96	No Flood Data	8.82207	No Flood Data