

FLOOD HAZARD ATLAS for Assam State

- A Geospatial Approach



nrsc

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The cover page shows the Indian Remote Sensing (IRS) Satellite data acquired over Assam State prior to floods (top image), during floods IRS data (middle image) and microwave satellite data (bottom image).

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15.	Abstract (with Keywords): Flood hazard zonation is one of the important initiatives towards flood risk reduction. Satellite remote sensing helps in identifying the flood inundated areas. This observed information over years further helps in identifying the frequently flood affected areas. In this approach, 10 years (1998-2007) of satellite data from Indian and foreign satellites was used in identifying the flood hazard zones based on frequency of flood inundation. The flood hazard is categorised into 5 classes, i.e., very high, high, moderate, low and very low based on the frequency of inundation. This atlas can help in understanding the flood problem in various districts of Assam State and help the planners accordingly.				

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FOREWORD

Flood is a major disaster recurrently being faced by India and causes huge loss to lives, livelihood and infrastructure. Assam State, a land of high rainfall and mighty river system, is one of the most flood-affected States in India. Identification of the flood-prone areas and the risk associated with each area offer significant cue for the planners for devising area-specific mitigation measures. Satellite Remote Sensing data provides information on actual flood inundation for different magnitudes of floods and various other land information which could be used for delineating the flood hazard zones.

Under the Disaster Management Support (DMS) Programme of Indian Space Research Organisation (ISRO), National Remote Sensing Centre (NRSC) has been generating flood inundation maps using satellite data for all major flood events occurred in the country for more than a decade, and the information has been provided to the State Relief/Disaster Management Departments. This has enabled generation of reliable database on flood inundation pattern.

The database generated over the past 10 years (1998-2007), provides the spatial extent of flood inundation and frequency of occurrence which are used to generate the flood hazard maps. It is estimated that about 2.2 million hectares in Assam state is affected by floods at least once during last 10 years, and about 0.13 million hectares of area gets inundated every year.

I am sure, the information provided in the atlas will be of great use for Government of Assam in flood risk assessment, planning and implementing necessary long-term mitigation measures for minimizing the impact of the flood disaster in Assam State.

Bangalore
09-04-2011

(K. Radhakrishnan)

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VK Dadhwal
Director



PREFACE

Flood is the one of the major natural disasters in India that occurs with an unfailing regularity. It is estimated that on an average almost 40 mha of India gets affected by floods every year, bringing misery to the community living in those floodplains. Several agencies, such as the Central Water Commission (CWC), the Building Materials and Technology Promotion Council (BMTPC), and the National Atlas and Thematic Mapping Organisation (NATMO) as part of their activity, have brought out Atlases reflecting the flood-hazards such as Flood Atlas of India, Vulnerability Atlas of India and Natural Hazard Map of India.

Department of Space (DOS), as the nodal agency for National Natural Resources Management System (NNRMS), has launched a major Disaster Management Support Programme (DMSP) with NRSC as the single window delivery mechanism for providing near-real time products and services using satellite remote sensing data for various phases of disaster management. Preparation of flood inundation maps and assessment of damages has been an ongoing operational activity for more than a decade, thus, enabling creation of reliable, long term database on flood hazards and associated risks.

With above long term database, National Remote Sensing Centre (NRSC), ISRO has prepared the flood hazard maps for Assam State using satellite remote sensing data sets, as Assam is one of the most flood affected States in the country. About 100 Indian Remote Sensing (IRS) Satellite and foreign satellite datasets, spanning over 10 years from 1998 to 2007, acquired during different flood magnitudes in Assam have been used to create the flood hazard maps. Spatial extent of flood inundation and the frequency of flooding in a given area, which are the crucial parameters for hazard assessment, are derived from the satellite data sets. The hazard zones are categorized into five classes ranging from very low hazard zone to very high hazard zone. To ensure effective utilization of the information, the hazard maps prepared from satellite data were peer reviewed by a Committee constituted by National Disaster Management Authority (NDMA). The maps have been field verified by the respective district administrations of Government of Assam. For better utilization and visualization of the information, a web enabled application has also been developed for the Flood Hazard Atlas of Assam State and will be made available at Assam State Disaster Management Authority (ASDMA).

I am sure that information on flood hazard derived from space datasets will be useful to Government of Assam in taking appropriate mitigation of flood disasters, people and academicians.

Hyderabad
27-06-2011

VK Dadhwal
(VK Dadhwal)
DIRECTOR

**Tarun Gogoi****Chief Minister, Assam
Guwahati**Dispur,
5th March, 2011

MESSAGE

I am very happy to know that National Remote Sensing Center, Hyderabad, in association with National Disaster Management Authority, New Delhi and Assam Disaster Management Authority has prepared the Flood Hazard Atlas for the State of Assam.

Assam is a highly flood prone area with more than 40% of its land surface susceptible to flood damage. Due to a variety of reasons, the extent of damage caused by floods has significantly increased over the recent years. The flood Hazard Atlas would, therefore, help the State Government to formulate an appropriate strategy for tackling and mitigating floods.

I compliment all those who have been associated with the preparation of the Atlas.

(TARUN GOGOI)



**Vice Chairman
National Disaster Management Authority
Government of India**

MESSAGE

With a vision to build a safer and disaster resilient India through a holistic proactive and technology-driven approach for disaster management (DM), National Disaster Management Authority (NDMA) has initiated various programmes to induct science and technology (S&T) in DM in the country. One such important initiative is to develop upgraded hazard profiles of various natural hazards (for their subsequent use in vulnerability and risk assessment work). Flood is one of the most frequent disaster that affects our economy very badly. Information of the flood hazard profile at a reasonably large scale is not available for planning necessary mitigation measures by concerned State Government.

The initiatives of Indian Space Research Organisation (ISRO) to utilize Space based technology for DM in the country are commendable. Accordingly the Working Committee of Experts constituted by NDMA decided to prepare the flood hazard map for the State of Assam on priority, utilizing the scientific inputs from the various Stake Holders and the actual observation data of flood inundation areas of Assam collected over the past 10 years by the National Remote Sensing Centre (NRSC) as a major step forward in NDMA's initiative to induct S&T for Disaster Management.

I am sure the Flood Hazard Atlas prepared by NRSC & ISRO utilizing the space based data would provide the much needed information for effective and better management of flood hazard in the State of Assam.

25 March 2011


(M. SHASHIDHAR REDDY)



आर. सी. झा
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MESSAGE

It is a matter of great pleasure that apex National Institutes including Indian Space Research Organization, National Disaster Management Authority, Central Water Commission and National Remote Sensing Centre have joined hands with the State Government of Assam to bring out the first Flood Hazard Atlas for Assam State based on satellite data/map. Flood is a regular, almost annual, phenomenon in the State of Assam causing enumerable damages to lives and properties. This is a well thought of effort and would add a new, effective, transparent and objective dimension in flood and disaster management in the country.

This Atlas, I believe, would not only help in effective flood management but also be a great help in post-flood activities particularly related to damage assessment and flood relief. Concept of hazard index would provide a tool to policy and decision makers to give due attention to the severely affected areas/districts. I am sure that the Atlas would be used by the people at large and their suggestions would be duly incorporated while attempting similar work for other States/areas.

I congratulate the team responsible for this pioneer work.

(R.C.JHA)
Member, River Management,
Central Water Commission.

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We are also grateful to Dr. V K Dadhwal, Director, NRSC for his constant encouragement and guidance and for providing necessary facilities during the execution of the project.

Thanks are also due to Dr. V. Jayaraman, Former Director, NRSC for his overall guidance, constant supervision and enthusiastic support during various phases of carrying out the project.

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Thanks are due to the Members of the Editorial Board Committee represented by Assam Disaster Management Authority (ASDMA), Government of Assam, National Disaster Management Authority (NDMA), Central Water Commission (CWC) and Indian Space Research Organisation (ISRO) for ensuring validation of the maps and content besides their active involvement in finalising the atlas.

Finally all the individuals of NRSC who are involved either directly or indirectly in completion of this task are duly acknowledged.

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1.0 INTRODUCTION

1.1 FLOOD AND ITS SEVERITY

Flood is one of the most severe disasters affecting the people across the globe. India is the worst flood-affected country in the world after Bangladesh and accounts for one-fifth of global death count due to floods. Nearly 75 per cent of the total Indian rainfall is concentrated over a short monsoon season of four months (June-September). As a result, the rivers witness a heavy discharge during these months, leading to widespread floods. About 40 million hectares of land in the country is liable to floods according to National Flood Commission, and an average of 18.6 million hectares of land is affected annually. Table-1 shows the extent of flood damages incurred during 1953-2005 in India. The annual average cropped area affected is approximately 3.7 million hectares. The most flood-prone areas in the country are the Brahmaputra, Ganga and Meghna River basins in the North and North-east India. These rivers carry 60 per cent of the nation's total river flow. The other flood prone areas are the west flowing rivers such as the Narmada and Tapti in the north-west region; east flowing rivers like Mahanadi, Godavari, Krishna and Cauvery in the Central India and the Deccan region.

There are several causative factors for flooding. Inadequate capacity of the rivers to contain the high flows brought down from the upper catchment due to heavy rainfall, leads to flooding. Area having poor drainage characteristic gets flooded by accumulation of water from heavy rainfall. Excess irrigation water applied to command area and increase in ground water level due to seepage from canals and irrigated field accentuate the problem of water logging. Flooding is accentuated by erosion and silting of the riverbeds resulting in reduction of carrying capacity of river channel, leading to changes in river courses & obstructions to flow due to landslides, synchronization of floods in the main and tributary rivers and retardation due to tidal effects. With the increase in population and developmental activity, there has been tendency to occupy the flood plains, which has resulted in more serious nature of damage over the years. Because of the varying rainfall distribution, many a times, areas which are not traditionally prone to floods also experience severe inundation. Floods have different dimensions, inundation due to spills over the banks, drainage congestion due to poor drainage characteristics, erosion due to change in river course. Fig. 1 shows a typical flood situation.



Fig 1 Field photograph showing flood situation

Table-1: The extent of flood damages incurred during 1953-2005 in India

			Human live lost Nos.	Damage to Crops		Damage to Houses		Cattle Lost Nos.	Human Live Lost Nos.	Damage to Public Utilities in Rs.Crore	Total damages Crops, Houses and public utilities in Rs.Crores (6+8+11)
Sl.No (1)	Year (2)	Area in Mha. (3)	Population afected in million (4)	Area in Mha. (5)	Value in Rupees Crore (6)	Nos. (7)	Value in Rs.Crore (8)	(9)	(10)	(11)	
1	1953	2.290	24.280	0.930	42.080	264924	7.420	47034	37	2.900	52.400
2	1954	7.490	12.920	2.610	40.520	199984	6.561	22552	279	10.150	57.231
3	1955	9.440	25.270	5.310	77.800	1666789	20.945	72010	865	3.980	102.725
4	1956	9.240	14.570	1.110	44.440	725776	8.047	16108	462	1.140	53.627
5	1957	4.860	6.760	0.450	14.120	318149	4.979	7433	352	4.270	23.369
6	1958	6.260	10.980	1.400	38.280	382251	3.896	18439	389	1.790	43.966
7	1959	5.770	14.520	1.540	56.760	648821	9.418	72691	619	20.020	86.198
8	1960	7.530	8.350	2.270	42.550	609884	14.309	13908	510	6.310	63.169
9	1961	6.560	9.260	1.970	24.040	533465	0.889	15916	1374	6.440	31.369
10	1962	6.120	15.460	3.390	83.180	513785	10.655	37633	348	1.050	94.885
11	1963	3.490	10.930	2.050	30.170	420554	3.701	4572	432	2.740	36.611
12	1964	4.900	13.780	2.490	56.870	255558	4.588	4956	690	5.149	66.607
13	1965	1.460	3.610	0.270	5.870	112957	0.195	7286	79	1.070	7.135
14	1966	4.4740	14.400	2.160	80.150	217269	2.544	9071	180	5.736	88.430
15	1967	7.120	20.460	3.270	133.310	567995	14.264	5827	355	7.857	155.431
16	1968	7.150	21.170	2.620	144.610	682704	41.112	1303305	3497	25.373	211.095
17	1969	6.200	33.220	2.910	281.900	1268660	54.423	270328	1408	68.112	404.435
18	1970	8.460	31.830	4.910	162.780	1434030	48.606	19198	1076	76.441	287.827
19	1971	13.250	59.740	6.240	423.130	2428031	80.241	12866	994	129.113	632.484
20	1972	4.100	26.690	2.450	98.560	897301	12.460	58231	544	47.174	158.194
21	1973	11.790	64.080	3.730	428.030	869797	52.482	261016	1349	88.489	569.001
22	1974	6.700	29.450	3.330	411.640	746709	72.434	16846	387	84.842	569.016
23	1975	6.170	31.360	3.850	271.490	803705	34.097	17345	686	166.050	471.637
24	1976	11.910	50.460	6.040	595.030	1745501	92.160	80062	1373	201.495	888.685
25	1977	11.460	49.430	6.840	720.610	1661625	152.290	556326	11316	328.948	1201.848
26	1978	17.500	70.450	9.960	911.090	3507542	165.574	239174	3396	376.100	1454.764
27	1979	3.990	19.520	2.170	169.970	1328712	210.606	618248	3637	233.627	614.203
28	1980	11.460	54.120	5.550	366.370	2533142	170.851	59173	1913	303.283	840.504
29	1981	6.120	32.490	3.270	524.560	912557	159.630	82248	1376	512.314	1196.504
30	1982	8.870	56.010	5.000	589.400	2397365	383.869	246750	1573	671.607	1644.876
31	1983	9.020	61.030	3.290	1285.850	2393722	332.327	153095	2378	873.429	2491.606
32	1984	10.710	54.550	5.190	906.090	1763603	181.308	141314	1661	818.164	1905.562
33	1985	8.380	59.590	4.650	1425.370	2449878	583.855	43008	1804	2050.043	4059.268
34	1986	8.810	55.500	4.580	1231.580	2049277	534.410	60450	1200	1982.535	3748.525
35	1987	8.890	48.340	4.940	1154.640	2919380	464.490	128638	1835	950.590	2569.720
36	1988	16.290	59.550	10.150	2510.900	2276533	741.600	150996	4252	1377.800	4630.300
37	1989	8.060	34.150	3.010	956.740	782340	149.820	75176	1718	1298.770	2405.330
38	1990	9.303	40.259	3.179	695.610	1019930	213.733	134154	1855	455.266	1708.920
39	1991	6.357	33.889	2.698	579.015	1134410	180.421	41090	1187	728.893	1488.329
40	1992	2.645	19.256	1.748	1025.578	687489	306.284	78669	1533	2010.670	3344.532
41	1993	11.439	30.409	3.206	1308.627	1926049	528.324	211193	2864	1445.534	3282.485
42	1994	4.805	27.548	3.963	888.622	914664	165.206	52315	2078	740.762	1794.590
43	1995	5.245	35.932	3.245	1714.787	2001898	1307.894	62438	1814	679.627	3702.308
44	1996	8.049	44.729	3.827	1124.491	726799	176.589	73208	1803	861.393	3005.743
45	1997	4.569	29.663	2.258	692.743	505128	152.504	27754	1402	1985.934	2831.181
46	1998	10.845	47.435	7.495	2594.167	1932874	1108.783	107098	2889	5157.771	8860.721
47	1999	7.765	27.993	1.753	1850.873	1613260	1299.057	91289	745	462.830	3612.760
48	2000	5.382	45.013	3.580	4246.622	2628855	680.943	123252	2606	3936.979	8864.544
49	2001	6.175	26.463	3.964	688.481	716187	816.474	32704	1444	5604.461	7109.416
50	2002	7.090	26.323	2.194	913.092	762492	599.368	21533	1001	1062.083	2574.543
51	2003	6.503	34.466	3.426	1424.826	846920	802.929	16425	1864	2206.599	4434.354
52	2004	8.031	34.215	2.693	615.070	1492814	852.655	63869	1275	1868.866	3336.591
53	2005	3.376	29.684	2.24	958.266	349624	316.954	113226	1503	1546.935	2822.155

(Source: Report of the working Group on Water Resources For the XI Five year plan (2007-2012), Annex-2.9, Page: 136, Govt. of India, Ministry of Water Resources)

1.2 MANAGING FLOODS

In order to mitigate the impact of floods, appropriate flood management measures have to be implemented. These measures can be classified into

1. Structural measures
2. Non-structural measures

Structural Measures: In this approach physical structures are envisaged to prevent the flood waters from reaching potential damage regions. The main structural measures undertaken so far in India are as follows.

1. Embankments, Floodwalls, Flood levees
2. Dams and Reservoirs
3. Natural Detention Basin
4. Channel Improvement
5. Drainage Improvement
6. Diversion of flood water
7. Catchment area treatment/ afforestation
8. Anti-erosion works

In India, systematic planning for flood management commenced with the Five Year Plans, particularly with the launching of National Program of Flood Management in 1954. During the last 48 years, different methods of flood protection, structural as well as non-structural have been adopted in different states depending upon the nature of the problem and local conditions. The various flood management measures undertaken through the successive five year plans are summarized in Table-2.

Table-2: Structural flood management measures undertaken during various five year plans

S No	Type of Flood Control Works	Extent
1	Flood Embankments	34397.61 km
2	Drainage Channels	51317.50 km
3	Town protection works	2400 Nos.
4	Villages raised.	4721 Nos.

(Source: Ministry of Water Resources: <http://mowr.gov.in/index3.asp>)

Reservoirs constructed with exclusive flood control storage include Maithon, Panchet, Tilaiya and Konar in Damodar Valley; Chandil dam on Subarnarekha river, Hirakud dam on Mahanadi river and Rengali dam on Brahmani river. In addition, a live storage of 177 billion cubic meters created so far in the various reservoirs for irrigation, hydropower generation, drinking water etc. also help in reducing flood intensity by storing part of the flood waters in them. The flood management measures undertaken so far have provided reasonable degree of protection to an area of 15.81 million hectares through out the country. State-wise break-up of the flood control works undertaken in are provided in Table-3.

Non-Structural Measures: Non-structural measures strive to keep the people away from floodwater. It contemplates use of floodplains judiciously. This technique allows the use of floodplains by reducing the disaster dimension, while retaining its beneficial needs. Following are the main non-structural measures

1. Flood forecasting and warning
2. Flood Hazard Zoning
3. Flood Proofing
4. Regulation of reservoirs
5. Flood Insurance

Towards non-structural flood management measure, Central Water Commission (CWC) has established flood forecasting system comprising 175 stations on all major rivers in the country and is implementing the scheme for its modernization and expansion.

Table-3: State-wise break-up of the flood control works

Sl.No	Name of State	Area benefited (Mha)	Length of embankment (Km)	Length of Drainage channel (Km)	Town/village protected (Nos.)	Villages on raised/ protected (Nos.)
1	Andhra Pradesh	1.0350	2600.58	17071.00	72	23
2	Arunachal Pradesh	0.0033	6.93	8.50	18	22
3	Assam	1.6361	4458.60	850.69	681	0
4	Bihar	2.9490	3454.00	365.00	47	0
5	Chhattisgarh	Included in M.P.				
6	Delhi(NCT)	0.0780	83.00	453.00	0	0
7	Goa	0.0030	17.07	31.77	2	0
8	Gujarat	0.4827	104.12	271.00	805	30
9	Haryana	2.0000	1144.00	4385.00	448	98
10	Himachal Pradesh	0.0097	58.00	11.00	0	0
11	Jammu & Kashmir	0.2173	230.00	14.00	12	5
12	Jharkhand	0.0002	3.49	0.00	2	5
13	Karnataka	0.0048	73.52	10.00	30	0
14	Kerala	0.0555	116.70	29.55	4	6
15	Madhya Pradesh	0.0040	26.00	0.00	37	0
16	Maharashtra	0.0010	44.50	110.00	0	0
17	Manipur	0.1300	360.00	126.00	1	1
18	Meghalaya	0.0011	112.00	0.00	8	2
19	Mizoram	0.0000	0.00	0.00	0	0
20	Nagaland	0.0000	0.00	0.00	0	0
21	Orissa	0.6300	6541.00	131.00	29	14
22	Punjab	3.1900	1370.00	6622.00	3	0
23	Rajasthan	0.0816	145.00	197.00	25	0
24	Sikkim	0.0020	7.00	12.00	6	0
25	Tamil Nadu	0.1220	87.00	19.00	46	4
26	Tripura	0.0261	133.30	94.00	11	0
27	Uttar Pradesh	1.5888	2810.00	13357.00	65	4511
28	Uttaranchal	Included in Uttar Pradesh				
29	West Bengal	2.2005	10350.00	7129.00	48	0
30	A & N Islands	0.0000	0.00	0.00	0	0
31	Chandigarh	0.0000	0.00	0.00	0	0
32	Dadra & Nagar Haveli	0.0000	0.00	0.00	0	0
33	Daman & Diu	0.0000	0.00	0.00	0	0
34	Lakshadweep	0.0000	0.00	0.00	0	0
35	Pondicherry	0.0040	61.00	20.00	0	0
	Total	16.4557	34397.61	51317.51	2400	4721
(Source: Ministry of Water Resources ; http://mowr.gov.in/writereaddata/linkimages/state9743650818.pdf)						

Flood hazard zonation (FHZ) is another most important non-structural measures, which facilitates appropriate regulation, and development of floodplains thereby reducing the flood impact. The recurrent flood events at frequent intervals demand the need for identification of flood hazard prone areas for prioritizing appropriate flood control measures. In this context, satellite remote sensing plays an important role in delineating such flood hazard zones.

1.3 REMOTE SENSING FOR FLOOD MANAGEMENT

Satellite remote sensing technology has made substantial contribution in every aspect of flood disaster management such as preparedness, relief and mitigation. Space systems from their vantage position have unambiguously demonstrated their capability in providing vital information and services for flood management. The Earth Observation satellites provide comprehensive, synoptic and multi temporal coverage of large areas in real time and at frequent intervals and thus have become valuable for continuous monitoring of floods. In case of persistent cloud cover situation, microwave satellites, which has got all weather capability can be used for identifying the extent of flood inundation. Table-4 provides list of satellites and sensors used for flood management in India. During last two decades satellite remote sensing has been operationally used for flood disaster management in India. Fig 2&3 show the pre-flood and during-flood IRS satellite data over Assam. Blue colour indicates the water, while red colour indicates vegetation and white colour indicates cloud cover, in these images.

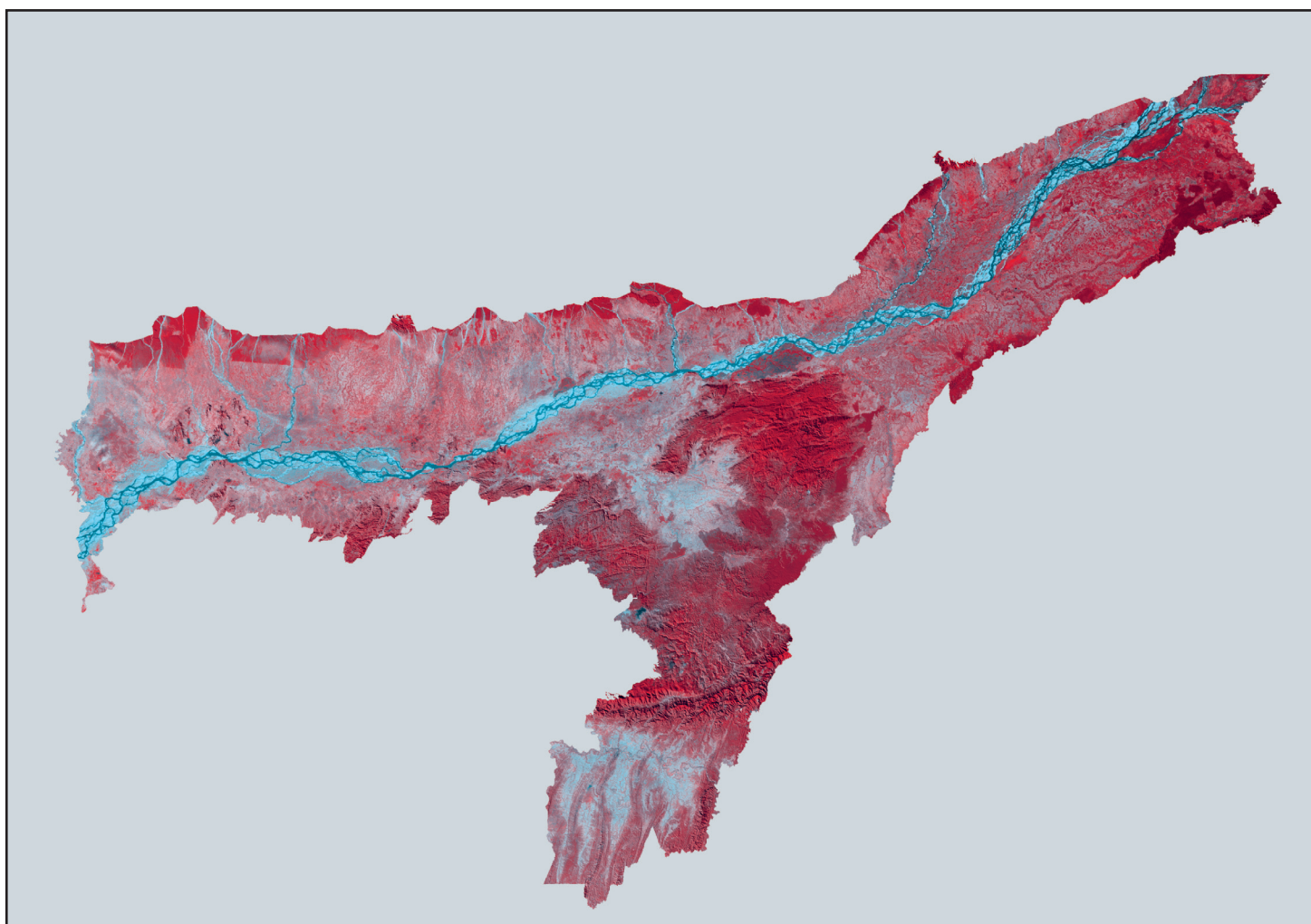


Fig 2 : IRS satellite image showing the pre-flood situation in Assam state

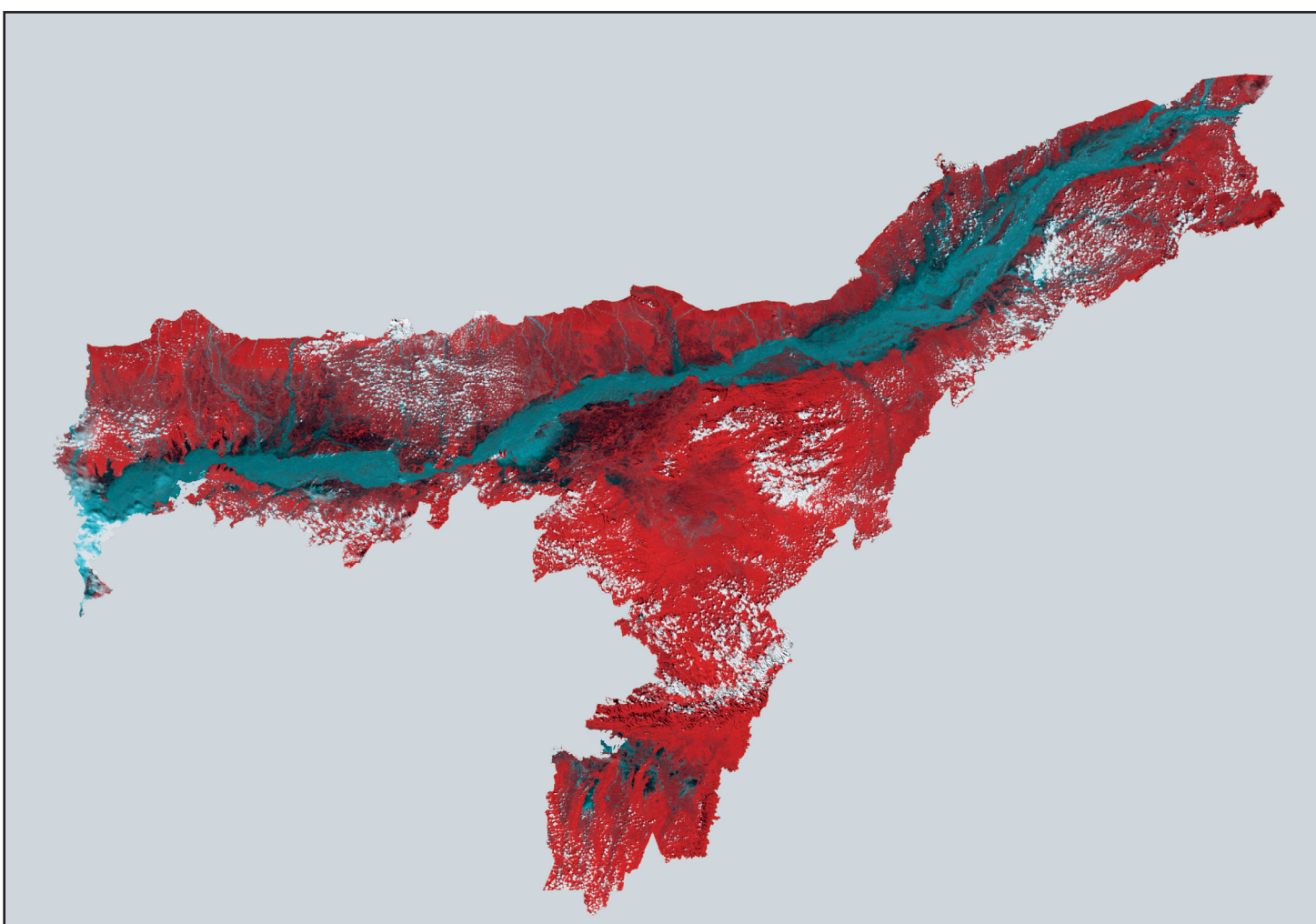


Fig 3 : IRS satellite image showing the flood situation in Assam state

Table-4 Satellites and sensors for flood management

SNo	Satellite	Sensor	Spatial Resolution
1	IRS-1C & 1D	WiFS	188 m
		LISS-III	23.5 m
		PAN	5.8 m
2	ResourceSat-1	AWiFS	56 m
		LISS-III	23.5 m
		PAN/L4-MX	5.8 m
3	CartoSat-1 & 2	PAN	2.5/1 m
4	RADARSAT	SAR	100/50 m

The potential use of remote sensing technology for flood disaster management can be as follows:

- Flood inundation mapping and monitoring
- Rapid Damage Assessment
- Monitoring and mapping of flood control works and changes in the river course
- Identification of river bank erosion
- Identification of chronic flood prone areas
- Improvement in flood forecasting & warning models

Conventional flood hazard mapping techniques use historical flood data to map floodplains. In addition to a record of peak flows over a period of years, a detailed survey (cross sections, slopes and close contour maps), maps such as soils, physiography, land use, vegetation, population density, infrastructure, and settlements along with hydraulic roughness estimates is required before the extent of flooding for an expected recurrence interval can be determined. Some of the data required for hazard mapping is difficult to obtain from ground measurements and time consuming. FHZ map requires mainly flow information and fine resolution Digital Elevation Model (DEM) to model. However, fine resolution DEM is not easily available for most of the floodplains. With these constraints it is difficult to prepare FHZ maps conventionally. In this context, the Earth Observation Satellites provide the extent of flooding for major flood events at regular intervals, which helps in identifying frequently inundated areas. If satellite data sets during flood times are available over a period of time for a floodplain, they can be used for flood hazard zone mapping.

1.4 INITIATIVES OF DEPARTMENT OF SPACE (DOS)

Keeping in view of the demonstrated potential of earth observation and communication satellites, ISRO, Department of Space (DOS) has launched Disaster Management Support Programme (DMS) for providing aerospace information for disaster management to the nation.

Disaster Management Support Programme: In order to provide vital inputs and support in the event of a disaster, ISRO has been developing techniques and methodology by integrating space based systems and services for disaster management. DOS is carrying out a Disaster Management Support (DMS) Programme for integrating operationally the space technology inputs and services on a reliable and timely basis for strengthening India's resolve towards disaster management. DMS Programme addresses five issues mainly (i) creation of digital databases at appropriate scales for facilitating hazard zonation, damage assessment, etc., in perennially disaster prone areas, (ii) development of appropriate Remote Sensing & Geographical Information System (GIS) based decision support tools and techniques and demonstrations catering to the information needs at different levels, (iii) acquisition of close contour information for priority areas, (iv) strengthening the communications backbone for addressing the real time / near real time information transfer needs and (v) networking of scientific institutions for exchange of data, information and knowledge.

Towards enabling the operational services, a Decision Support Centre (DSC) is established at National Remote Sensing Centre, (NRSC), Hyderabad, as a single window provider, interfacing with the National / State disaster management agencies. The major components of the DSC include satellite/ aerial data acquisition, derivation of information in user required formats, output generation, dissemination of information to the users through the network, development of support functions such as digital database, query shells, hazard zonation, etc.

2.0 FLOOD PROBLEM IN ASSAM

2.1 ABOUT ASSAM

Assam popularly called as the land of the red river and blue hills. Assam is the gateway to the northeastern part of India. It is the eastern most state of the Indian sub-continent, extending from 22°19' to 28°16' North Latitude and 89°42' to 96°30' East Longitude between the foot hills of the Eastern Himalayas and the Patkai and Naga Ranges. Assam is bordered in the North and East by Bhutan and Arunachal Pradesh. Along the south lie Nagaland, Manipur and Mizoram. Meghalaya lies to the South-West, Bengal and Bangladesh to the West. Assam comprises of the Brahmaputra and the Barak river valleys and the Karbi Anglong and the North Cachar Hills. With an area of 78,438 square kilometres, Assam also shares international borders with Bhutan and Bangladesh. Assam is known for Assam tea, petroleum resources, Assam silk and for its rich biodiversity. It is increasingly becoming a popular destination for wild-life tourism and notably Kaziranga and Manas are both World Heritage Sites. A land of high rainfall, Assam is endowed with lush greenery and the mighty river Brahmaputra, whose tributaries and oxbow lakes provide the region with a unique hydro-geomorphic and aesthetic environment.

2.1.1 Administrative Setup

Assam is divided into 27 administrative districts (Fig 4). Table-5 shows the various districts, their area, population and district headquarters.

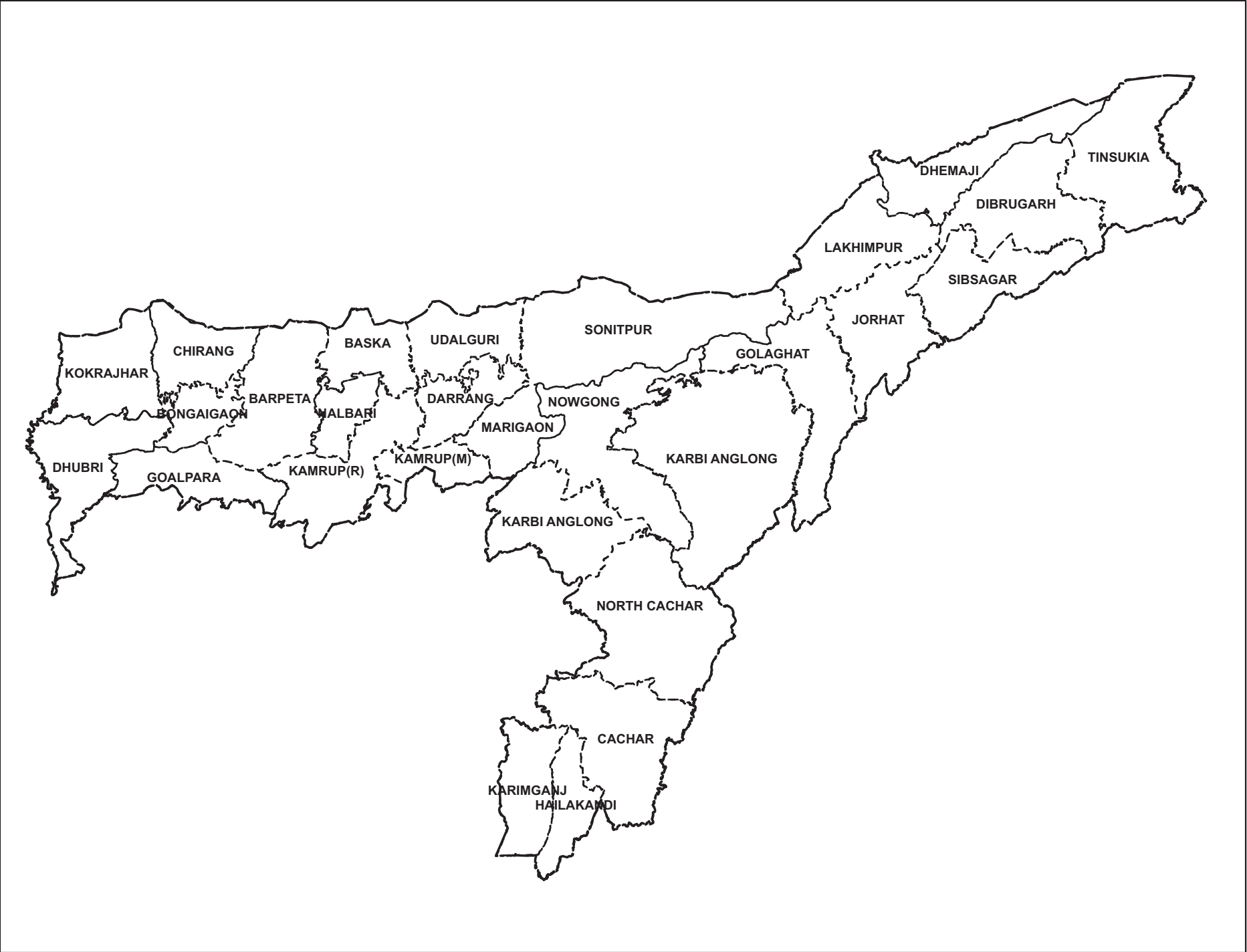


Fig 4 : Districts in Assam State

Table-5: Districts in Assam state and their headquarters

Sl.No	Name of District	Headquarters
1	Dhubri	Dhubri
2	Kokrajhar	Kokrajhar
3	Bongaigaon	Bongaigaon
4	Goalpara	Goalpara
5	Barpeta	Barpeta
6	Nalbari	Nalbari
7	Kamrup (R)*	Rangia
8	Darrang	Mangaldoi
9	Sonitpur	Tezpur
10	Lakhimpur	North Lakhimpur
11	Dhemaji	Dhemaji
12	Marigaon	Marigaon
13	Nowgong	Nowgong
14	Golaghat	Golaghat
15	Jorhat	Jorhat
16	Sibsagar	Sibsagar
17	Dibrugarh	Dibrugarh
18	Tinsukia	Tinsukia
19	Karbi-Anglong	Diphu
20	North Cachar Hills	Haflong
21	Karimganj	Karimganj
22	Hailakandi	Hailakandi
23	Cachar	Silchar
24	Baska*	Mushalpur
25	Chirang*	Kajalgaon
26	Kamrup(M)*	Guwahati
27	Udalguri*	Udalguri

(Note:- * Districts newly formed)

(Source: The Encyclopaedic District Gazetteers of India, Vol 10, 2000 and details from ASDMA)

2.1.2 Demography

As per the Census of India 2001, total population of Assam was 26.66 million with 4.91 million households. Higher population concentration was recorded in the districts of Kamrup, Nowgong, Sonitpur, Barpeta, Dhubri, Darang and Cachar. The Technical Group on Population Projection constituted by the National Commission on Population (India) in 2006 has estimated Assam's population at 28.67 million in 2006 and has estimated it to be 30.57 million by 2011, 34.18 million by 2021 and 35.60 million by 2026. In 2001, the census recorded literacy in Assam at 63.30 percent with male literacy at 71.30 and female at 54.60 percents. Urbanisation rate was recorded at 12.90 percent. Table-6 shows the district-wise demographic profile of Assam. Fig 5 & 6 shows the population growth trend and district-wise major demography characteristics of Assam.

Table-6: District-wise demographic profile of Assam, 2001 (P)

Sl. No.	District	Area (Sq. Km.)	Population	Rural Population	Urban Population	Sex ratio (Female per 1000 males)	Percentage of literacy	Density per Sq. Km.
1.	Dhubri	2838	1634589	1444043	190546	944	49.86	584
2.	Kokrajhar	3129	930404	866772	63632	945	52.55	294
3.	Bongaigaon	2510	906315	796028	110287	945	60.27	361
4.	Goalpara	1824	822306	755017	67289	955	58.56	451
5.	Barpeta	3245	1642420	1517280	125140	941	57.35	506
6.	Nalbari	2257	1138184	1110706	27478	937	68.08	504
7.	Kamrup	4345	2515030	1614512	900518	894	74.69	579
8.	Darrang	3481	1503943	1430099	73844	943	55.92	432
9.	Sonitpur	5324	1677874	1530043	147831	942	60.29	315
10.	Lakhimpur	2277	889325	824196	65129	952	69.59	391
11.	Dhemaji	3237	569468	530138	39330	936	65.96	176
12.	Morigaon	1704	775874	737813	38061	945	59.46	455
13.	Nowgong	3831	2315387	2037466	277921	939	62.28	604
14.	Golaghat	3502	945781	866625	79156	929	70.36	270
15.	Jorhat	2851	1009197	838549	170648	903	77.91	354
16.	Sibasagar	2668	1052802	955701	97101	926	75.33	395
17.	Dibrugarh	3381	1172056	952080	219976	923	71.21	347
18.	Tinsukia	3790	1150146	925972	224174	909	63.28	303
19.	Karbi Anglong	10434	812320	719569	92751	922	58.83	78
20.	N.C. Hills	4888	186189	128110	58079	883	68.59	38
21.	Karimganj	1809	1003678	930131	73547	944	67.21	555
22.	Hailakandi	1327	542978	497421	45557	933	59.84	409
23.	Cachar	3786	1442141	1240723	201418	945	68.42	381
	A S S A M	78438	26638407	23248994	3389413	932	64.28	340

(Source: Census of India, 2001 , P – Provisional)

(NB:Breakup for newly formed districts is included under old district names)

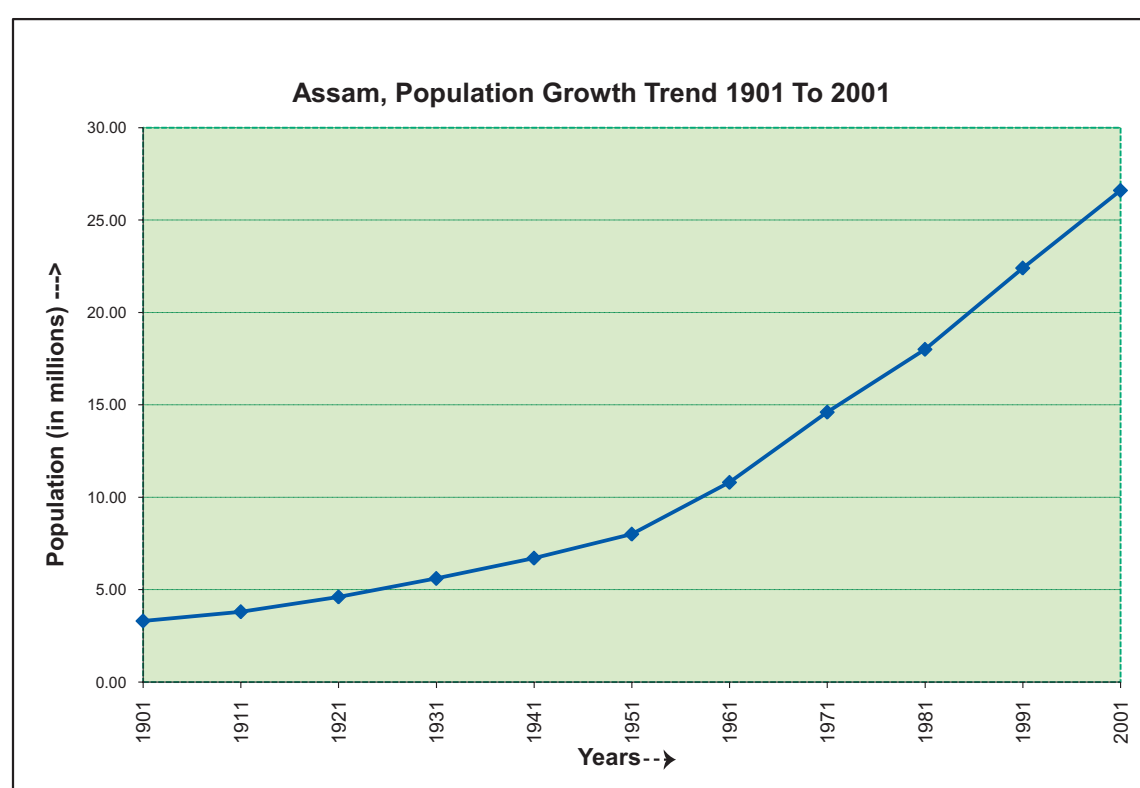


Fig 5: Population Growth Trend of Assam – 1901 to 2001

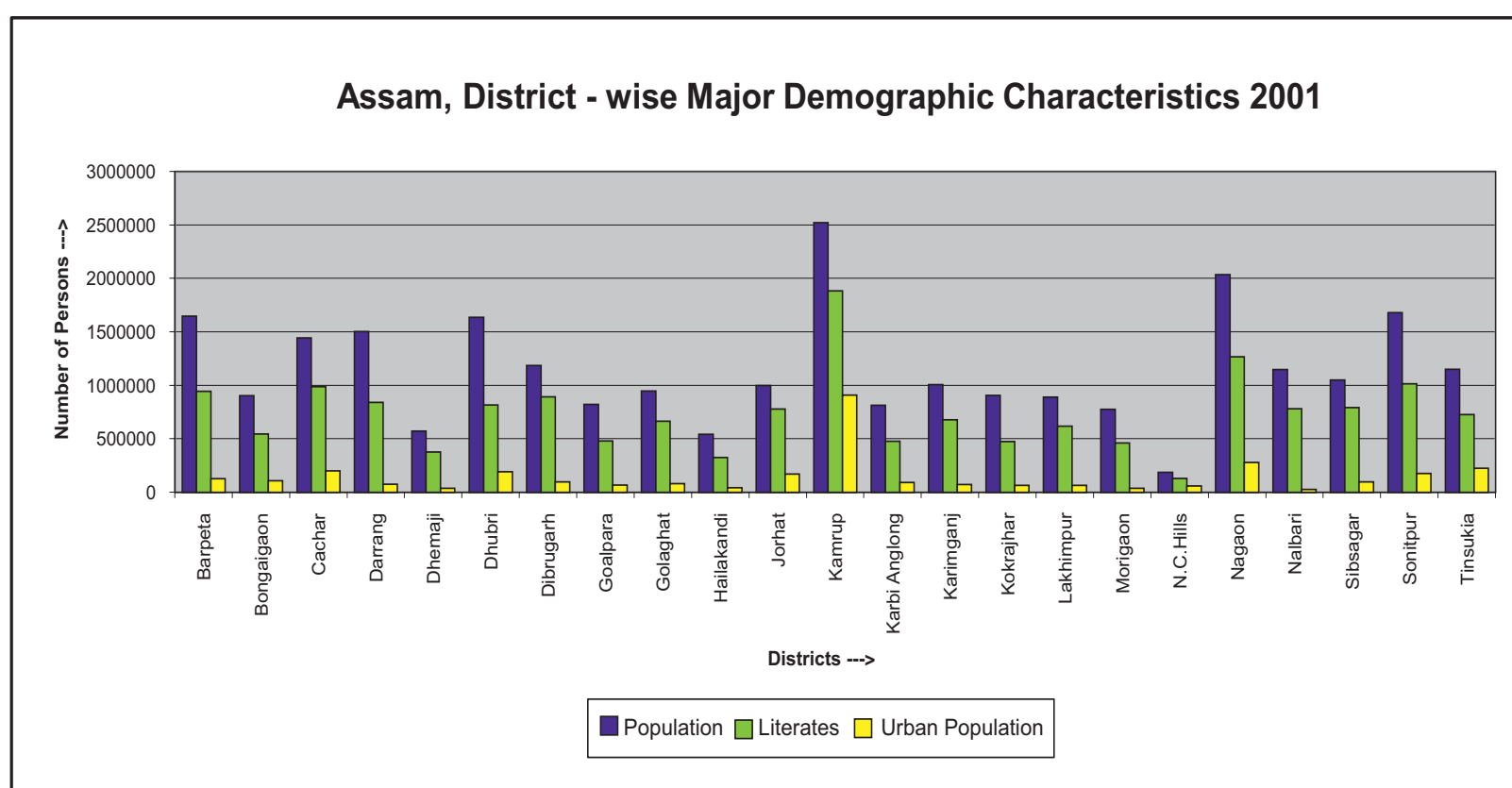


Fig 6: District-wise major demography characteristics, 2001 in Assam

2.1.3 Physiography

The state is divided into three broad geographic units:

- **The lower and central Assam hills, known as the Shillong Plateau**

The lower and central Assam range which includes, the Garo, Khasi, Jaintia and the outlying Mikir hills are in reality a plateau or table-land. The general height of the plateau ranges between 3,000ft and 6,000ft. The Khasi and Jaintia hill portion of the plateau are comparatively higher and flatter than the Garo and Mikir hills on the west and northeast. The highest peak of the plateau is the Shillong peak (6450 ft).

- **The Barail ranges and the low hilly terrains of Mizo hills**

The lofty Barail ranges, also known as the North Cachar hills, are separated from the Shillong plateau on the Northwest by a system of narrow valleys. Tectonically, the Barails form a south westerly extension of the mountain chain of Nagaland and western Burma. It is this chain of mountain that separates the valley of Irrawaddy and Chindwin of Burma from the valley of Brahmaputra and the Meghna. The Patkai, Naga and Manipur hills and the Mizo hills, form part of this great mountain system. The Mizo hills consist of a belt of North-South trending ridges with intricate valleys, with an average height of 3,000ft.

- **The Alluvial valley of Brahmaputra, Dhansiri and the Barak River**

The alluvial plains of Assam consist of two distinct parts:

- a) The valley of the Brahmaputra and its tributaries and
- b) The Barak valley.

These are separated from each other by the watershed of the Shillong plateau and the Barail ranges. The Brahmaputra valley separates the sub-Himalayan foothills from the Shillong plateau and the Patkai-Naga hill ranges. The Mizo hills and the Barail ranges die out towards the west and south west into the plains of Cachar, which is a part of Surma-Kusiyara valley.

2.1.4 Climate

The sub-tropical climate of Assam is characterized by high rainfall and high humidity and is worked by three dominant seasons, viz. winter (November to February), summer (March to May) and monsoon (June to October). Most of the rainfall in the state is received under the influence of the south-west monsoon between June and October.

The Brahmaputra valley represents three broad climatic regions, viz. eastern, western and middle. The mean annual rainfall of eastern, western and middle regions is 245.2 mm, 1982.5 mm and 1527.4 mm respectively. The mean annual temperature is 23.5°C, 24.5°C and 24°C with nine months having 20°C in eastern, western and middle regions respectively.

The mean annual rainfall of Barak valley is 4103 mm and mean annual temperature is 24.9°C which is higher than those of the Brahmaputra valley. In both Brahmaputra and Barak valley, the natural water availability exceeds the water need during the rainy and summer seasons. This renders the soil moist for seven to nine months and therefore, the climate of these regions qualifies for udic moisture regime. During this period, the low-lying areas remain saturated and the ground water levels remain high. Such localized wet areas qualify for aquic moisture regimes.

(Source: “Inventory of Viable Technologies Based on Resources of North Eastern Region” prepared by Assam Productivity Council)

2.1.5 Temperature Variations

In general, the average temperatures in Assam varies from 13.33 °C to 28.11°C .Table-7 shows variability in temperature, rainfall and humidity in Brahmaputra valley.

Table-7: Variability in temperature, rainfall and humidity in Brahmaputra valley

SEASONS		WIN TER	PRE-MONSOON				RAINY MONSOON					RETREATING MONSOON	WINTER	
Major Stations	Climatic Variables	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Av. Annual Rainfall (cm)
Dibrugarh	Temperatures in °C	13.33	16.00	19.83	22.22	24.83	26.28	26.67	27.00	26.28	24.33	19.83	14.22	285.35
	Rainfall in cm	3.78	6.20	16.51	24.10	30.71	49.96	53.64	45.11	35.18	15.21	3.35	1.60	
	Humidity in percentage.	94	88	79	82	86	90	90	90	89	95	95	94	
Sibsagar	Temperatures in °C	13.17	15.67	19.39	22.22	25.11	27.17	27.56	27.59	26.83	24.28	19.17	14.11	249.16
	Rainfall in cm	3.07	5.13	11.18	25.70	30.63	38.42	45.69	41.58	30.05	13.13	3.10	1.47	
	Humidity in percentage.	96	91	84	84	87	88	90	89	90	91	92	97	
Tezpur	Temperatures in °C	14.00	16.33	20.61	23.17	25.22	26.94	27.33	27.50	27.44	24.72	20.22	15.17	184.41
	Rainfall in cm	1.47	2.74	4.88	15.27	27.05	30.84	34.77	33.07	20.98	10.41	2.29	0.64	
	Humidity in percentage.	91	84	74	77	84	87	89	90	89	85	84	91	
Guwahati	Temperatures in °C	14.17	16.44	20.83	24.00	25.83	27.44	28.11	28.11	27.56	25.06	20.00	15.28	161.19
	Rainfall in cm	0.97	2.97	5.05	14.50	23.60	31.24	31.19	26.06	16.74	7.06	1.40	0.41	
	Humidity in percentage.	91	82	73	76	82	85	86	86	85	86	89	92	
Dhubri	Temperatures in °C	14.56	16.67	21.39	24.39	25.44	26.50	27.50	27.56	27.00	25.11	20.79	16.27	284.68
	Rainfall in cm	0.97	1.88	4.22	13.77	40.11	61.23	43.66	33.76	35.61	12.45	1.02	0.18	
	Humidity in percentage.	87	79	69	74	85	82	88	88	88	85	82	86	

(Source: Vijay P.Singh Brahmaputra Basin)

2.1.6 Major Rivers

Brahmaputra River originates from Kailash ranges of Himalayas at an elevation of about 5150 m and flows for about 2900 km through Tibet (China), India and Bangladesh and joins the Ganga. The principal tributaries of the river in India are the Dibang, the Lohit, the Subansiri, the Manas, the Tista, the Dhansiri and the Champamati. The drainage area lying in India is 194413 sq.km which is nearly 5.9% of the total geographical area of the country.

Barak rises in the Manipur hills and enters the plains near Lakhimpur. The river enters Bangladesh as Surma and Kushiara. Later, the river is called the Meghna and receives the combined flow of the Ganga and Brahmaputra. The principal tributaries of Barak are the Jiri, the Dhaleswari, the Singla, the Longai, the Sonai and the Katakhal. The drainage area lying in India is 41723 sq.km. Table-8&9 show the drainage area of Brahmaputra & Barak rivers in India.

Table-8: Drainage area of Brahmaputra River in India

State	Drainage area (sq.km)
Arunachal Pradesh	81,424
Assam	70,634
West Bengal	12,585
Meghalaya	11,667
Nagaland	10,803
Sikkim	7,300
Total	194,413

Table-9 :Drainage area of Barak River in India

State	Drainage area (sq.km)
Meghalaya	10650
Manipur	9567
Mizoram	8866
Assam	7224
Tripura	4688
Nagaland	728
Total	41,723

2.2 FLOOD PROBLEM

Assam represents highly flood-prone region characterized by severe hazards of floods. Although occurrence of flood has been an age-old phenomenon in the riverine areas of this region, the extent of damage caused by the flood has increased significantly in recent years. With more than 40 percent of its land surface susceptible to flood damage, the total flood-prone area in the Brahmaputra valley is about 3.2 Mha. (Goswami, 2001). The Brahmaputra valley had experienced major floods in 1954, 1962, 1966, 1972, 1974, 1978, 1983, 1986, 1988, 1996, 1998, 2000 and 2004.

The unique environmental setting of the basin i.e. the eastern Himalayas, highly potential monsoon regime, and accelerated rates of erosion, rapid channel aggradation, deforestation, intense landuse pressure and high population growth especially in the floodplain belt are some of the dominant factors that cause floods in Assam. The limited width of the valley and the abruptly flattened gradient, leads to tremendous drainage congestion and resultant flooding.

Fig 7 shows the damages resulted due to floods in Assam during 1953 to 2005 (Goswami, 2001). It can be observed from the figure that over years the damages shows an increasing trend.

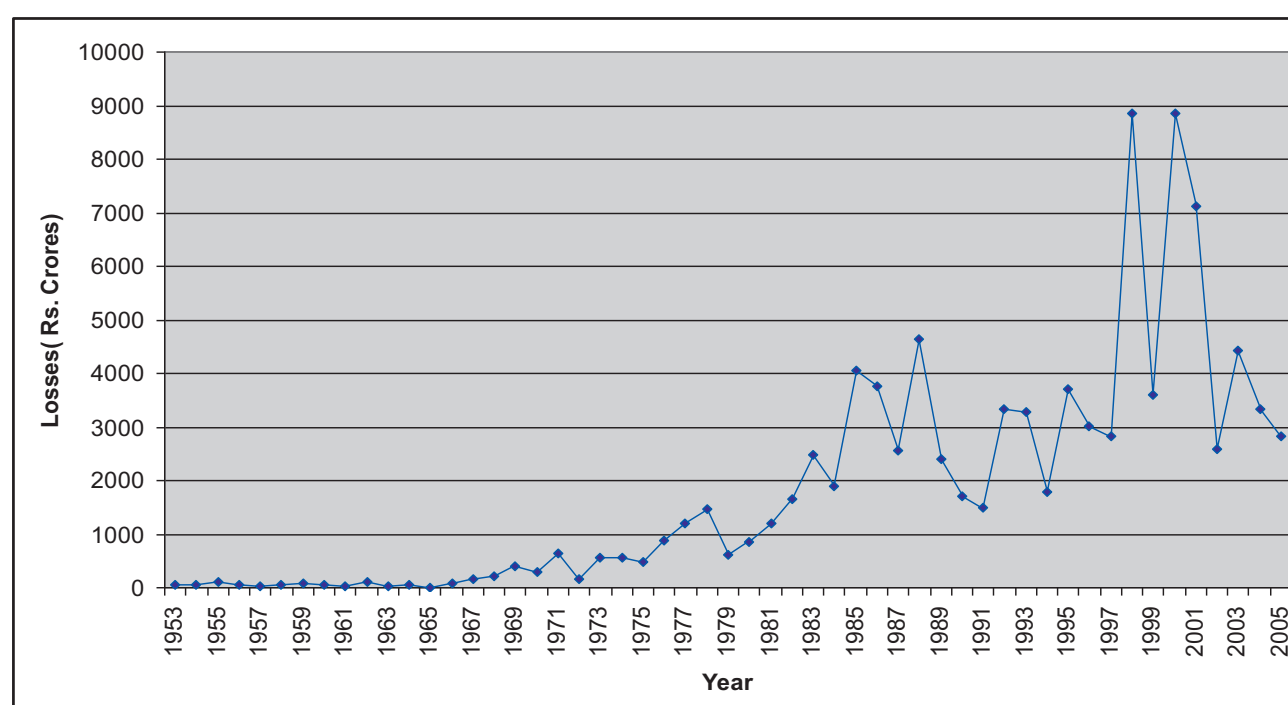


Fig 7 Damages resulted due to floods in Assam during 1953 to 2005

2.2.1 Flood Control Measures

Based on the 1954 Policy Statement and the recommendations of Task Force-2004 on Flood Management/Erosion control, the State Government has undertaken the short-term measures as shown in Table-10

Table-10: Short-term Flood Control Measures Undertaken by the State of Assam.

Sl. No	Item	Brahmaputra Valley		Barak Valley		Total
		Brahmaputra	Tributaries	Barak	Tributaries	
1	Embankments (km)	1016.187	2681.24	251	510.17	4458.60
2	Anti-erosion/town protection schemes (Nos.)	531		156		687
3	Drainage Channel (km)	599		251.69		850.69
4	Sluices (Nos.)	56		29		85
5	Raised Platform (Nos.)	3		-		3

(Source: Water Resources Department, Assam)

Above measures have afforded reasonable protection to flood affected area of 16.20 lakh ha out of 31.50 lakh ha flood prone area of Assam

- **Short-Term Structural Measures:**

The State Government of Assam has suggested short-term measures like new embankments, gap closure, raising and strengthening of existing embankments, anti-erosion works, drainage development and raised platforms. The total cost of such short-term works as informed by the State Government is around Rs.2022.01 crore out of which the works identified as Priority-I are of Rs.1195.47 crore and as Priority-II of Rs.826.54 crore.

- **Long-Term Structural Measures:**

The State Government has suggested for early completion of surveys, investigations and DPRs and expediting the work on 8 major dams (Pagladiya, Tipaimukh, Subansiri, Dehang, Kameng, Lohit, Debang) under projects for ensuring flood moderation benefits to the State of Assam.

- **Non- Structural Measures:**

The State Government has also suggested the following non-structural measures

- Flood forecasting based on real time data by installation of modern/sophisticated instruments
- Flood Plain Management, Flood Proofing, Disaster preparedness and response planning, Flood insurance.

2.3 FLOOD FORECASTING AND WARNING SYSTEM IN ASSAM

The Flood Forecasting and Warning System have been recognized as one of the most significant, dependable and cost effective non-structural measures for flood mitigation. After the most severe floods of 1954 and 1968, the Government of India pondered about the ways for mitigation of the woes of the people and reduction of flood damages. Accordingly, the then Ministry of Irrigation set up a few flood forecasting centers at selected places in the country in 1969 under the administrative control of Central Flood Forecasting (CFF) Directorate, New Delhi of the then Central Water and Power Commission. Subsequently, two Divisions at Guwahati and Jalpaiguri were initially set up during 1969 to look after the flood forecasting activities of the Brahmaputra and Barak in the North East Region and the North Bengal rivers respectively. For expansion of flood forecasting network, Central Water Commission (CWC) created a new Division at Dibrugarh under CFF Circle (renamed as Hydrological Observation Circle, CWC, Guwahati) in 1976.

2.3.1 Flood Forecasting Network

CWC has been rendering Flood Forecasting (FF) services at 24 FF stations in the State of Assam covering both the Brahmaputra and Barak basins having 6 FF stations on main Brahmaputra river, 15 FF stations on the tributaries of Brahmaputra including 2 stations each on Buridehing, Kopili and Dhansiri and 1 station each on Subansiri, Dikhow, Disang, Jiabharali, Pagladiya, Puthimari, Manas, Beki and Sankosh and 3 on Barak river, utilizing real time data of 29 base stations. A map exhibiting these stations is at Fig 8. The details of FF stations are tabulated in Table-11.

Table-11: Division-wise Flood Forecast Sites under HOC,CWC, Guwahati

Sl.No	Name of the FF site	Name of the River	Danger Level (m)	Warning Level (m)	H.F.L. (m)
UPPER BRAHMAPUTRA DIVISION, DIBRUGARH					
1	Dibrugarh	Brahmaputra	104.24*	103.24*	106.48
2	Neamatighat	Brahmaputra	85.04	84.04	87.37
3	Tezpur	Brahmaputra	65.23	64.23	66.59
4	Khowang	Buridehing	102.11	101.11	103.92
5	Naharkatia	Buridehing	120.4	119.4	122.69
6	Golaghat	Dhansiri(s)	89.5	88.5	91.3
7	Numaligarh	Dhansiri(s)	77.42	76.42	79.87
8	Sivasagar	Dikhow	92.4	91.4	95.62
9	Nangalmoraghat	Disang	94.46	93.46	96.49
10	NT Rd.xing	Jia-Bharali	77	76	78.5
11	Dharamtul	Kopili	56	55	58.09
12	Kampur	Kopili	60.5	59.5	61.86
13	Badatighat	Subansiri	82.53	81.53	86.64
MIDDLE BRAHMAPUTRA DIVISION, GUWAHATI					
14	A.P.Ghat	Barak	19.83	18.83	21.84
15	Goalpara	Brahmaputra	36.27	35.27	37.35
16	Guwahati	Brahmaputra	49.68	48.68	51.46
17	Matizuri	Katakhal	20.27	19.27	22.73
18	Karimganj	Kusiara	14.94	13.94	16.57
19	N.T.Rd.xing	Pagladiya	52.75	51.75	55.45
20	N.H.xing	Puthimari	51.81	50.81	55.08
LOWER BRAHMAPUTRA DIVISION, JALPAIGUDI					
21	Rd.Bridge	Beki	45.1	44.1	46.2
22	Dhubri	Brahmaputra	28.62	27.62	30.36
23	N.H.Xing	Manas	48.42	47.81	50.08
24	Golokganj	Sonkosh	29.94	28.94	30.95

(Source: Central Water Commission)

2.3.2 Cooperation with Neighbouring Countries

Bangladesh: Flood related information in respect of 6 sites is sent to the Government of Bangladesh as per Bilateral agreement with India, through IMD, twice daily at 08 hrs and 20 hrs and flood bulletin for 7 sites, thrice daily at 09 hrs, 13 hrs and 18 hrs through wireless network under point-to-point communication during flood season.

Bhutan: During 1979, a scheme has been drawn by MoWR for strengthening of FF network considering the rivers common to India and Bhutan for improving accuracy and warning time of flood forecasts. Initially, the rivers Puthimari, Pagladiya, Manas and Sankosh in Assam and Torsa in North Bengal were considered under this scheme and the collected data was used for FF and formulation of Irrigation and Hydropower scheme in both the countries. The rivers Aie in Assam and Raidak & Jaldhaka in North Bengal have further been added under the scheme. Hydro-meteorological data at 32 sites (including 7 gauge, 1 GD and 3 GDS) in the catchment of these river basins lying in Bhutan is being observed and transmitted to India. During monsoon, the real time data is transmitted by the Bhutanese authorities for taking up flood forecasting activities in India.

China: As per agreement of 4th Expert level Mechanism (ELM) on Trans Border Rivers between India and China, Chinese authorities transmit hydrological information i.e. water level, discharge and rainfall of three stations namely Yangcun, Nugesha and Nuxia on Yaluzangbu river to CWC, twice daily at 0530 & 1730 hrs (IST) through e-mail/ FAX. During non-monsoon season, the data is transmitted whenever the water level reaches warning level. The data received is used for computing impact of water flow coming from these stations for formulation of flood forecasts at Dibrugarh on river Brahmaputra.

2.3.3 Methodology

Gauge data is collected round the clock on hourly basis during Flood season ie. 15 May – 15 October. Data from up-stream sites is communicated to forecast formulation units/Control Rooms (Division Offices) through wireless, phone, FAX etc. on real time basis. Forecast is generated and Daily Flood Bulletins are issued when water level approaches Warning level at the Forecasting site. Warning Time of forecast is generally 12-24 hrs. Warning level is normally 1 M below the Danger Level. The Danger level is fixed by the State Government.

2.3.4 Flood Forecast Performance

The number of forecasts issued during the period 1998-2007 for various rivers and their accuracy are shown in Table-12.

Table-12: Forecasts issued during 1998-2007 for various rivers with percentage of accuracy.

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Details										
Total no. of forecast issued	2760	2402	2715	1787	2056	2519	2414	1809	1769	2779
Forecast within +/- 15cm range	2686	2347	2656	1762	2027	2460	2351	1758	1736	2734
% of Accuracy	97.32	97.71	97.83	98.60	98.59	97.66	97.39	97.18	98.13	98.38

(Source: Central Water Commission)

2.3.5 Utility

Daily flood bulletin is issued to user agencies viz., Civil Authorities (Deputy Commissioner, Irrigation, Police, Water Resources [Flood Control], Railways), Defence Authorities, State Relief Commissioner of NE Region, State Disaster Management Authority, National Remote Sensing Centre, Hyderabad and other concerned Government Departments, Mass media like Internet, Doordarshan, AIR, News papers etc. depending on the situation through special messenger/ phone/ FAX/ telegram/ email etc. The bulletin is also uploaded on the website of CWC (www.cwc.nic.in) and on some news websites. CWC has introduced a new service for sending flood alerts (during high & unprecedented flood situations) through SMS during flood season 2010 to the user agencies.

2.3.6 Modernisation of FF Activities

CWC has taken up steps for Modernization of Flood Forecasting system in the NER. They have introduced Sensor based instrumentation for water level, rainfall and for other observations, data communication through satellite on real time, mathematical modeling for flood estimation and dissemination through internet/ e-mail. 19 Telemetry stations have already been installed during Xth Five year plan and 16 telemetry stations are being installed during XIth Plan. Remaining network is proposed to be taken up during the XIIth Five Year Plan.

FF activities, with a view to increase no. of forecasting stations as per requirement of the NE States, to improve warning time, to improve data transmission and also to improve presentation of the forecasts by exhibiting area likely to be flooded, are being reviewed.

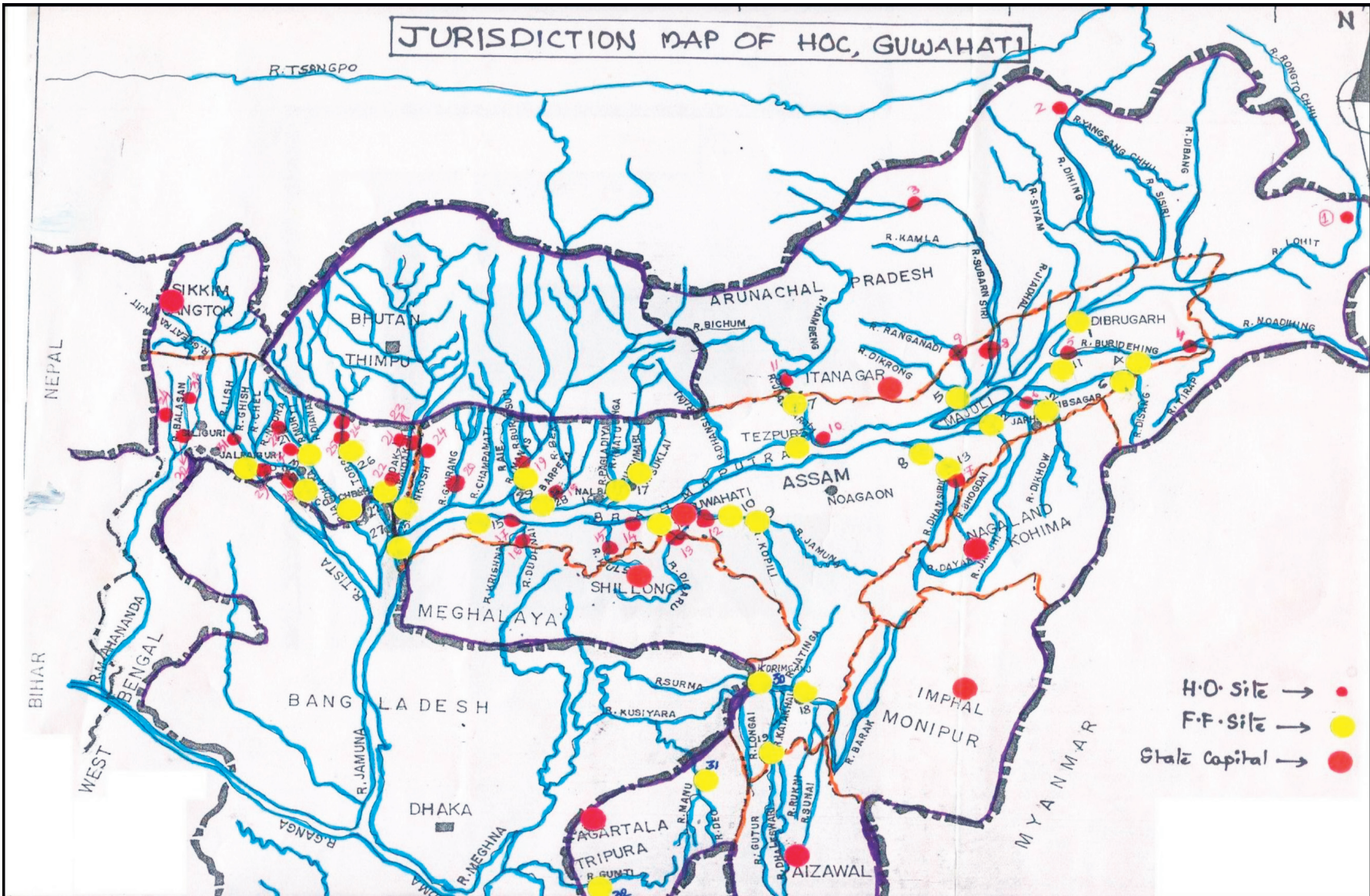


Fig 8: Flood forecasting stations on Brahmaputra River in Assam

3.0 FLOOD HAZARD ZONATION USING SATELLITE REMOTE SENSING

Since floodplains can be mapped, the boundary of the different return period flood is used in floodplain mitigation programs to identify areas where the risk of flooding is significant. Flood hazard maps are used to delineate areas of land which are at risk from flooding up to some extreme limit. Hazard maps show a flood boundary based on different magnitudes of flood with various specific return periods. These maps can be used to regulate developmental activities within the floodplain, so that damages can be minimized.

Conventional flood hazard mapping techniques use historical flood data to map floodplains. In addition to a record of peak flows over a period of years, a detailed survey (cross sections, slopes and close contour maps), maps such as soils, physiography, land use, vegetation, population density, infrastructure, and settlements along with hydraulic parameters are required for determining the extent of flooding for an expected recurrence interval. Some of the data required for hazard mapping is difficult to obtain from ground measurements and time consuming; in such cases remote sensing plays an important role.

Satellite remote sensing from their vantage position has unambiguously demonstrated their capability in providing important information and services for flood disaster management. Satellites provide synoptic and frequent coverage of flood affected areas and thus become valuable for monitoring flood disaster. Satellite data can be directly used for deriving the flood inundation limits. If satellite data sets during flood times are available over a period of time for a floodplain, they can be conveniently used for hazard zone mapping. In addition, information on latest land use/land cover, infrastructure, etc. can also be generated from satellite data.

3.1 APPROACH

In this attempt, a large number of satellite images covering the Assam region during all the flood events occurred during last 10 years (1998-2007) were used. All satellite data sets were analyzed and flood layers were extracted. All the flood layers corresponding to a year are combined as one inundation layer so that this layer represents maximum flooded area in one year. All such combined flood layers for 10 years were integrated into flood hazard layer representing the observed flood inundated areas with different frequencies.

This layer was integrated with digital database layers of Assam. The flood inundation represented in different colours indicates varying frequencies as observed during 1998 to 2007. The road and railway lines are shown to indicate the probable frequency of flooding they are subjected to. The normal river course and water bodies are also shown in the map.

Similarly, the layer was also integrated with digital database layers of different districts, these layers include road, rail, village, etc. The details of each of the element subjected to flooding were given district-wise in the following units.

Generation of the Flood hazard zones was done based on the analysis of multi-temporal satellite data acquired during the floods of 1998-2007. Following are the major steps involved in preparation of flood hazard zonation maps

- **Satellite data Acquisition:** Satellite data from Indian Remote Sensing Satellites (IRS) and microwave satellite data from Radarsat satellite was acquired during the floods in Brahmaputra since 1998. The water levels observed at different gauge stations were closely monitored during floods and attempts were made to programme the satellite data during near peak situations. Satellite data was also programmed and procured during progression and recession of the flood wave for studying the impact of the flood.
- **Rectification:** The acquired satellite datasets were rectified to a defined projection system for integration with database layers.
- **Flood inundation layer:** Using image processing classification algorithms water layer was extracted from the satellite data and integrated with the pre-flood river and water bodies layer to derive flood inundation layer. Fig-9 shows the methodology for extraction of flood inundation layer from satellite data.
- **Annual Flood Layer:** The flood inundation layers generated for different flood waves in a calendar year were integrated to generate the maximum flood inundation extent observed in that year.
- **Hazard layer:** The maximum flood inundation layers corresponding to various years (1998-2007) were integrated for assessing the frequency of inundation and subsequent generation of hazard layer. Fig 10 shows the methodology for generation of flood hazard layer.
- **Database integration:** The hazard layer was further integrated with the database consisting of administrative boundaries, landuse/landcover, infrastructure, etc. for impact assessment and statistics generation.
- **Map Composition:** Flood hazard maps were composed at State, District and Detailed levels comprising of base details and hazard layer.

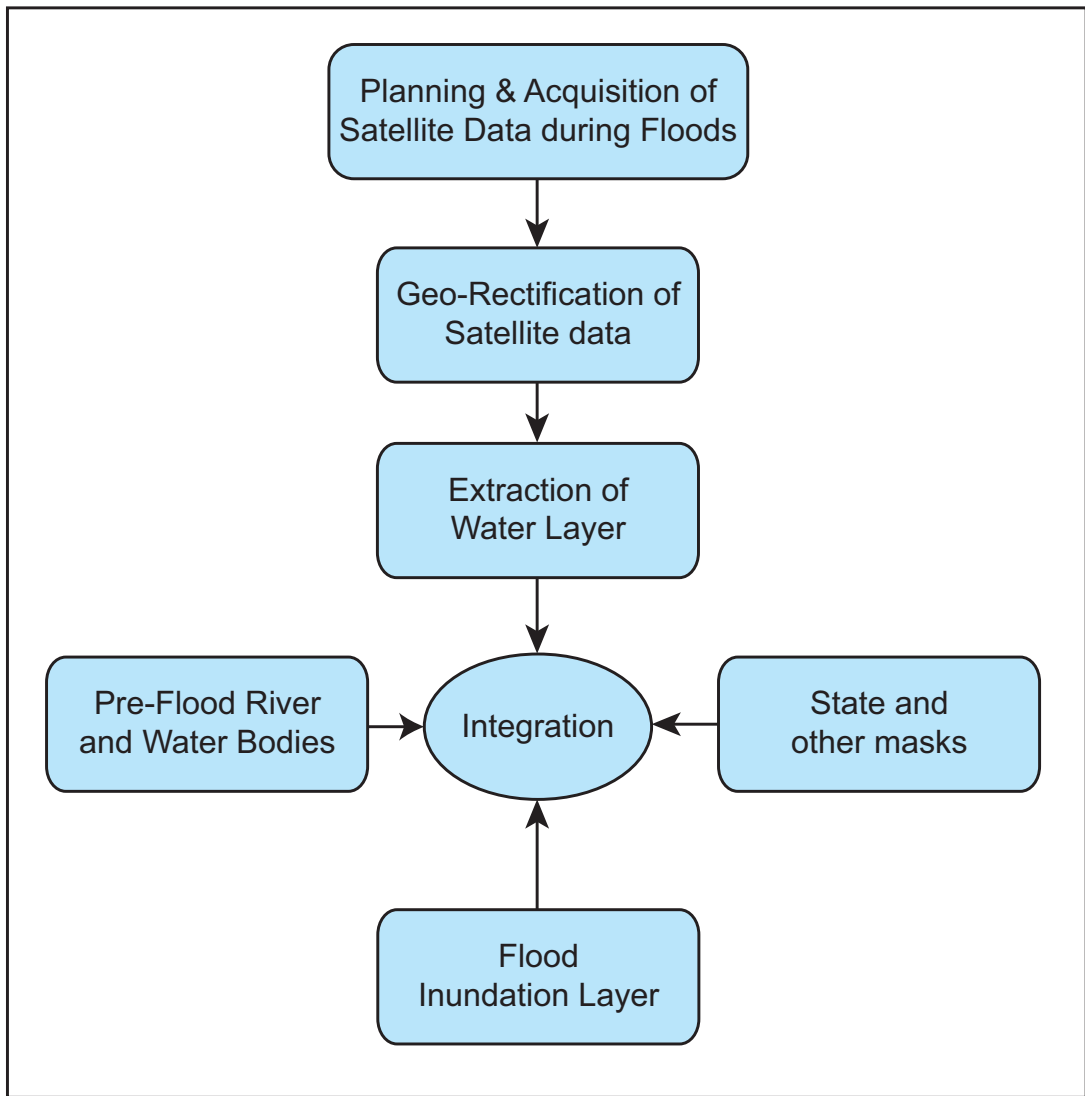


Fig- 9: Extraction of Flood inundation layer from satellite data

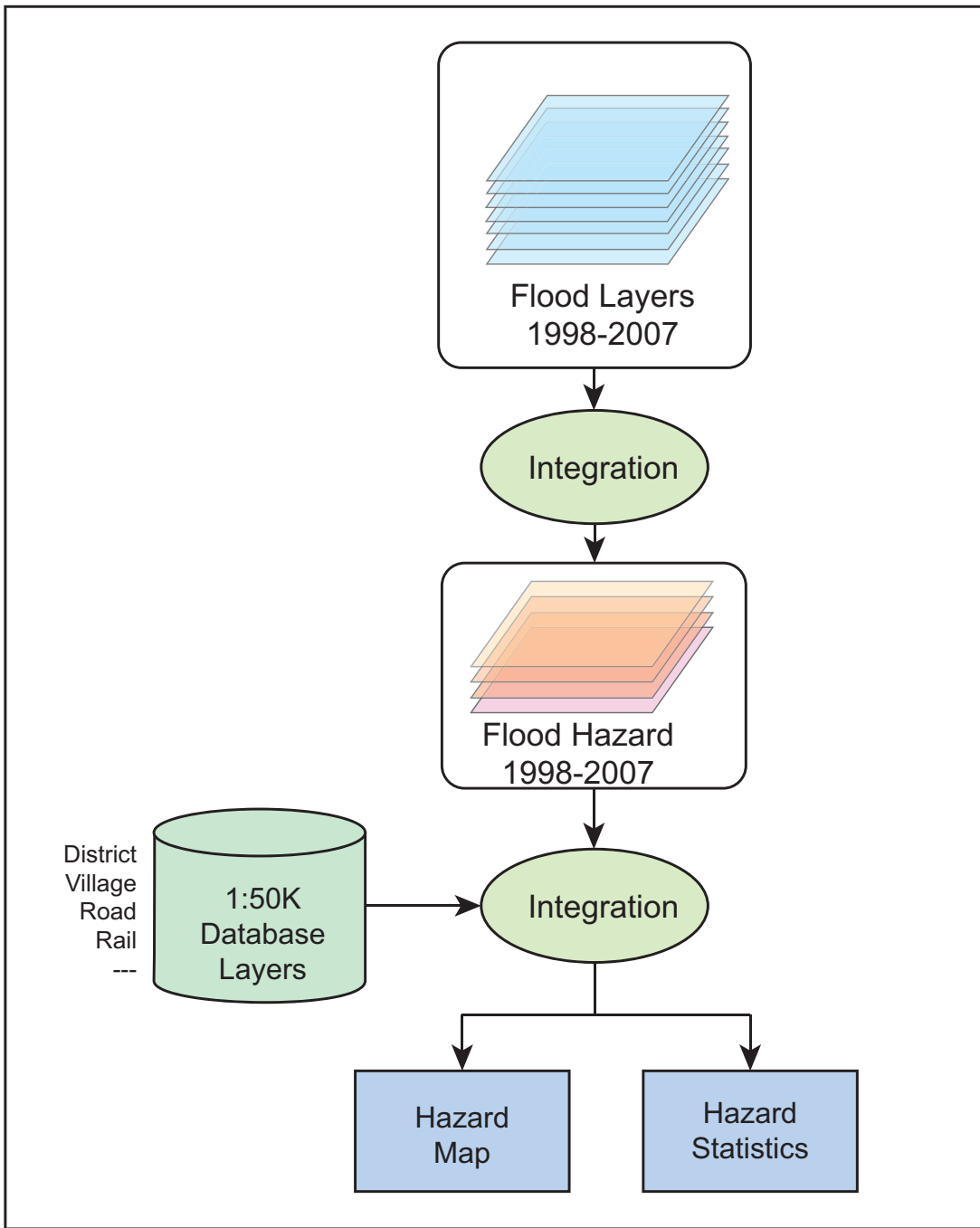
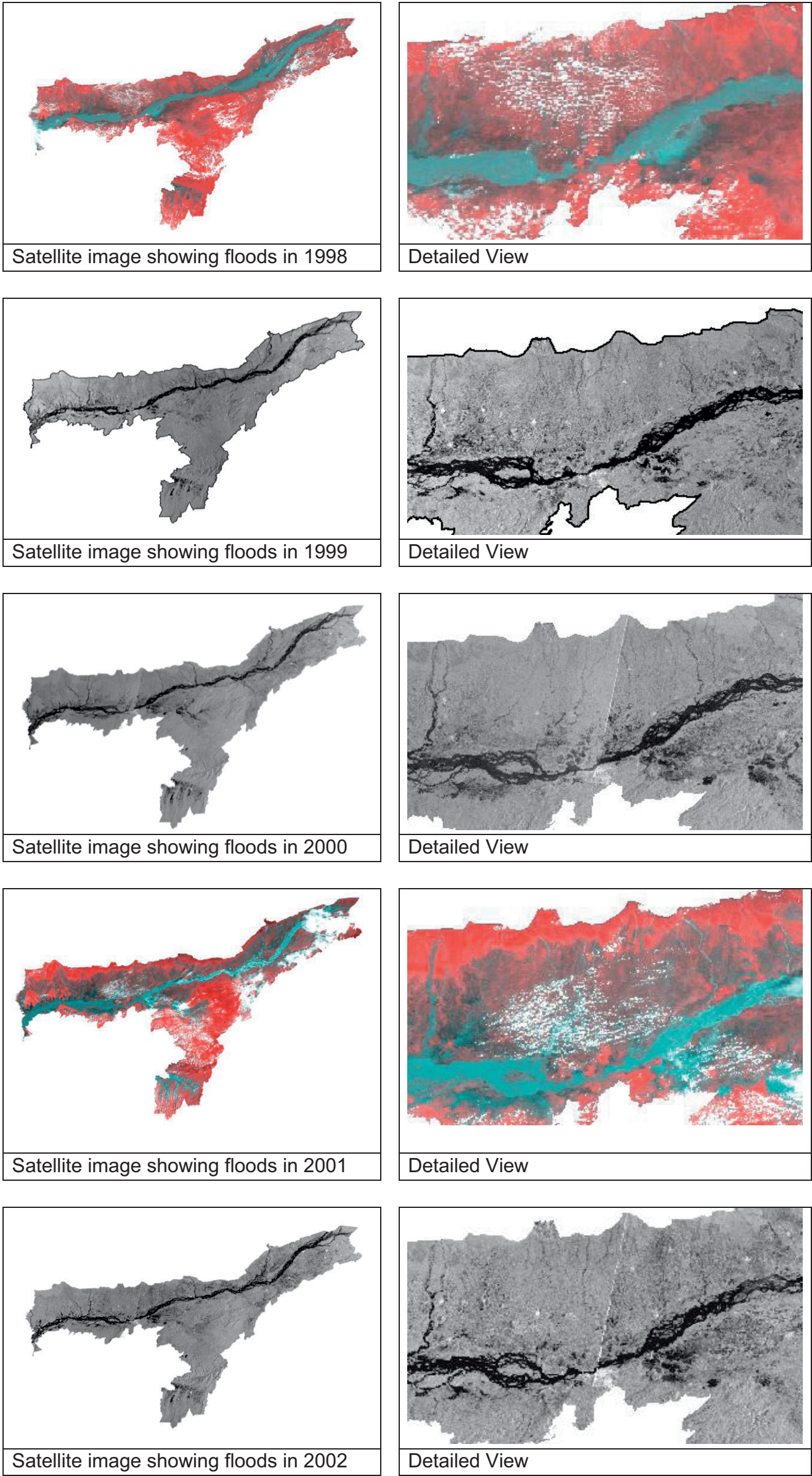


Fig-10 : Generation of flood hazard layer

3.2 SATELLITE DATA USED

Satellite datasets were acquired from different satellites during floods over Assam State year after year. About 93 satellite data sets are selected for flood hazard zoning spanning for a period of 10 years, from 1998 to 2007. Some of the datasets cover full Assam and some cover part of the state. IRS as well as Radarsat data is mostly used for this study, as they have wider swath. Fig 11 shows selected satellite datasets showing the flood inundation in Assam from 1998 to 2007. Table 13 shows satellite datasets acquired during the floods of 1998-2007.



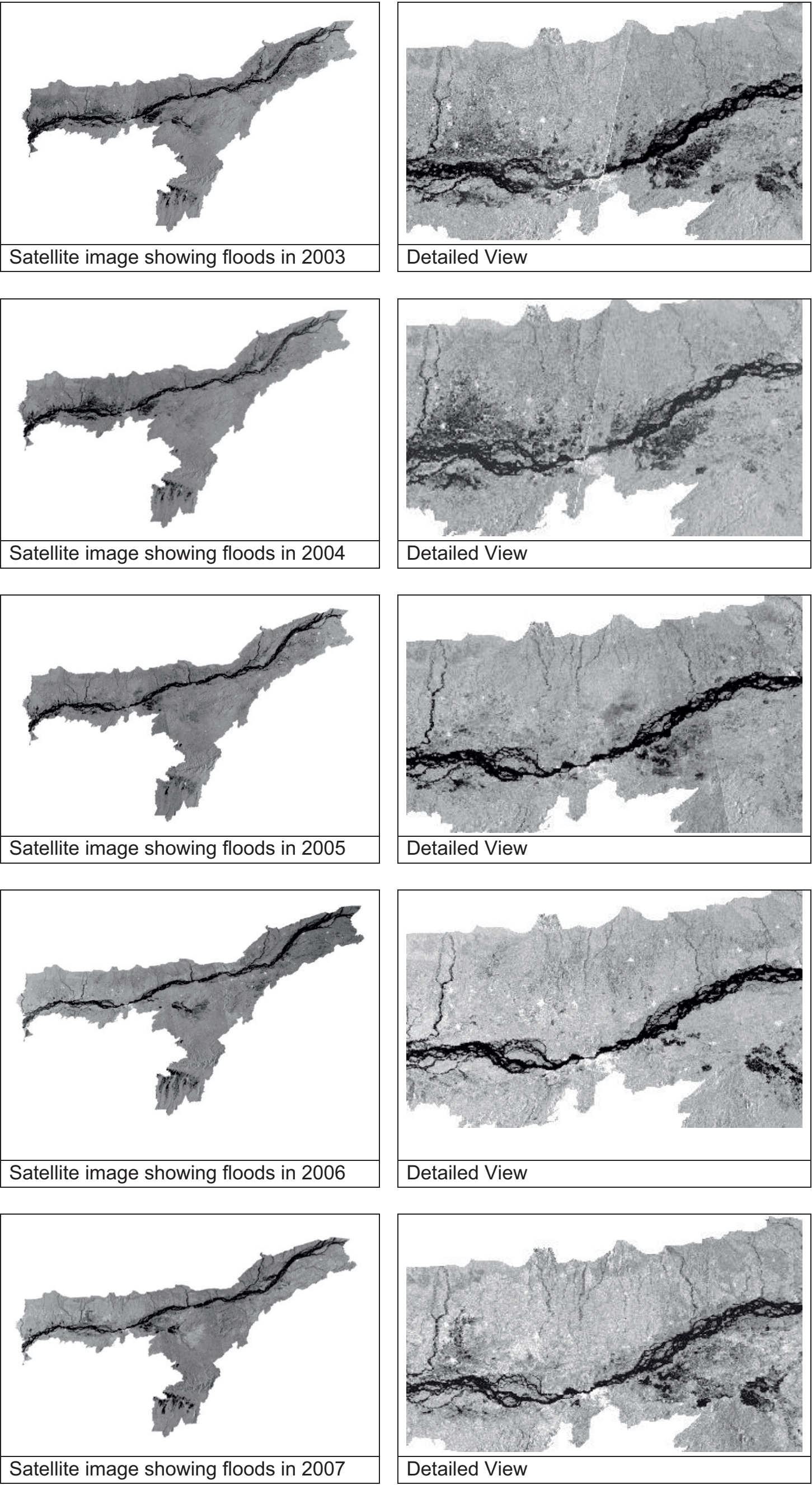


Fig-11 Selected satellite datasets showing the flood inundation in Assam during 1998-2007

Table – 13: Satellite data sets used for flood hazard zonation

S No	Date	Satellite / Sensor	S.No.	Date	Satellite / Sensor	S.No.	Date	Satellite / Sensor
1998			2003			2006		
1	28-Jun-98	RADARSAT	32	19-Jun-03	RADARSAT	63	02-Jun-06	RADARSAT
2	18-Jul-98	RADARSAT	33	22-Jun-03	RADARSAT	64	06-Jun-06	RADARSAT
3	21-Jul-98	RADARSAT	34	03-Jul-03	RADARSAT	65	15-Jun-06	IRS AWiFS
4	7-Sep-98	IRS WiFS	35	05-Jul-03	IRS WiFS	66	16-Jun-06	RADARSAT
5	8-Sep-98	IRS WiFS	36	06-Jul-03	IRS OCM	67	26-Jun-06	RADARSAT
6	10-Sep-98	IRS WiFS	37	06-Jul-03	RADARSAT	68	28-Jul-06	RADARSAT
7	10-Sep-98	RADARSAT	38	12-Jul-03	RADARSAT	2007		
8	11-Sep-98	IRS WiFS	39	16-Jul-03	RADARSAT	69	21-Jun-07	RADARSAT
9	13-Sep-98	IRS WiFS	40	20-Jul-03	RADARSAT	70	28-Jun-07	RADARSAT
10	14-Sep-98	RADARSAT	41	23-Jul-03	IRS WiFS	71	14-Jul-07	RADARSAT
1999			42	12-Oct-03	IRS OCM	72	19-Jul-07	RADARSAT
11	12-Jun-99	RADARSAT	43	14-Oct-03	IRS OCM	73	22-Jul-07	RADARSAT
12	15-Jun-99	RADARSAT	2004			74	29-Jul-07	RADARSAT
13	29-Jun-99	RADARSAT	44	28-Jun-04	RADARSAT	75	30-Jul-07	RADARSAT
14	09-Jul-99	RADARSAT	45	29-Jun-04	RADARSAT	76	02-Aug-07	RADARSAT
15	12-Jul-99	RADARSAT	46	05-Jul-04	RADARSAT	77	05-Aug-07	RADARSAT
16	30-Jul-99	RADARSAT	47	06-Jul-04	RADARSAT	78	07-Aug-07	RADARSAT
17	02-Aug-99	RADARSAT	48	10-Jul-04	RADARSAT	79	08-Aug-07	RADARSAT
2000			49	13-Jul-04	RADARSAT	80	12-Aug-07	RADARSAT
18	27-Jun-00	RADARSAT	50	16-Jul-04	RADARSAT	81	16-Aug-07	RADARSAT
19	30-Jun-00	RADARSAT	51	20-Jul-04	RADARSAT	82	22-Aug-07	RADARSAT
20	11-Aug-00	RADARSAT	52	22-Jul-04	RADARSAT	83	26-Aug-07	RADARSAT
21	14-Aug-00	RADARSAT	53	23-Jul-04	RADARSAT	84	29-Aug-07	RADARSAT
2001			54	27-Jul-04	RADARSAT	85	01-Sep-07	RADARSAT
22	04-Aug-01	IRS WiFS	55	29-Jul-04	RADARSAT	86	08-Sep-07	RADARSAT
23	07-Aug-01	IRS WiFS	56	30-Jul-04	RADARSAT	87	09-Sep-07	RADARSAT
24	29-Aug-01	IRS WiFS	57	10-Oct-04	IRS WiFS	88	12-Sep-07	RADARSAT
25	08-Jul-02	RADARSAT	58	12-Oct-04	IRS WiFS	89	13-Sep-07	RADARSAT
26	10-Jul-02	RADARSAT	2005			90	16-Sep-07	RADARSAT
27	26-Jul-02	RADARSAT	59	16-Jul-05	RADARSAT	91	18-Sep-07	RADARSAT
28	28-Jul-02	RADARSAT	60	18-Jul-05	RADARSAT	92	25-Sep-07	RADARSAT
29	31-Jul-02	RADARSAT	61	25-Jul-05	RADARSAT	93	04-Oct-07	RADARSAT
30	08-Aug-02	RADARSAT	62	01-Sep-05	RADARSAT			
31	10-Aug-02	RADARSAT						






3.3 FLOOD HAZARD ZONATION SCHEMA

Ten years (1998-2007) of satellite data was used for deriving the flood hazard layer for Assam state. The hazard layer demarcate areas in terms of number of flooding events occurred in that area during last 10 years, such as 10-times flooded, 9-times flooded, etc. The flood hazard has been classified into 5 categories based on frequency of inundation (Table 14). Very Low category indicates the areas, which are inundated once or twice during the 10-year period. Similarly, Low indicates three to four times, Moderate indicates five to six times, High indicates seven to eight times and Very High indicates nine to ten times.

Table 14: Flood Hazard Classification

Sl.No	Flood Hazard Classification	Number of times / years the area was subjected to flood inundation during 1998-2007
1	Very Low	1-2 times
2	Low	3-4 times
3	Moderate	5-6 times
4	High	7-8 times
5	Very High	9-10 times (almost every year)

To facilitate better visualization, the following colour coding scheme has been adopted for different hazard zones based on their frequency of inundation.

	Very Low
	Low
	Moderate
	High
	Very High

3.4 FLOOD HAZARD INDEX

In addition to categorizing the flood hazard zones, an attempt is made to find the severity of flood hazard in various districts, using the following flood hazard index.

Flood hazard Index = \sum Hazard Category(H) x Hazard Area (A)

1. Weightages were given to each category of flood hazard (H) and are shown in Table 15
2. Weightages were also given as per the percentage of flood hazard area (A) in the district as shown in the Table 16
3. Flood hazard index is derived for each district by using above formula (Refer Table 17)

Table 15 Weightage for Flood Hazard category

Hazard Zones	Weightage for Hazard Zones (H)
Very High	5
High	4
Moderate	3
Low	2
Very Low	1

Table 16 Weightage for % Submerged Area

Percentage of District Hazard area	Weightage (A)
0-10 %	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

3.5 CROPPED AREA UNDER VARIOUS FLOOD HAZARD ZONES

The cropped area (consisting of kharif, double/triple crop categories) was extracted from the landuse / land cover information (generated under ISRO-NRC project using 2006-07 satellite data) and integrated with the various flood hazard categories.

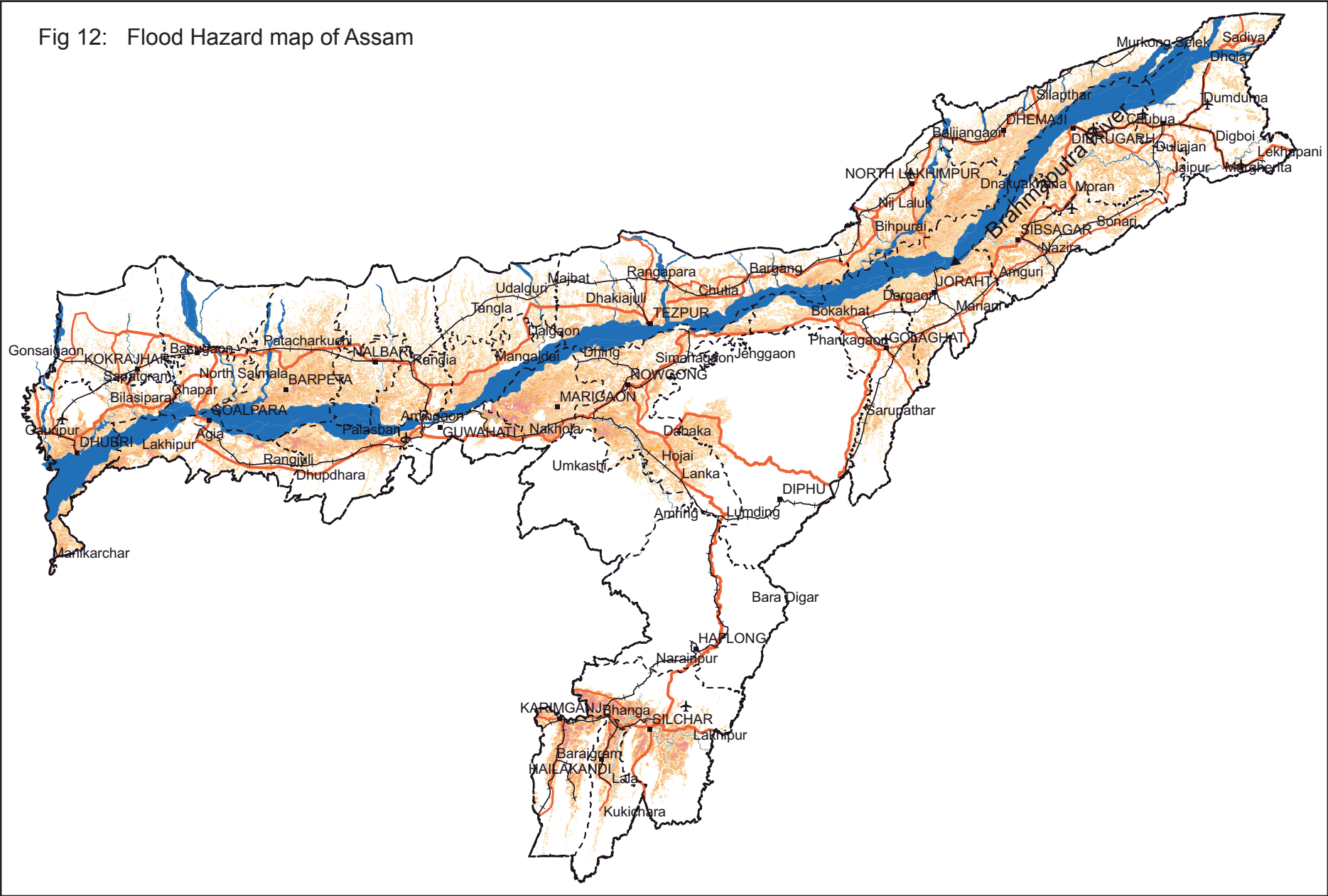
3.6 LIMITATIONS

The flood hazard zonation was carried out with available satellite data with NRSC. The satellite coverage may not correspond to the peak flooding in all cases. Further, all river gauge stations need not record the peak situation on a single day. For States like Assam where the topography is quite gentle, the flood inundation remains same for few days, even after the peak has passed. Hence, in most of the cases, satellite data acquired even after the flood peak resembles the peak situation. Observed flood inundation includes flooding due to embankment breaches and also due to rainwater accumulation in low lying areas.

4.0 OBSERVATIONS

4.1 FLOOD HAZARD ZONES

Based on the analysis of about 93 satellite datasets, acquired during floods of 1998-2007, the flood hazard layer was derived. Figure 12 shows the flood hazard map prepared for Assam. Table 17 shows the flood hazard area computed under various categories. Following are the observations:

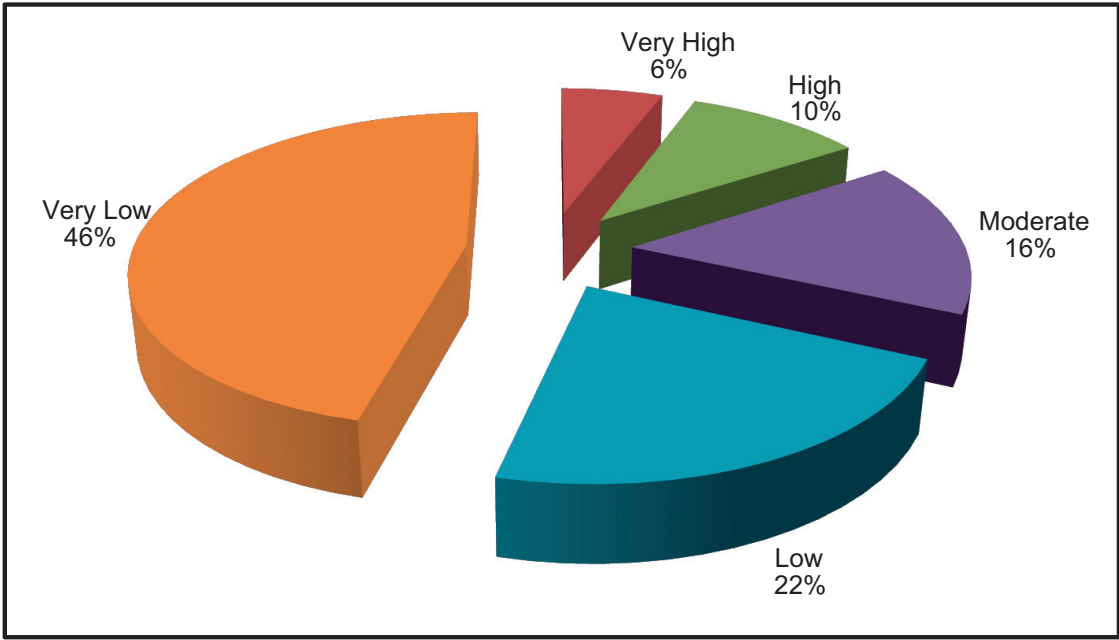


- About 28.31% (22.21 lakh hectares) of land in Assam state is affected by flood during 1998-2007 (Table 17).
- Out of total flood affected area (22.21 lakh hectares), about 3.53 lakh hectares of land falls under high (inundated 7-8 times) to very high (inundated 9-10 times) flood hazard categories.
- Within flood affected zones, the percentage area of each flood hazard category varies from about 6 to 46. Figure 13 shows the graphical distribution of area under different hazard categories.

Table 17 Flood Hazard Area under Various Categories

Sl. No	Hazard Severity	Flood Hazard Area (ha)	% Flood Hazard (wrt State Geographic area)	% Flood Hazard (wrt Total Hazard Area)
1	Very High	1,28,687	1.64	5.79
2	High	2,24,629	2.86	10.11
3	Moderate	3,51,667	4.48	15.83
4	Low	4,91,761	6.27	22.14
5	Very Low	10,24,584	13.06	46.13
	TOTAL	22,21,328	28.31	100.00

Fig 13 Percentage of various hazard categories wrt total hazard in the state

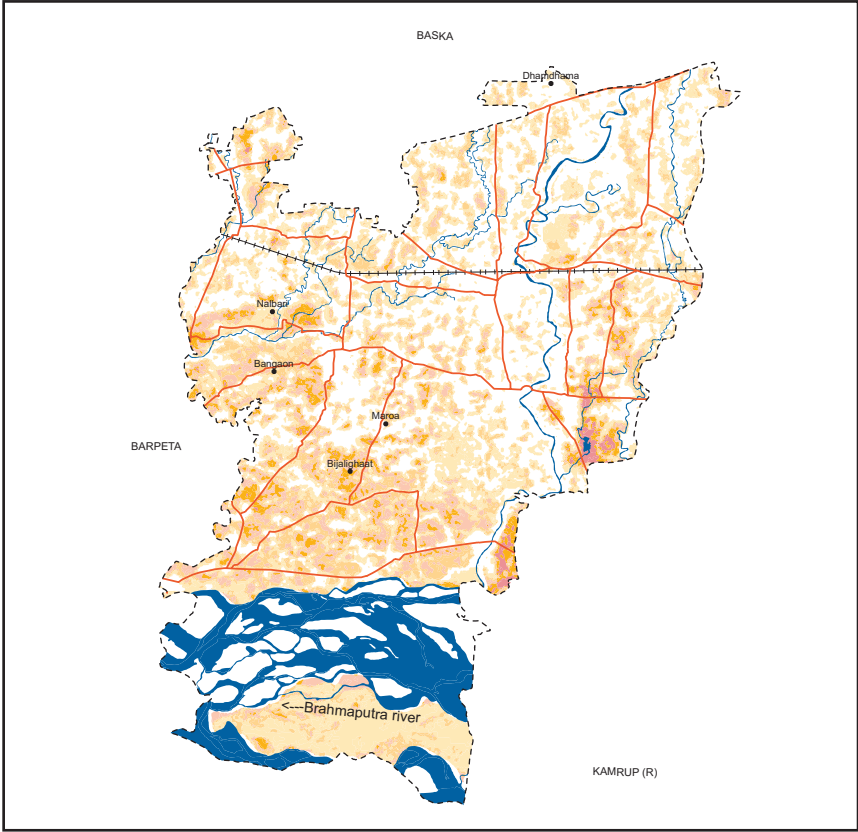


- Based on the flood hazard index derived for various districts, it can be observed that Nalbari, Marigaon, Darrang, Lakhimpur and Dhemaji districts are the five most flood affected districts in Assam. Table 18 provides the flood hazard index for various districts and Figure 14(a-e) shows the flood hazard maps of five most flood affected districts.

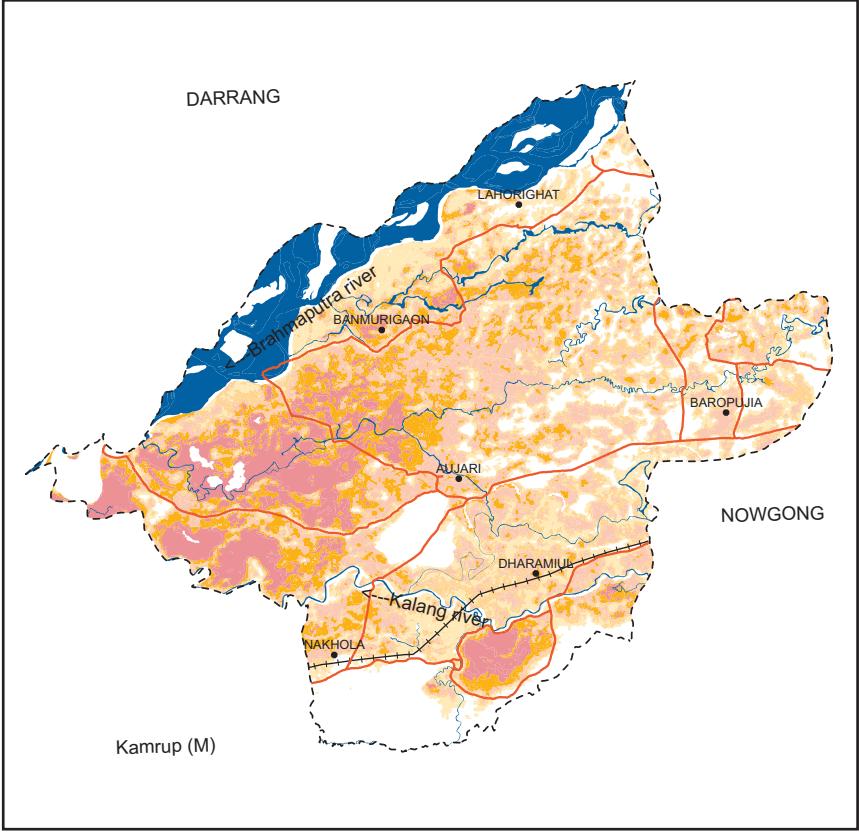
Table 18 District-wise Flood Hazard Index

S.No	District	District Area (Hectares)	Total Flood Hazard Area (Hectares)	% Flood Hazard Area	Hazard Index
1	NALBARI	110586	51737	46.78	27
2	MARIGAON	149300	107834	72.23	25
3	DARRANG	155598	116294	74.74	21
4	LAKHIMPUR	289686	153527	53.00	19
5	DHEMAJI	252527	117417	46.50	19
6	BARPETA	213851	147591	69.02	18
7	SIBSAGAR	262656	122519	46.65	18
8	JORHAT	283134	121074	42.76	18
9	UDALGURI	197518	48867	24.74	17
10	NOWGONG	400002	191193	47.80	16
11	GOLPARA	200731	76987	38.35	16
12	KAMRUP(RURAL)	306706	116849	38.10	16
13	BONGAIGAON	110160	41605	37.77	16
14	DHUBRI	271003	98753	36.44	16
15	DIBRUGARH	337731	117234	34.71	16
16	SONITPUR	527723	160450	30.40	16
17	GOLAGHAT	353499	104814	29.65	16
18	TINSUKIA	383365	74345	19.39	16
19	KARIMGANJ	185840	51968	27.96	15
20	HAILAKANDI	132892	32661	24.58	15
21	CACHAR	378136	92772	24.53	15
22	KAMRUP (METRO)	102705	21987	21.41	15
23	KOKRAJHAR	258923	33665	13.00	15
24	BASKA	262748	26191	9.97	-
25	CHIRANG	188189	13167	7.00	-
26	KARBI ANGLONG	1042757	46337	4.44	-
27	NORTH CACHAR	486293	462	0.10	-

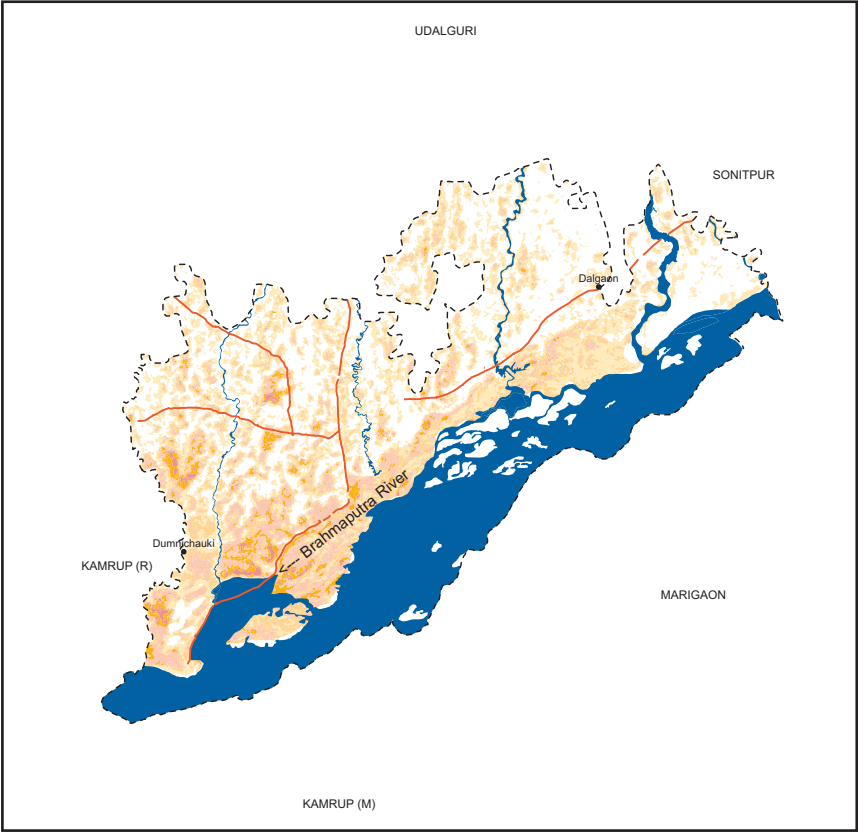
Note: For districts with less than 10% flood hazard area (Baska, Chirang, Karbianglong and North Cachar), flood hazard index is not computed



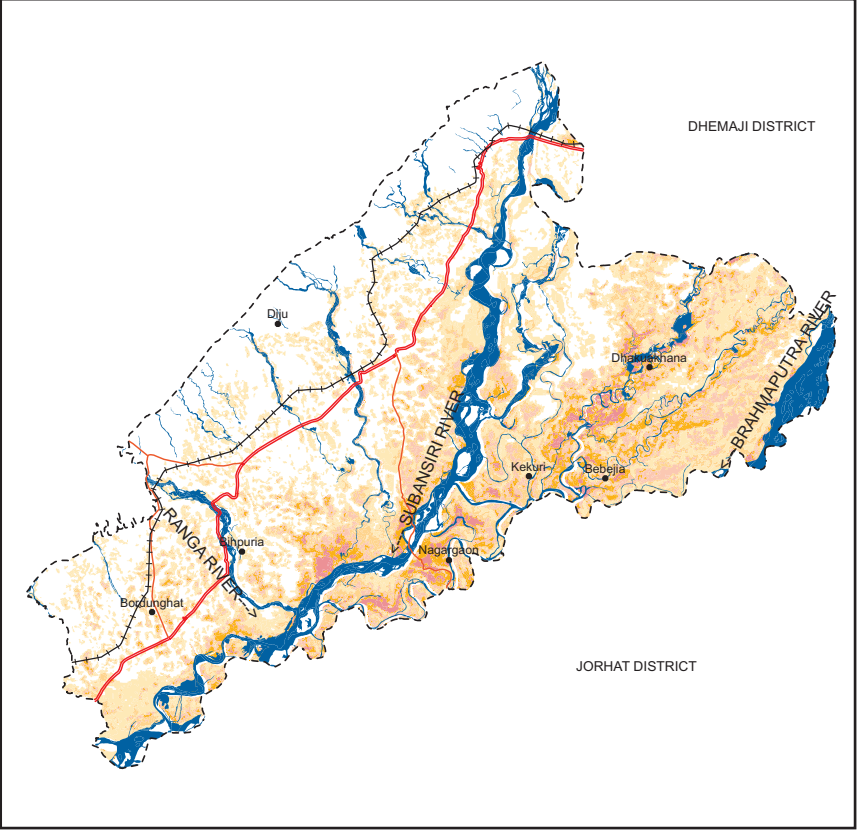
(a) Nalbari



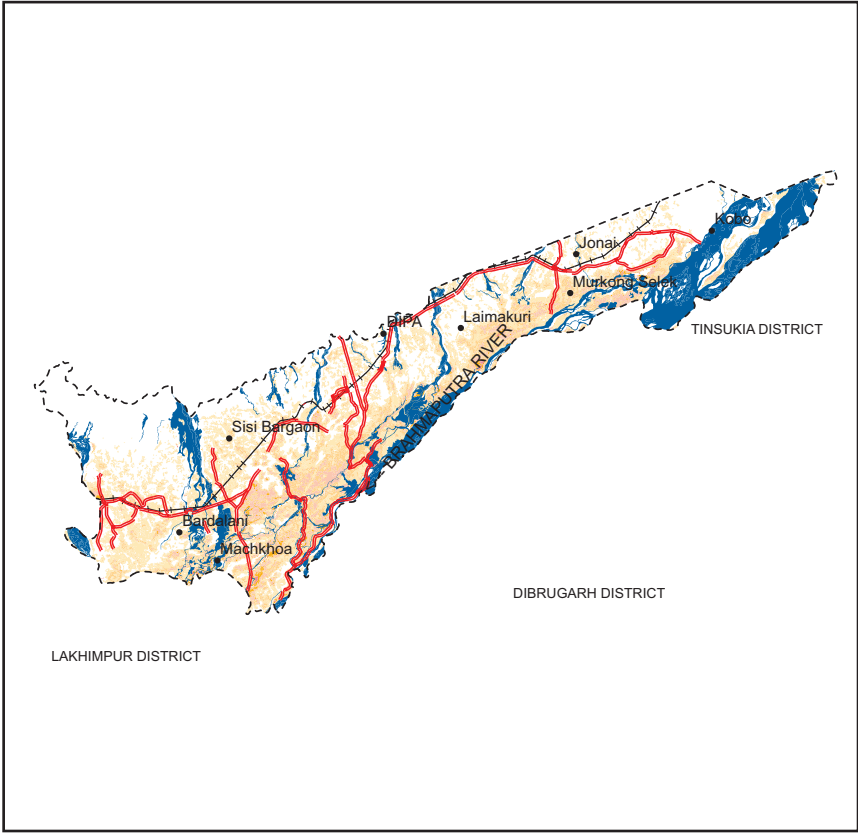
(b) Marigaon



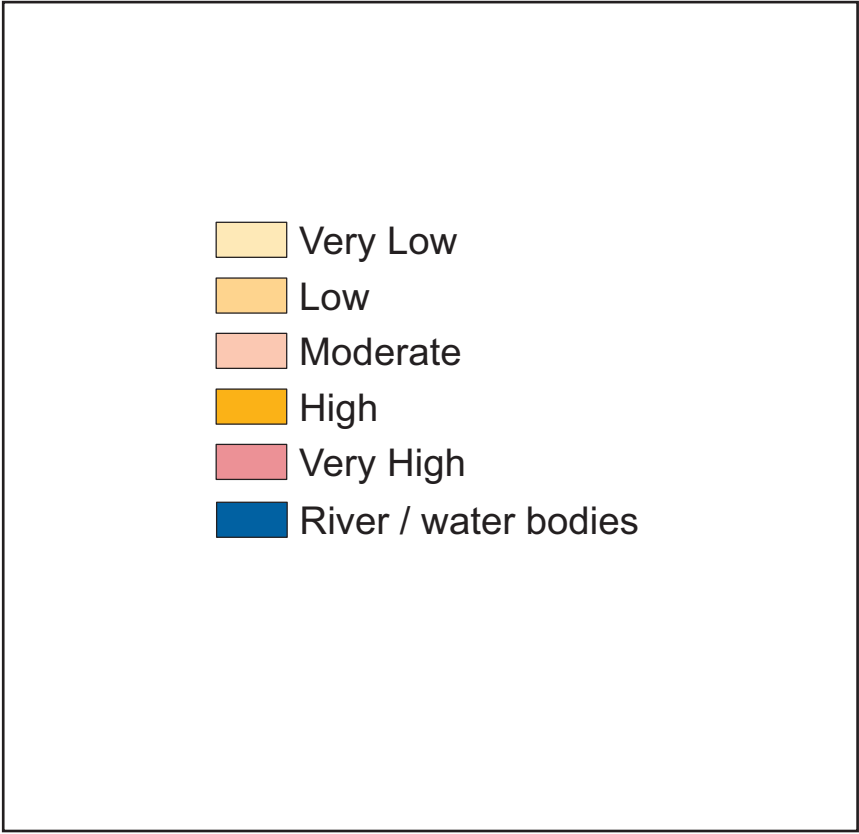
(c) Darrang



(d) Lakhimpur



(e) Dhemaji



Legend

Fig 14 (a-e) Flood Hazard zones in the worst flood affected districts

- It can be observed that about a maximum of 14.95 lakh hectares of cropped area is under various categories of flood hazard. Out of which about 2.52 lakh hectares of land falls under very high to high flood hazard zones. District-wise details of cropped area in different flood hazard zone are given in Table 19.
- The districts of Cachar, Nowgong, Marigaon, Kamrup Rural, Karimganj have maximum cropped area under very high to high flood hazard categories ranging from 0.31 to 0.17 lakh hectares.

Table 19: District-wise cropped area in different flood hazard zones

Crop Area Under Different Flood Hazard Categories						
District	Very High	High	Moderate	Low	Very Low	Total
BARPETA	2868	9737	17837	23912	35321	89675
BONGAIGAON	651	1339	2716	5078	10898	20682
CACHAR	19662	11426	10433	12299	20735	74555
CHIRANG		31	198	1147	9892	11268
DARRANG	925	4314	11601	13532	20535	50907
DHEMAJI	152	1419	8351	19813	39736	69471
DHUBRI	4534	8944	10015	13162	26665	63320
DIBRUGARH	2208	12841	16942	16983	27570	76544
GOALPARA	4281	7708	9611	14152	23216	58968
GOLAGHAT	565	5558	11465	14721	25213	57522
HAILAKANDI	4697	3640	3064	4522	9321	25244
JORHAT	1739	7502	15641	20318	26593	71793
KAMRUP(M)	1996	3574	3224	1807	2543	13144
KAMRUP(R)	6506	11952	18541	21494	29360	87853
KARBI ANGLONG	86	3847	8335	10972	18577	41817
KARIMGANJ	11249	6202	5180	6931	12458	42020
KOKRAJHAR	1	165	1069	4488	21373	27096
LAKHIMPUR	3115	11559	17882	23863	43697	100116
MARIGAON	9103	12702	20125	13176	13104	68210
NOWGONG	4835	20446	28610	31168	48935	133994
NALBARI	568	2920	6356	10670	16101	36615
NORTH CACHAR	0	0	0	6	2	8
SIBSAGAR	2088	11913	18097	20288	23527	75913
SONITPUR	1402	7003	20651	34178	61168	124402
TINSUKIA	257	2004	3740	6882	18069	30952
UDALGURI	0	56	874	5794	36758	43482
Total	83488	168802	270558	351356	621367	1495571

4.3 GROUND VALIDATION

The flood hazard maps were provided to Assam State Disaster Management Authority (ASDMA). Subsequently these maps were distributed further to each district administration and feedback was obtained. Almost all districts have provided positive feedback. However, minor corrections with respect to district boundaries were reported by newly formed districts, which were subsequently incorporated.

ANNEXURE - I

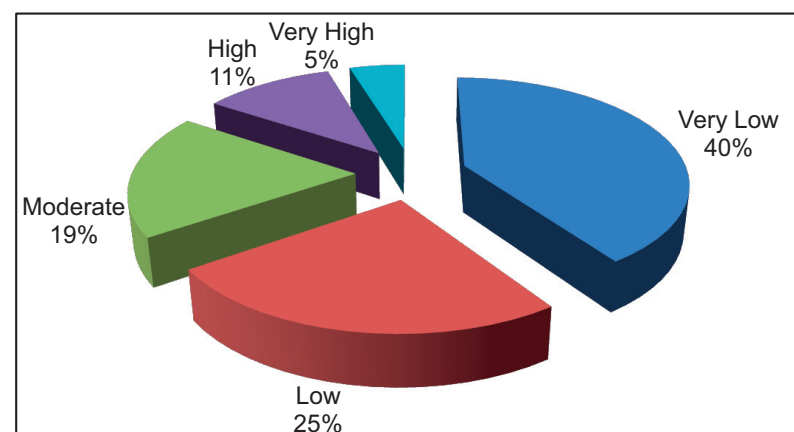
**DISTRICT - WISE FLOOD HAZARD
MAPS & TABLES**

Barpeta

Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	59619
2	Low	37014
3	Moderate	27724
4	High	16296
5	Very High	6938

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (218 nos)

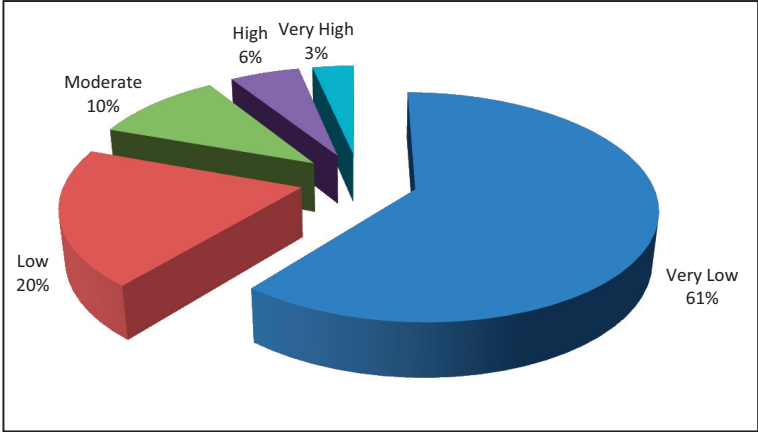
Agdia Pathar	Bhatkuchi	Goremara Gaon	Khudra	Panimaricha Pathar
Agmandia	Bhatnapaity Char N.C	Goria Chatala	Gomura	Parahkuchi Pam
Amda	Bhella	Gumir Pathar	Khudra Kuchi	Pathali Kuchi
Amda Pathar	Bhera	Gurala	Khudra Phaladi	Pithadi Gaon
Ara Gaon	Bheraldi	Hahchara	Khutra Khowa	Pithadi Pam
Ata	Bhogpur	Haldhi Bari	Kiadoba	Pomara
Bagadi	Bhotanta Mahitara	Hariadi	Kismot Moinbory (N.C	Potlar Kur
Bagana	Bogchara	Haripur	Krihar Pam	Pubhati
Bagarir Tari	Borbhitha	Hasanpur	Kukarpar	Puttar Tari
Bagemari	Borbil Pathar	Hatchara	Kurubaha Gaon	Radha Kuchi
Bahari	Borbori	Hathinapur	Lahararpar N.C.	Radha Kuchi
Bahmura	Chapra	Jabri Kuchi	Lechara Para	Habi
Balar Tari	Chatala	Jabrikuchi	Lurfuria	Rangapani
Balarbari	Chauliabari	Jalkara	Major Gaon	Rangia Gaon
Bamun Baradi	Cheki	Jasodar Pam	Mandia Gaon	Rowly
Bamun Kata Beel	Chengolia	Joharpam	Mandia Pathar	Rupakuchi
Bamuna	Chikni Reserve	Joshihati	Manikpur	Salekura
Bamundi	Dabaliapara	Kachkuri Pam	Maricha Pathar	Sarihkuchi
Banbaria	Dakhin Sitali	Kachkuri Pathar	Marisa Kandi (N.C.)	Saru Chenga
Bangali Para	Dalor Pathar	Kadamtola	Mauri Pam	Sarudia (N.C.)
Bangti	Damaljar	Kadong	Medhikuchi	Satra Baradi
Bar Agdia	Dangarkuchi	Kah Doba	Medhirtari	Satra Barala
Bar Bhala	Debara	Kaharagaon	Metua Kuchi	Sawrachara Gaon
Bar Bila	Debrodi	Kahi Bari	Mohia	Sidhani
Bar Chenga	Dewan Khetri	Kahi Kuchi	Nagaon	Sila
Bar Gomura	Dhakua	Kaldi Pathar	Nalana	Singra
Bar Kapala	Dhan Bandha	Kalgachia	Nangalkur	Sitali
Bar Palli	Dharmapur N.C.	Kaljahi	Nasatra	Suagpur
Bar Phaladi	Digir Pam	Kaljahi Pathar	Neular Bhitha	Tangla
Bar Saderi	Era Kachari Pam	Kandapara	Niz Barala	Tapa
Bara Mara	Era Tari	Kandulia	Niz Bhabanipur	Tapajuli Pathar
Baradi	Gabindapur	Kapahartari	Niz Saldah	Taparbari
Barala	Gadeshali Pam	Karagori	Niz-Baghbar	Tati Kuchi
Bariar Pathar	Gagalmari	Karagori Pathar	No.1 Chachra	Tedhera Pathar
Barkur Gaon	Gahia	Kawoimari Karaguri R	No.1, Rasulpur	Tekela Bala
Barnali Kuchi	Galabil	Kayakuchi Gaon	No.2 Chachra	Telereaa
Barsimla	Ganak Kuchi	Kayakuchi Pathar	No.4 Bhera	Temura
Batua	Ganak Para	Keot Kuchi	Odalguri	Thekar Gaon
Bayarsha	Gandhi	Khablar Bhita	Pahartali	Thekar Pathar
Belana	Garaimari	Khander Kur	Paka Bet Bari	Uprupi
Belbari Pathar	Garalirpam	Khankar Para	Pakdaha Bilar Pathar	
Besimari Pam	Garapit	Khardhara	Palhaji	
Bhaira Guri	Garar Tari	Khat Bar Saderi	Panara	
Bhairar Pam	Gathia Para	Khudra Amrikhowa	Panichilla Village	
Bhakuamari	Goherpam	Khudra Chinadi	Panimaricha Gaon	



Bongaigaon
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	25326
2	Low	8172
3	Moderate	4368
4	High	2346
5	Very High	1393

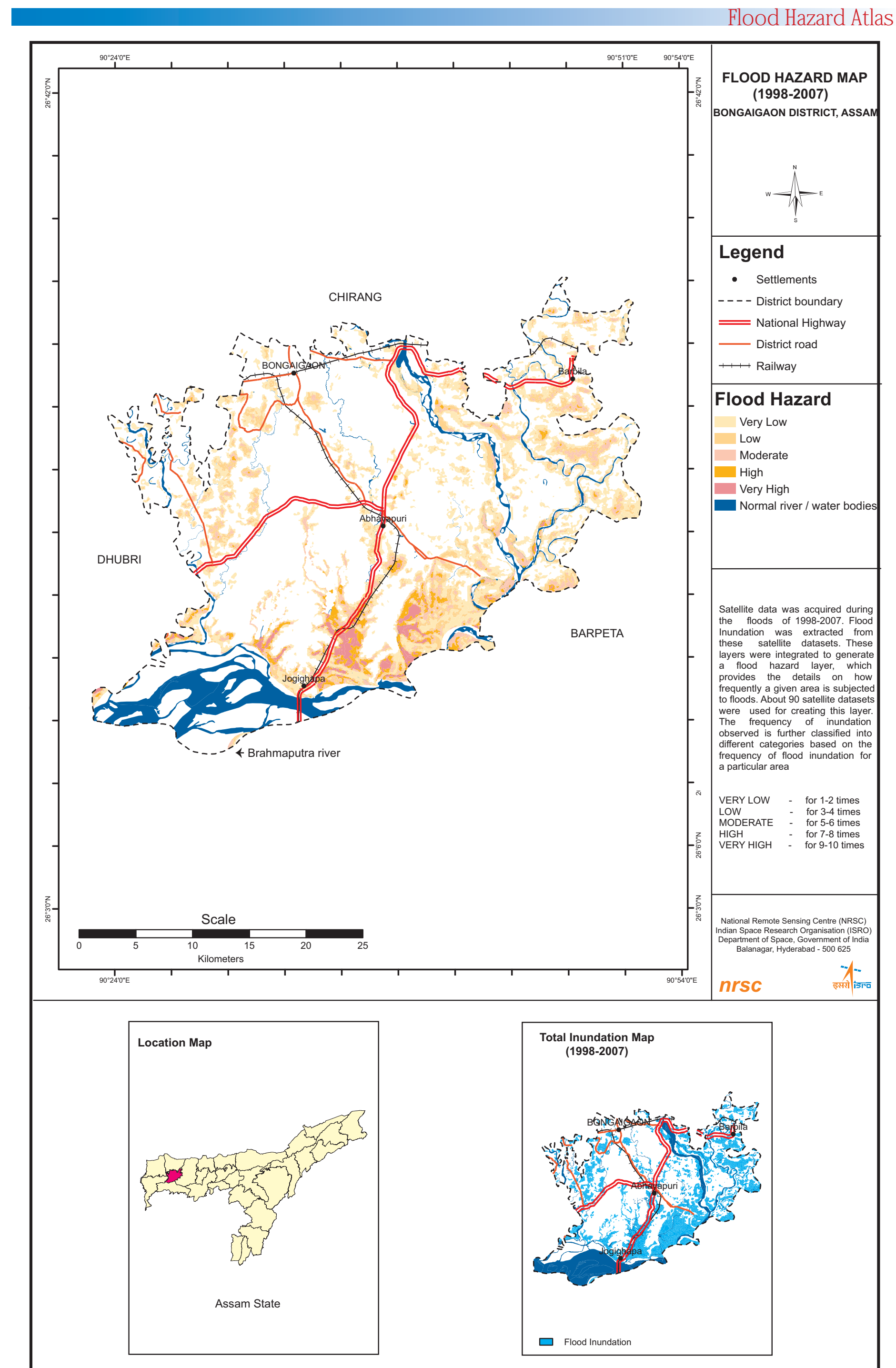
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (36 nos)

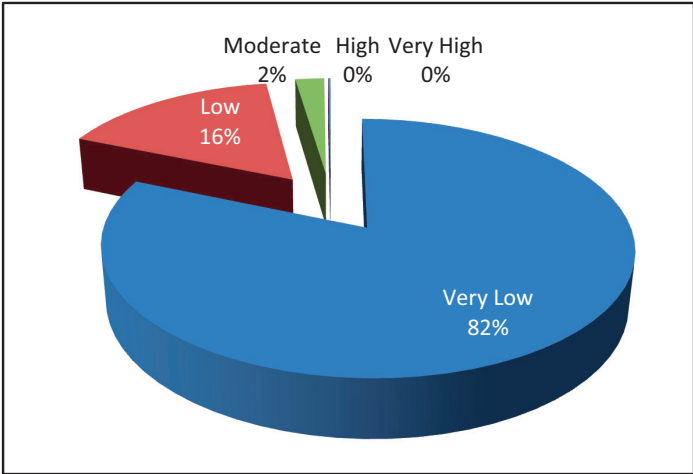
Amguri Part-I	Kheluapara Part-II
Amguri Part-II	Khoragaon Part-III
Arimari	Lalmati
Balapara	Latibari Part-I
Barjana Part-I	Latibari Part-II
Barjana Part-II	Pachonia Pahar
Beltoli Simalartoli	Pachonia Part-II
Bhakumari Part-I	Salabila No.1
Bhalipara Part-II	Sikatari Part-II
Bhomapara	Similaguri
Chautaki	Tinkonia Part-III
Chotobarjana	Uttarkhoragaon Part-II
Goraimari	Bechimari
Kabaitari Part-I	Bhakumari Part-II
Kabaitari Part-II	Chalantapara Part-I
Kabaitari Part-III	Chalantapara Part-II
Kabaitari Part-IV	Hakodoba Part-II
Kanarabeel	Malegarh Part-II



Baska
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	21303
2	Low	4278
3	Moderate	566
4	High	37
5	Very High	7

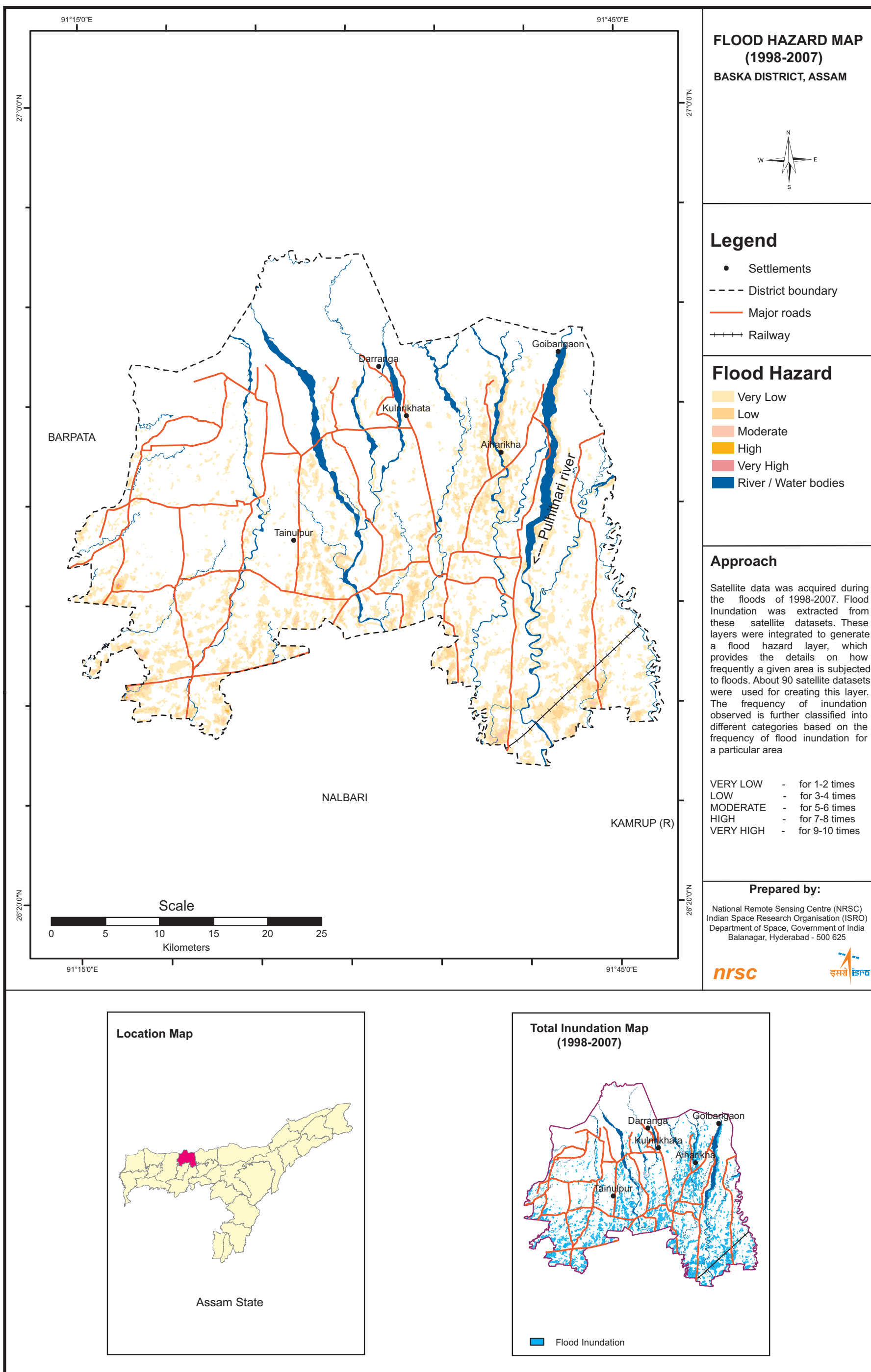
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (17 nos)

Barkhata
Barpathar
Chapatal
Dhulabari
Dipta
Gurmou
Nakuchi
Niz Namati
No.-2 Nathkuchi
No-2 Dongargaon
No-2 Pipleni
Pub Athiabari
Santipur
Sarubalisiha
Satiapara
Suradi
Vehguri

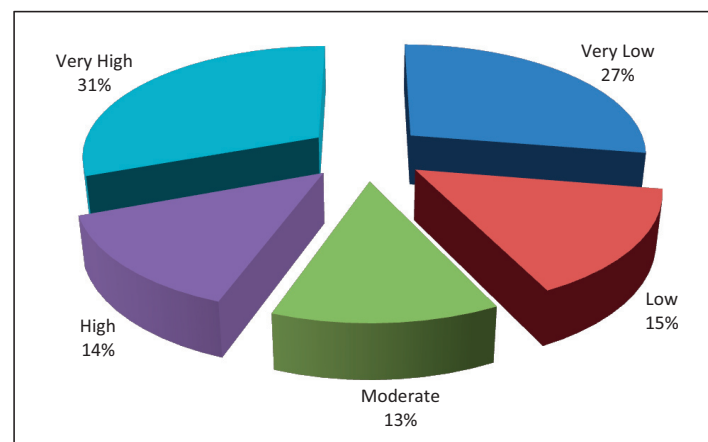


Cachar

Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	25599
2	Low	14091
3	Moderate	11803
4	High	12844
5	Very High	28435

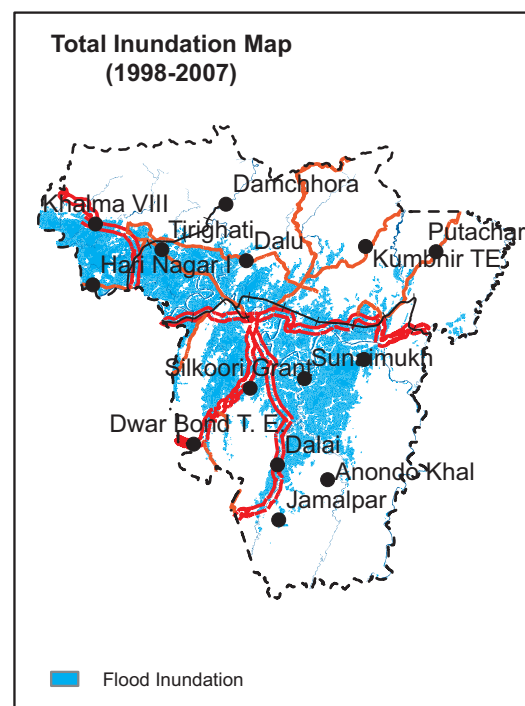
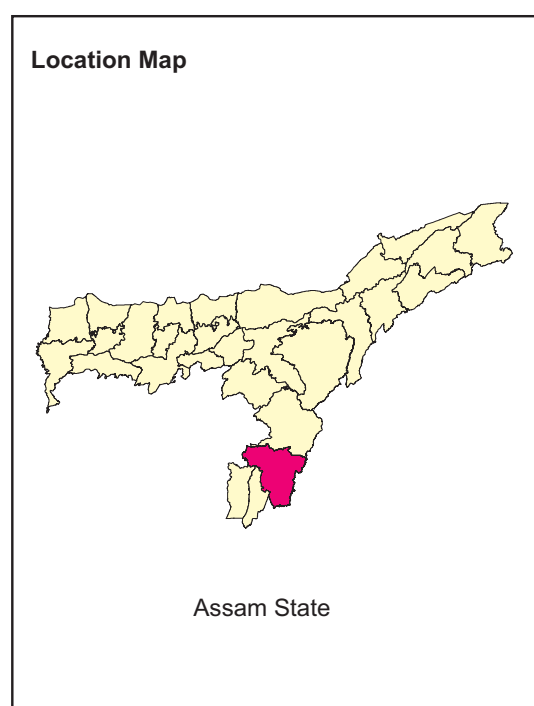
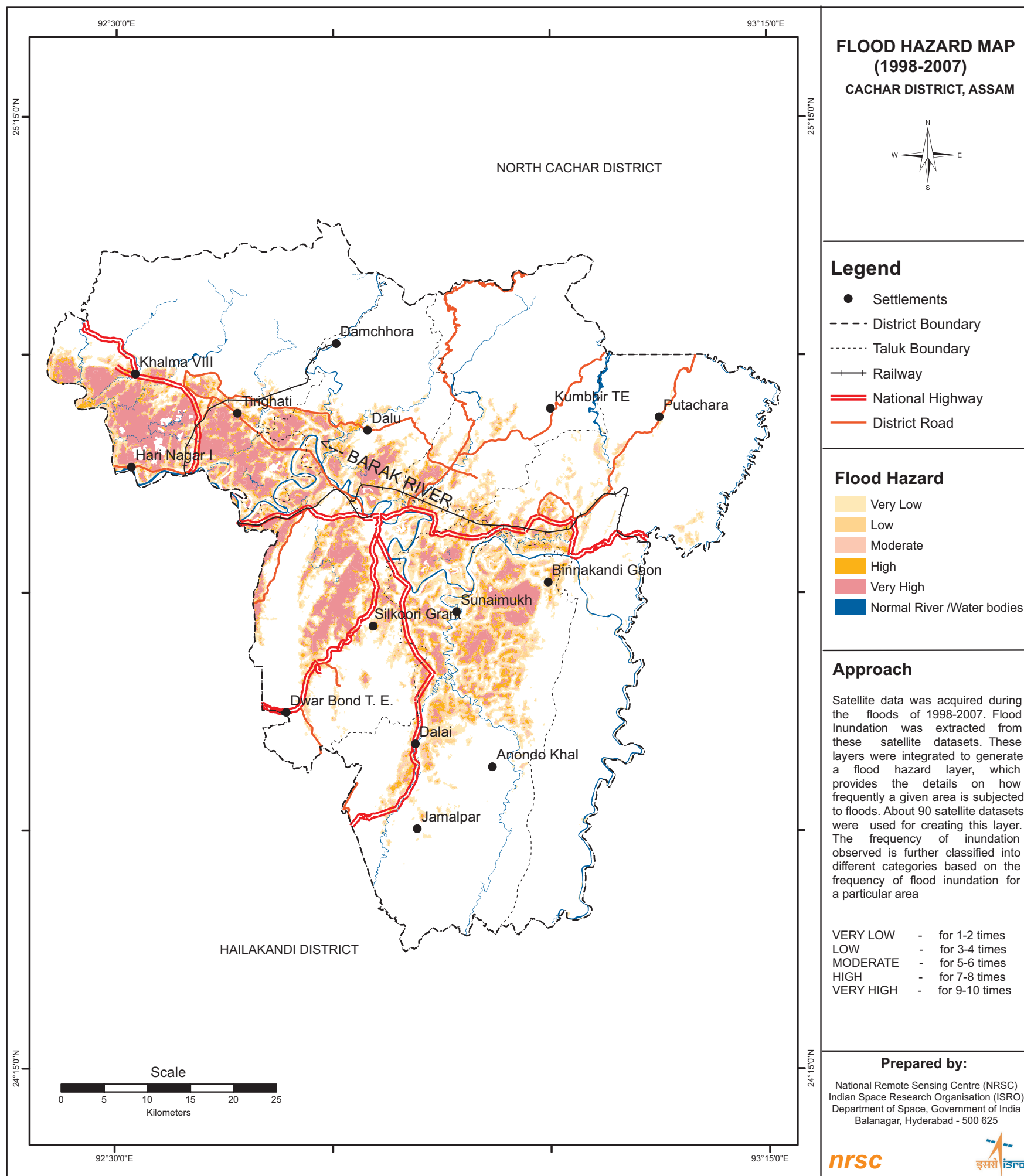
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (295 nos)

Alambag	Chandi nagar I	Durganagar	Khalma III	Norsingpur V
Algapur I	Chandi nagar III	Durgapur	Khalma IV	Pashin Barain Howar
Alipur II	Chandi nagar IV	Forest	Khalma V	Pathri gram
Ambicapur I	Chandi nagar V	Goarh Bond I	Khalma VI	Pir Nagar
Ambicapur II	Chandi nagar VI	Gobido Nagar	Khalma VII	Purandharpur
Ambicapur III	Chandi nagar VII	Gobindapur I	Khatal Grant	Raj Ghat
Ambicapur IV	Chandpur	Gobindapur II	Kurkuri I	Rajiswarpur I
Ambicapur V	Chandpur I	Gobindapur III	Kurkuri II	Rajiswarpur II
Ambicapur VI	Chandpur II	Gobindar Kupa	Kurkuri III	Rakhal Tila
Ardvollick	Chandpur III	Gonir Gram	Kusmir kol	Rakhalarpar I
Babi pur	Chandpur IV	Gonir Gram II	Lakhipur II	Rangpur Ghat I
Badarpur I	Chandrapur I	Goravitor I	Lakhipur III	Rangpur Ghat II
Badarpur II	Chandrapur II	Gumra Grant	Lakhipur T.E.	Rani Nagar
Badripar II	Chang Dwar I	Hairbond I	Lalang II	Rongpur II
Badripar III	Chankoori grant	Hairbond II	Lalang III	Rongpur III
Badripar IV	chasree	Hari Nagar I	Lalang IV	Rose Candi I
Baglaghat	Chiripar II	Hari Nagar II	Lati Mara	Rose Candi II
Bagpur II	Chivita Bichia II	Hatihar I	Machimpur II	Roypur
bajantipur I	Chivita Bichia IX	Hatihar II	Malu gram	Rukni II
bajantipur II	Choto Jalamga I	Islamabad	mapharpur	Rukni III
bajantipur III	Chutra Sangan	Jagadishpur I	Mari Nagar I	Rukni T.E.
Balair Bond	Clover House IV	Jagadishpur II	Mari Nagar IV	saidpur
Bar - Sangan Grant	D' Sonpur	Jagadishpur III	Masu Grant	Saidpur II
Baraback I	Dakin Mohan pur I	Jagadishpur IV	Merua Grant	Saidpur III
baraback II	Dakin Mohan pur III	Jagadishpur V	Mohadevpur	salchapar I
Barik Nagar I	Dakin Mohan pur IV	Jaiforpur	Mohadevpur I	salchapar II
Bath Gram	Dakin Mohan pur V	Jarail Tula	Mohadevpur II	salchapar III
Bhairabpur I	Dakin Mohan pur VI	Jingerball	Mohadevpur IV	Salchakra I
Bhairabpur III	Dakin Mohan pur VII	Kachu Daram I	Mohanpur	Salchakra II
Bhairabpur V	Dakin Mohan pur VIII	Kachu Daram II	Monipur	saraspur
Bhangarpar I	Dakin Mohan pur XII	Kachu Daram IV	Monipur I	Sauti II
Bhangarpar II	Darby T.E.	Kachu Daram V	Mopur III	Sauti III
Bhangarpar III	daurikandi I	Kajidhar I	Mou Gram	Sauti IV
Bhangarpar IV	dayapur III	Kajidhar II	najatpur	Shivnarayanpur
Bharakhi Grant	debpara	Kajidhar III	Natun Kanchanpur	Shivpur II
Bihara II	Dhonipur	Kalinagar	Natun Kanchapur	Shivpur III
Bihara IV	Dhonohori III	Kalinagpur I	Natun Ram nagar I	Siddaswar I
Bihara V	Dhonohori IV	Kalinagpur II	Natun Ram nagar II	Silkoori Grant
Bihara VI	Digabor	Kaptainpur II	Natun Ram nagar III	Singirbond II
Binakandi II	Digar Kashipur Grant	Kaptainpur III	Natun Ram nagar IV	Singirbond V
Binnakandi Gaon	Digar Srikona I	Kaptainpur IX	Neyer Gram I	Snapur III
Biswa muar	Dudpatil I	Kaptainpur V	Neyer Gram II	Sonabari Grant II
Bitor Chotfy	Dudpatil II	kaptanpur I	Nichintapur	Soto Mamada Grant
Boloi-Hawar	Dudpatil III	kaptanpur XI	Niskantapur	Sundari III
Bon Gram	Dudpatil IV	kaptanpur XII	Niz Banaskandi I	Tali Gram
Boranga I	Dudpatil V	kaptanpur XIII	Niz Banaskandi II	Tali Takarl
Boranga IV	Dudpatil VI	kaptanpur XIV	Niz Chatla	Tali TakarlI
Boratoli I	Dudpur I	kaptanpur XV	Niz Jalalpur I Niz	Talkor Grant
Boratoli II	Dudpur II	kaptanpur XVI	Laverpura I	Tapang I
Boratoli III	Dudpur III	kaptanpur XVII	Niz purairball	Tapang II
Boratoli IV	Dudpur IV	kaptanpur XVIII	Nizbokhola I	Taranipur I
Boratoli V	Dudpur V	KashipurIV	Nizfulbari I	Taranipur II
Borjatrapur	Dudpur VI	Kata Kandi I	Nizfulbari III	Taranipur III
Boro Mamada Grant	Dulal Gram	Kata Kandi II	Noar Bond Grant	Tarapur
Boro Rampur	Dungaipar I	Katigora I	Nogdir Grant II	Tarapur IV
Buranga II	Dungaipar II	Katigora II	Norsingpur I	Tarapur VII
Buranga III	Durga Nagar II	Katigora III	Norsingpur II	Tarutaj Bari II
Burirai II	Durga Nagar III	Khalma I	Norsingpur III	Tila Nagap
Burirai III	Durga Nagar IV	Khalma II	Norsingpur IV	Ujan Gram

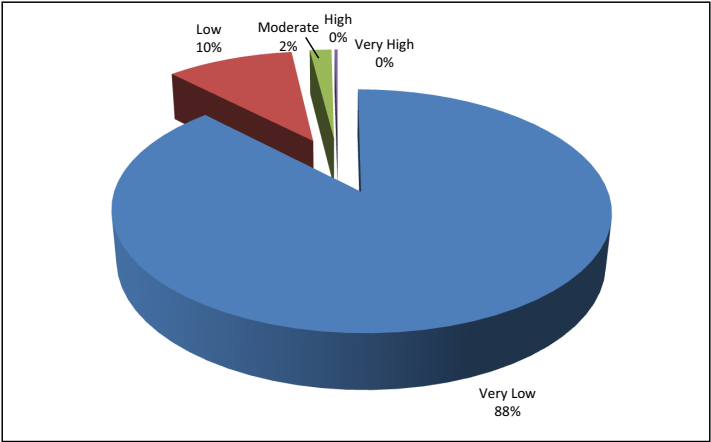


Chirang

Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	11562
2	Low	1344
3	Moderate	229
4	High	32
5	Very High	0

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (8 nos)

Bedlengkhaiti
Dewanpara No.1
Garaimari No.3
Gossaingaon
Kakragaon
Kaliagaon
Kathalpara
Monakosa No.2



- Settlements
- - - - District boundary
- Major roads
- + + + + Railway

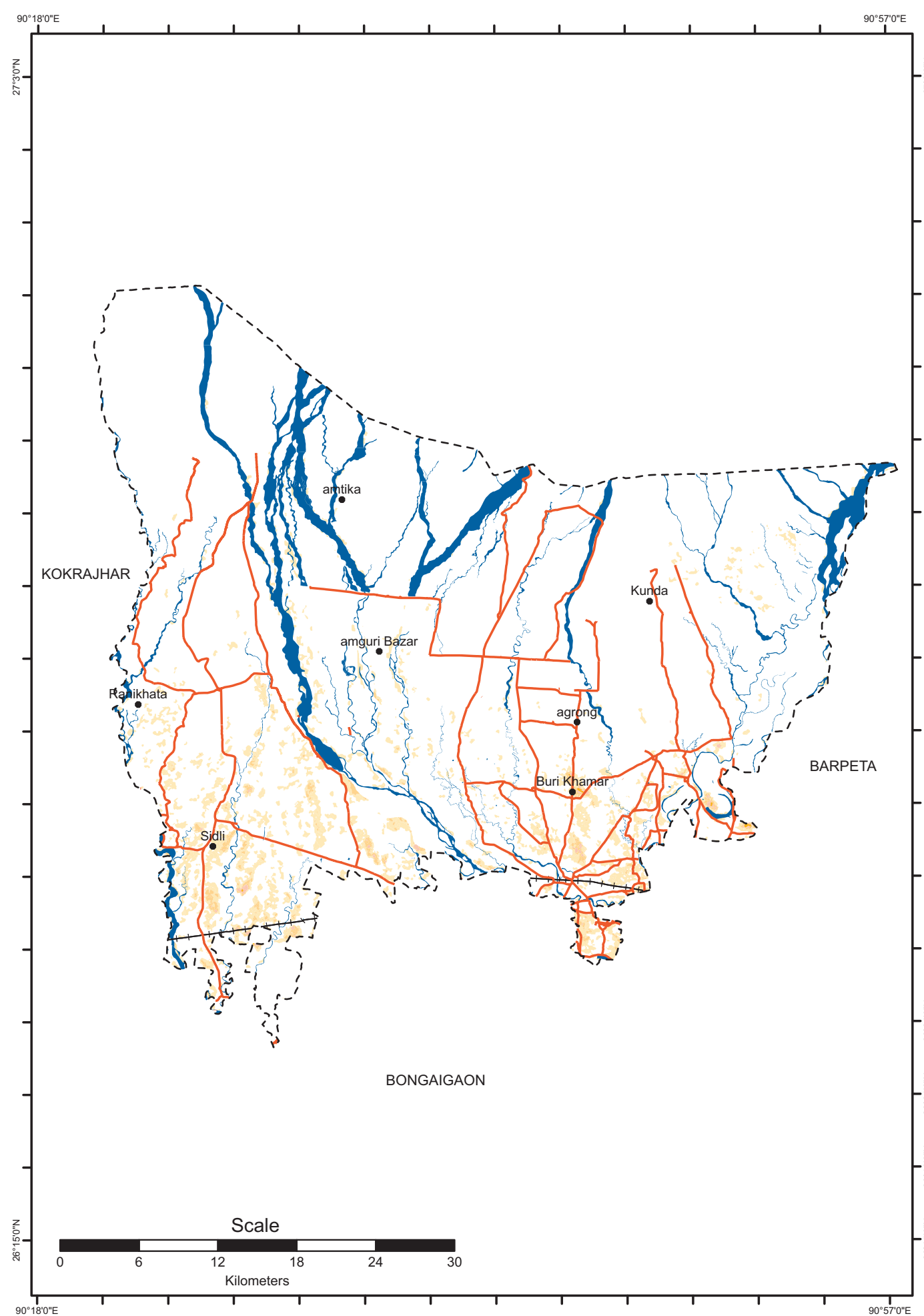
Very Low
 Low
 Moderate
 High
 Very High
 Normal river/water bodies

Satellite data was acquired during the floods of 1998-2007. Flood Inundation was extracted from these satellite datasets. These layers were integrated to generate a flood hazard layer, which provides the details on how frequently a given area is subjected to floods. About 90 satellite datasets were used for creating this layer. The frequency of inundation observed is further classified into different categories based on the frequency of flood inundation for a particular area

VERY LOW	-	for 1-2 times
LOW	-	for 3-4 times
MODERATE	-	for 5-6 times
HIGH	-	for 7-8 times
VERY HIGH	-	for 9-10 times

National Remote Sensing Centre (NRSC)
Indian Space Research Organisation (ISRO)
Department of Space, Government of India
Balanagar, Hyderabad - 500 625

nrsc



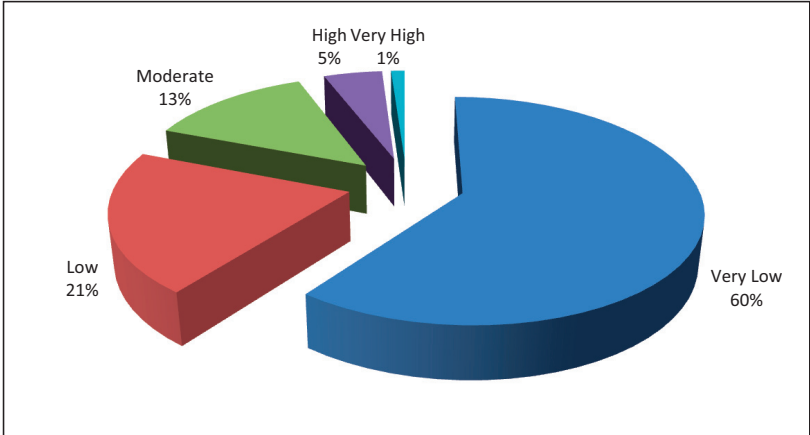
Assam State

 Flood Inundation

Darrang
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	70250
2	Low	23777
3	Moderate	15449
4	High	5533
5	Very High	1285

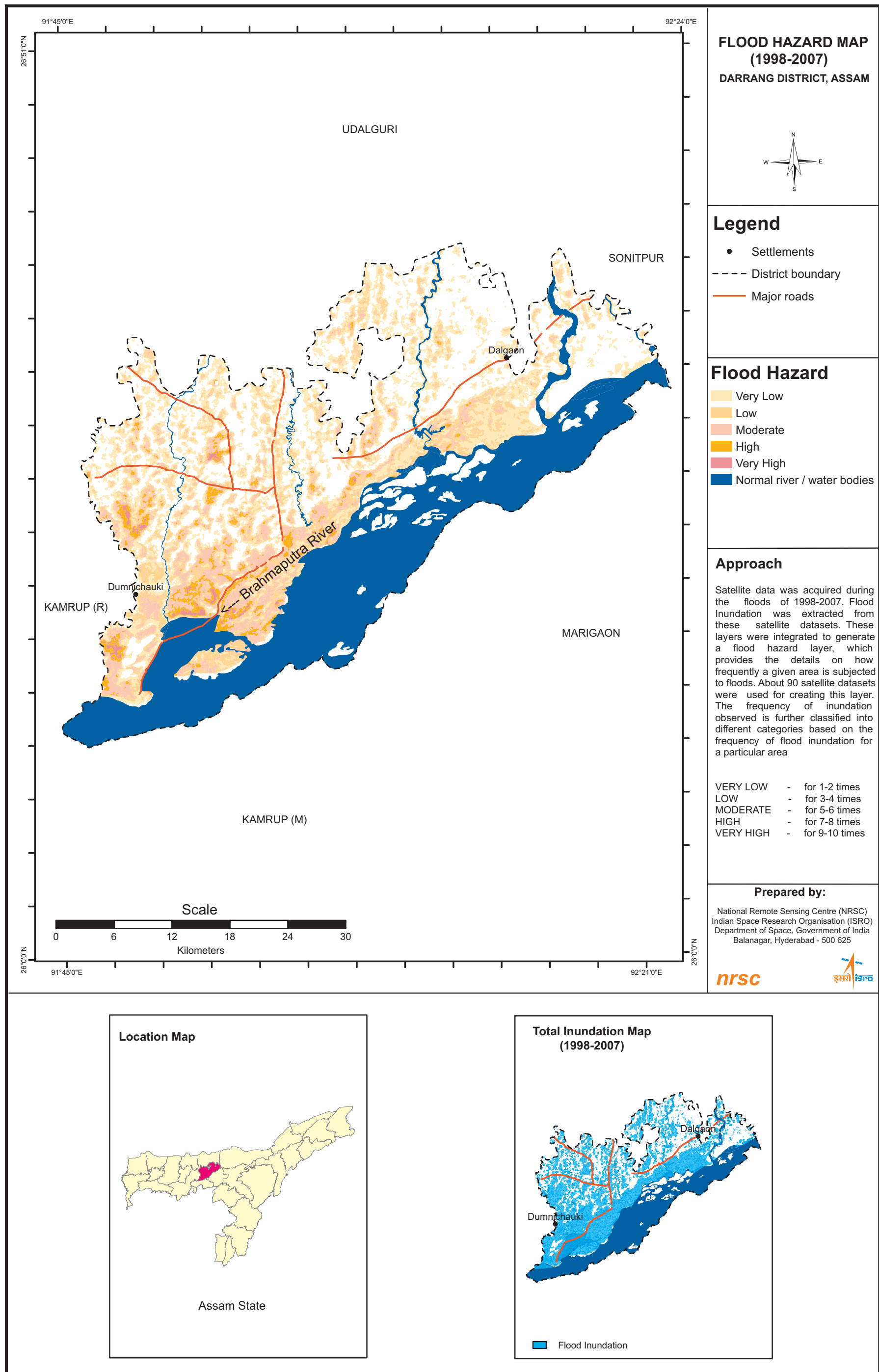
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (45 nos)

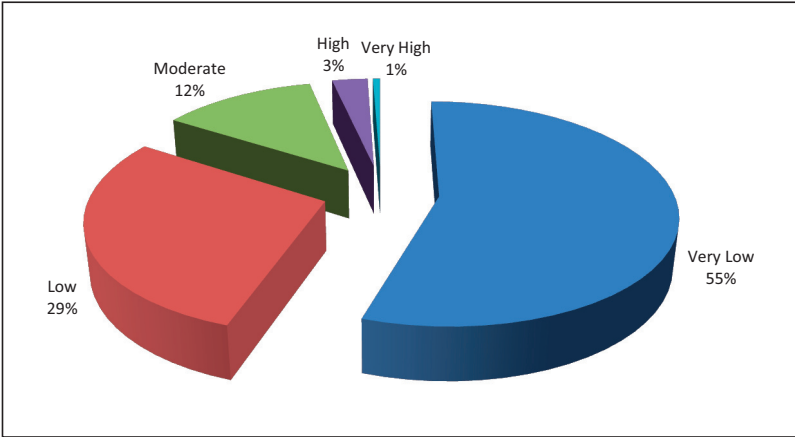
Bagachala	Khadan Mara
Bagh Para Chapari	Kumar Para Maharidal
Bandia Gaon	Manitari
Bara Chuba	Nijsipajhar
Barkaliajhar	No.1 Ghatarag
Bhokeli Khanda	No.2 Changapara
Bhotadal	No.2 Ghatarag
Bishnupur	Nowdingadal
Chakarmukh	Nowpota
Chalardal	Palhabange Chuburi
Chamua Para	Pashim Kuruah
Chamukha	Patidarrang
Dholpur No.2	Rajapukhuri
Dholpur No.3	Rangamati Barmari
Dostany	N.C.
Durduria	Sanowa
Ganak Para	Sanowatari
Geri Mari Chapari	Satkhali
Hatimuria	Suktaguri No.1
Hira Para	suktaguri No.2
Kabaichuba	Suktaguri Pathar
Kacharipara	Sutiakatadal
Kalita Para	



Dhemaji
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	64736
2	Low	33871
3	Moderate	14726
4	High	3397
5	Very High	687

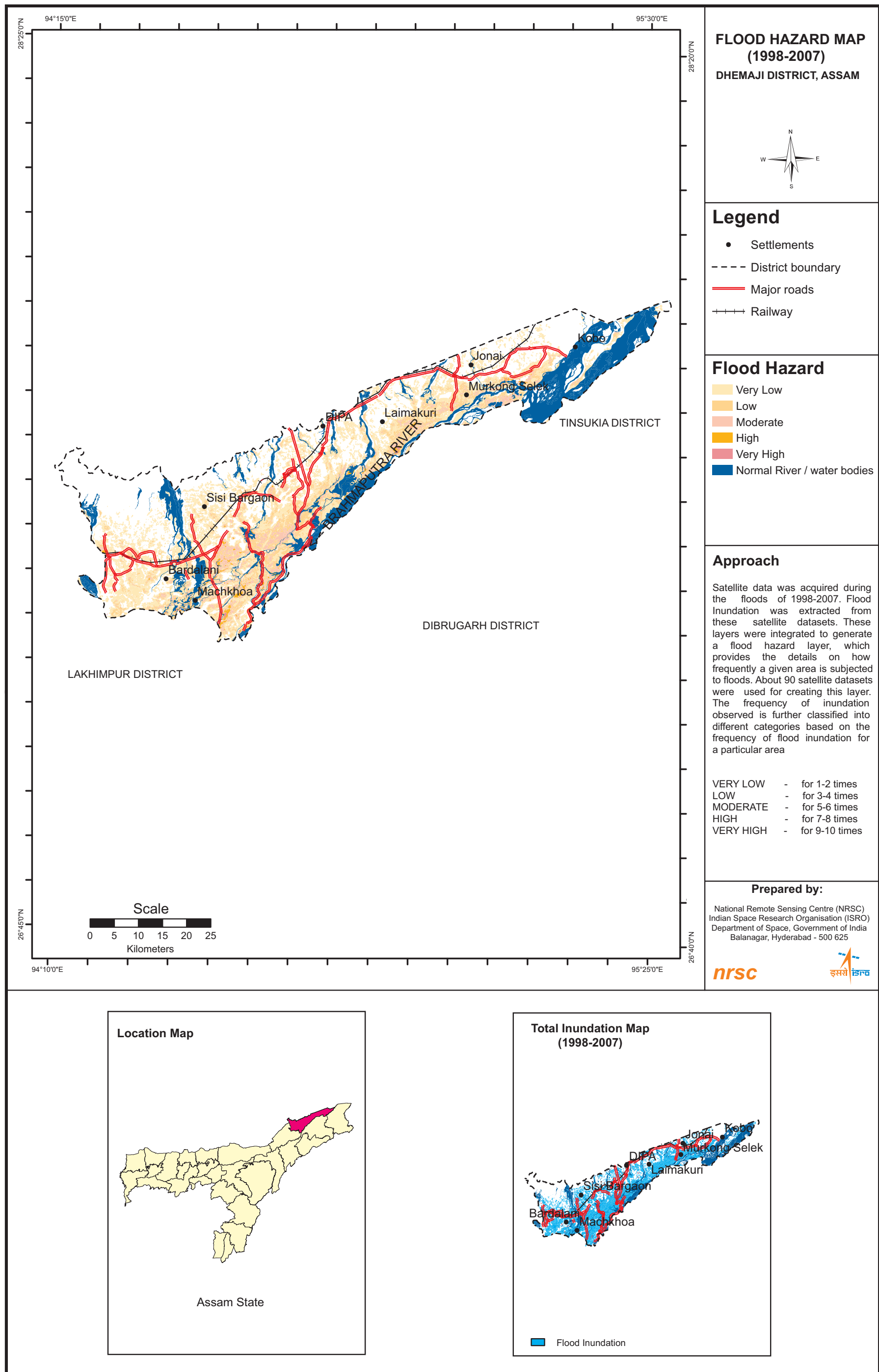
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (11 nos)

Barhabí Dikhari
Bordoi Bam 296 No.
Dizmur Miri
Garubondha Block
Jorkata Bongali
Majgaon
Mati Khola
Mishamara Dikhari
No.1 Languabora
Patta No.1, 10 Tea
Sawaria Gaon

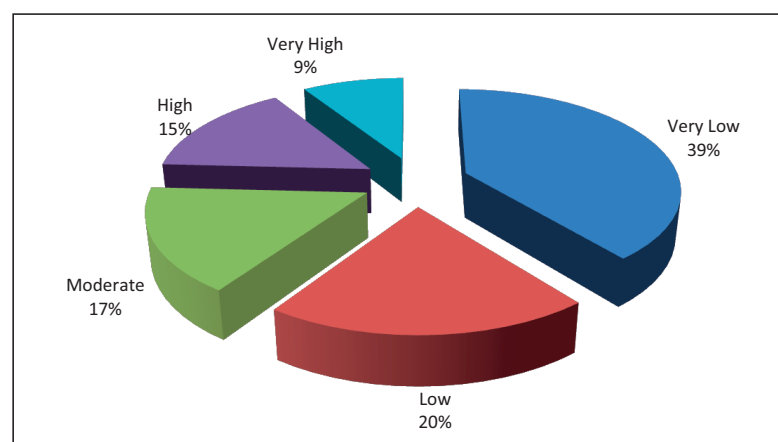


Dhubri

Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	38707
2	Low	20047
3	Moderate	16119
4	High	14945
5	Very High	8935

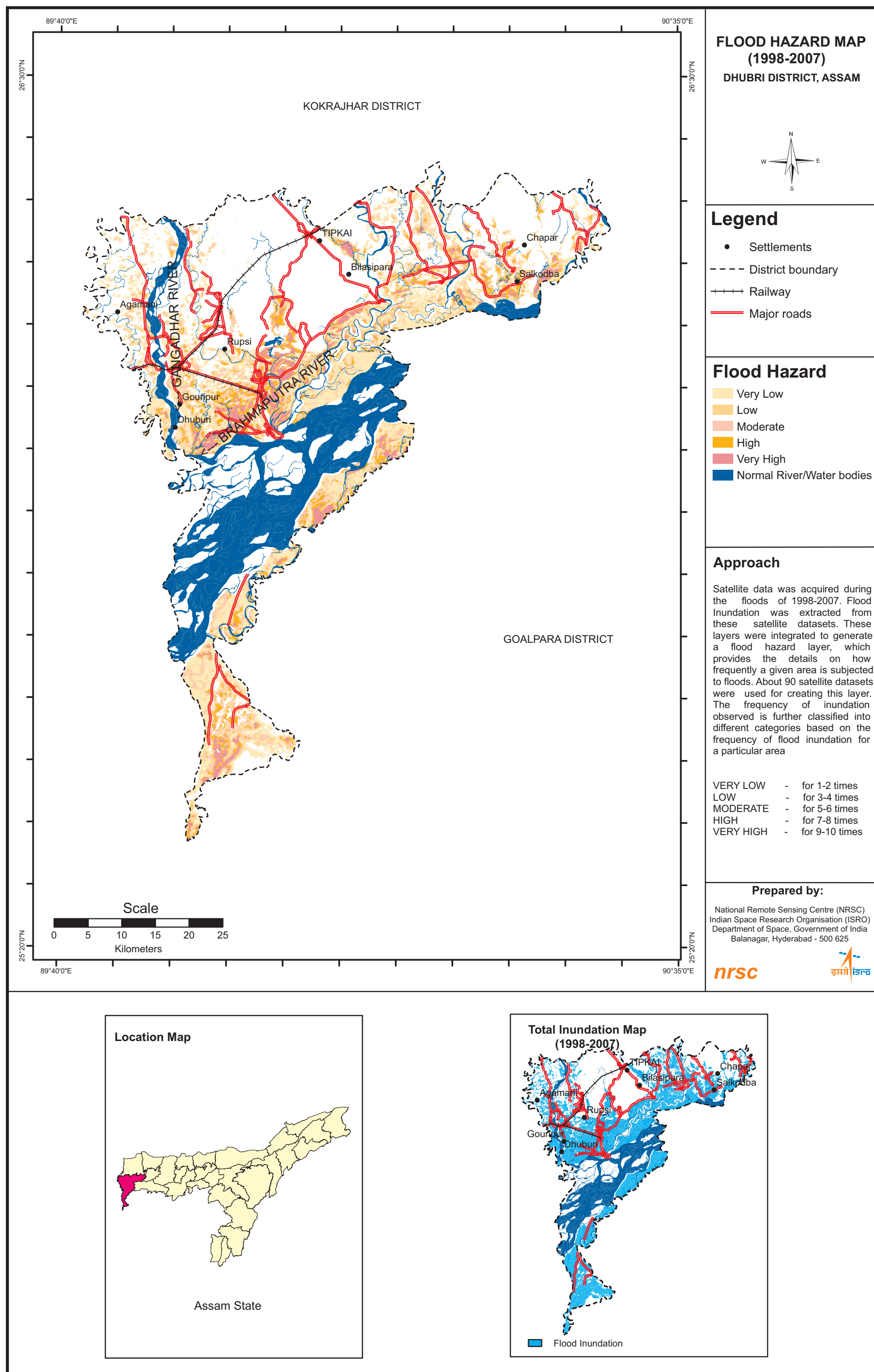
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (202 nos)

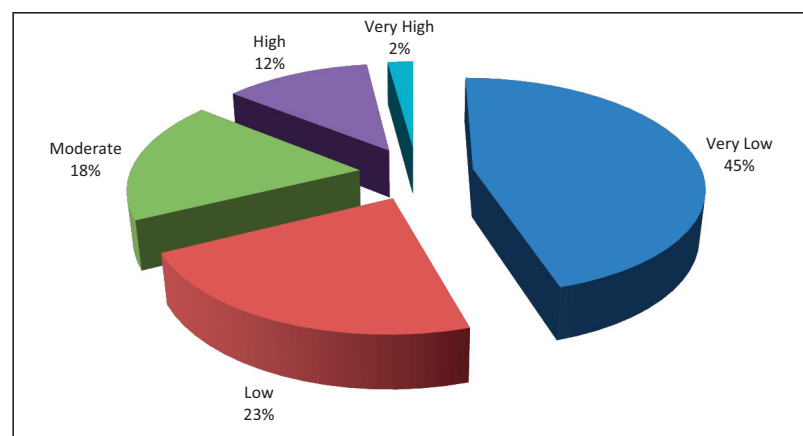
Adabari I	Chagolchara I	Fulerchar	Khalipur	Piaz Bari Pt-Ii
Aironjangla Ii	Chagolchara Ii	Fulerchar-Ii	Khamar	Poddar Alga Pt.I
Alomganj Ii	Chakaikhola	Fulerchar-Iii	Khanabari Araiani Pt	Puranapanbari
Alomganj Iii	Chalakurachar	Fulerchar-Iv	Kharida Gosaigaon	Raghupara
Alomganj Iv	Changbandha Pt.Iii	Fulgacha	Kharuabandha-I	Rajabala
Alomganj Vii	Char Katdanga Pt-I+I	Gambhira Khata-I	Kheksiali	Rajapara Pt Ii
Aluabari	Charaldanga	Gambhirakhata-Ii	Kherbari Pt-Iv	Ramsorobar
Alupara Pt.I	Chilkikhata Pt. I	Gauripur Town	Khopatia Pt-Iv	Rangamati Jhar Pt. I
Alupara Pt.Iii	Chinamari	Ghashbari	Khudhigaon-Ii	Rangamati Pt.I
Angarkata Ptii	Chirakhowa Pt.Ii	Godairbhita	Khurkhuri	Rangamati Pt.Iii
Arranya	Chirakhowa Pt.Iii	Gokulpur Tenganmari	Khutabagra Pt-I	Routhmari
Asomkata	Choto Kulia Pt-Ii	Guma Reserve N.L. Sh	Kkachuarkhas	Rowah Ii
Baghmara	Choto Kulia Pt-Iii	Gutipara Pt. Vii	Hasdaha	Rowah Iii
Bagulamari Pt.Ii	Chotobachani	Gutipara Pt.V	Kokradanga-Ii	Rowar Kuti
Baladoba Iii	D. Raipur I	Gutipara Pt.Vi	Kuntirchar Ii	Rupshi Pt-Iv
Bangal doba Pt-Ii	Dakhin Tokererchar	Haldibari-I	Kurshakati	Sadhu Bhasa No.2
Baniamari	Dakhin Kach Khana	Hapapara Pt-Ii	Lahajani	Salmara Pt.Iii
Baniamari Pt Vi	Dakuwamari	Harjhora	Machipara Pt.I	Shyamcharkuti Iii
Baraibari Ii	Dalsingaralga I	Hatibanda	Madhusaulmari Ii	Siber Alga
Baraibari Iii	Darchanka I	Hatsingimari	Madotipahar Basti-Iv	Silbari
Barshijhora-Iii	Darirpar Maizali	Isarpanga	Mairakuchi Pt-Ii	Silghagri I
Barundanga	Debottar Hasdaha Pt-	Jalai Gaon	Majerlga	Simlabari Pt-I
Bedlongmari	Dehi Chapar	Jaldoba Pt-Ii	Malakhaar	Singimari Ii
Berabhangal-Ii	Dhaka Bill	Jamadar Para	Malandubijhar Block	Sonamaya I
Berbhangi Pt-I	Dhanua	Jatikura	Maliralga-Ii	Soulmari Pt-Ii
Berbhangi Pt-Iii	Dharmasala I	Jhalopara	Masuai Kutir Jhar Pt	Sreegram Pt-I
Bhabanipur	Dharmasala Ii	Jhaloralga Ii	Matiadol	Sukanjhora Pt.Ii
Bhakurchar	Dhirbil	Jharner Char Pt. Ii	Moinabondha	Sundar Para Pt-Iv
Bhelakoba	Dholagaon-Ii	Jharner Char Pt.I	Nalia Pt-I	Suparikuti
Bhelengamori	Dhubri Town	Jharner Char Pt.Iv	Nalia Pt-Iii	Tangaon Pt. I
Bhowrijhora	Dhurbari Pt.Ii	Jheltar Char Pt.Iii	Nirikhel Khowa	Thuriapahar
Bhutiadanga	Dikhopati-Iii	Kachuarkhas	Paddarbhita	Tiamari I
Binnachara I	Dukhi Sukhi Jhar Pt-	Hasdaha	Paikandara-Iii	Tisterpar
Binnachara Ii	Dumardaha Pt-Ii	Kalairalga-I	Pakihaga-Ii	Tolli Pt-I
Bisandai Pt-Iii	Dumardaha Pt-Iv	Kaldoba pt_ Iii	Pakiramirjhar-Ii	Tongarita
Biskhowa Pt-Iii	Durahati	Kanaimara-I	Paschim Gaikhowa Pt-	Tushpara
Biskhowa Pt-Iv	Duttala	Katalamari Pt.Iii	Paschim Kanuri Pt-I	Uramari-I
Boalkamari-I	Falimari I	Katdanga Satdubi Pt-	Paschim	Uttar Raipur Pt-Ii
Borbhita	Fasatpur	Kathalbari	Moragadadhar	Uttar Tokorerchara P
Borbila I	Fekamari-Ii	Kazigaon-Iii	Pashuarkhal-I	
Borkanda	Ferengichar	Kedar Pt-Ii	Pashuarkhal-Ii	
Boro Rabhatary Pt-Ii				



Dibrugarh Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	53139
2	Low	26210
3	Moderate	21169
4	High	14210
5	Very High	2506

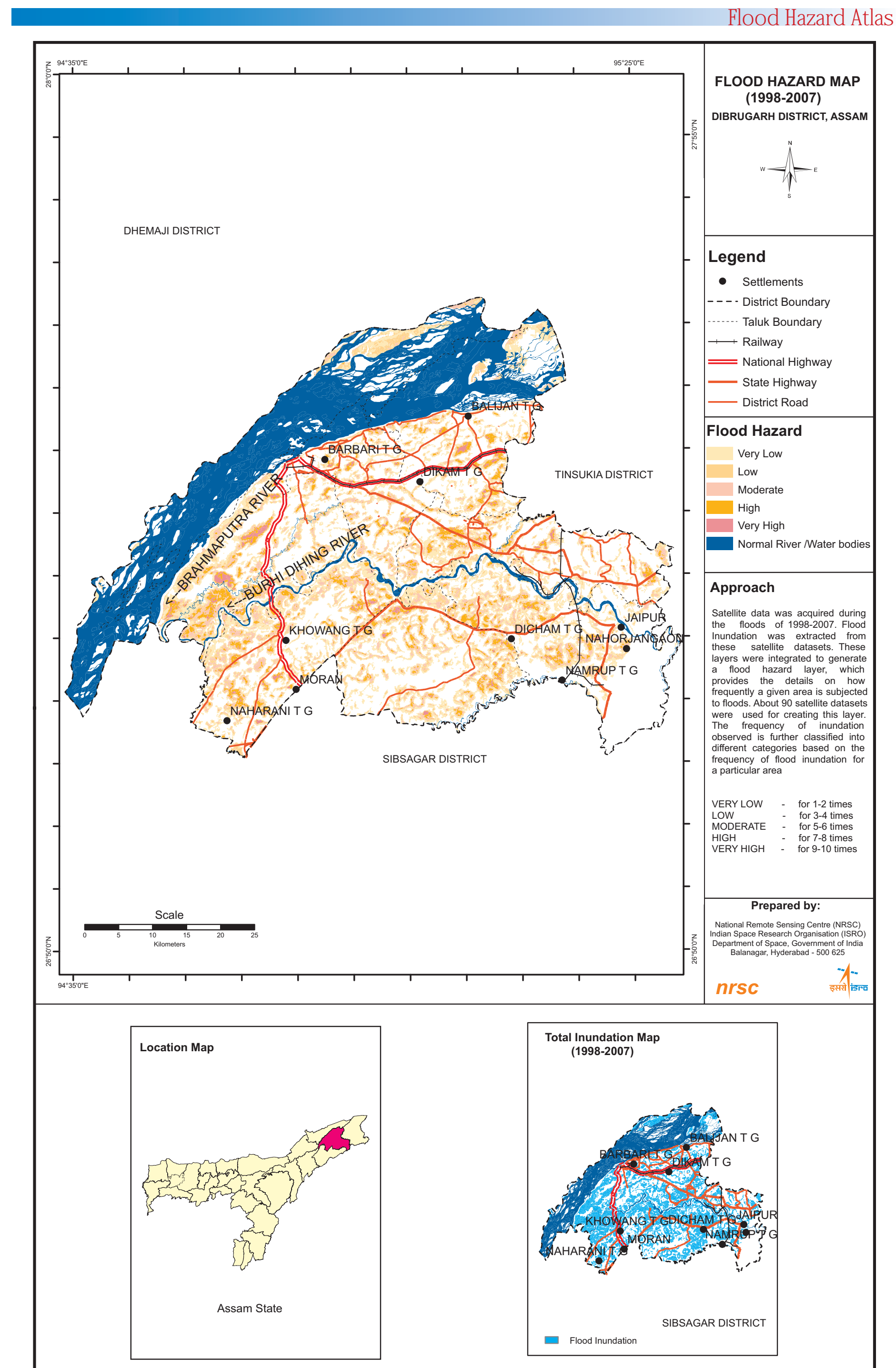
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (179 nos)

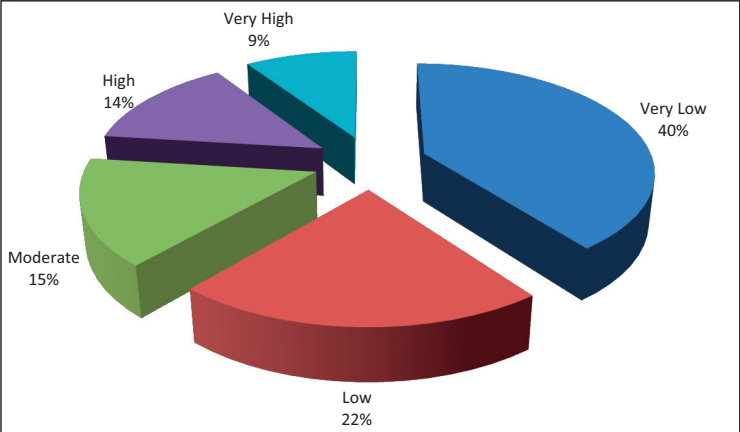
1 No.Leorgeri Gaon	Chomni Gaon	Gondhia No.1	Kutaha Bangal	Patra Gaon
Alimur Gaon	Chungi Chuk Gaon	Gurania No.2	Lebang Khula Gaon	Phatikachowa
Amguri	Chungi Pather Gaon	Haldhibari Bor Pather	LENGRI, NAMDANG R.F.	Abhoyapuria Gaon
Asamia Gaon	Dehing Hola No.1	Hatigarh N.C.	Lepat Kata Gaon	Pulunga Gaon
Bacha Gaon	Denga Chuk	Hatikhola Bongali	Lezai Gaon	Pulungari Rajabari
Bairagimath Kachari Gaon	Deobil Gaon	Hatimura Gaon	Lezai Gaon Pather	Rasipather No.1
Balijan Chah Bagan No.117	Deodhai Kapahuwa	Hiloidhari Chandoi Gaon	Lezai Miri Pather	Romai Bongali
Balimora	Deogharia No.1	Hologuri Gaon	Longboi	Romai Gaon
Bamunibil No.3	Dewanbari Gaon	Jamuguri Konwari Pather	Losongaya Miri N.C.	Rong Chungi
Bamunpukhuri	Dhopabar Chuk	Jamuguri No.1	Madhakali No.1	Sachani
Barahi Da-Pather	DIBRU R.F.	Jatiyani	Mahmora Kapohua	Saragphola Gaon
Barghoguloni	Dibrual Dihingia Gaon	Jun Gaon No.1	Majumolia Gaon	Saru Abhoyapuria
Barpather Konwar Gaon	Dighali Daloni Gaon	Kachalo	Marani Amguri	Sisumaria Borpather
Bebejia Gaon	Dighalia Gaon	Kachari Pather No.1	Marani Pather	Sologuri 9/182>NNL TP Grant Vi
Betoni No.2	Digholia No.1	Kachogaon	Mathawani	Sologuri No.1
Bhajani	Dihing Kaibarta Gaon	Kala Khowa Gohai Gaon Kamaldai Gaon	Merbondha Gaon	Subha Chuk Gaon
Bhardhora Bongali	Dihingia Gaon	Kamar Gaon	Nabhakatia No.1	Sukan Pather
Binoigatia Gaon	Dihingmukh R.F.	Kamarchuk Bakobot	Naga Chuk Pather	Tairai Gaon
Bor Pather No.1	Dikam Chacha Gaon	Kapahuwa	Nahar Saku Gaon	Tamuli Khat Gaon
Borbam No.1	Dikhari Moran No.1	Kathalguri Gaon No.1	Naharani Block No.1	Tarani Pather
Borkheremia Gaon No.2	Dinjan Satra	Kathalguri-2	Nahazar Kanwar Gaon	Tepor Pather Gon
Borkheremia Ghilaguri	Dinjoy Chapori T.E.	Kereng	Nahazar Sonowal	Thangal No.1
Bormeshlow Gaon	Dolonikur Kumar Gaon	Kheroni Pathar	Nahrani Block No.2	Thengal Gaon
Burhayar Kanwar Gaon	Duchuk Bakobat	Khongia Gaon	Nakari Village	Timona Gaon
Chagali Pather	Ekorani No.2	Khowang Chah Co 108 No. f.s.Gr	Na-Khat Sonowal	Tingkhongia
Chakli Bharalua	Fatikachowa Ahom Gaon	Khowang Grant	Naloni Grant No.29	Tingrai Doom Gaon No.2
Changmai Gaon	Gandhiya Gaon	Khowang Sonowal Bengali	NC	Tingrai N.C.
Changmai Gohain Gaon	Ganisuk Kobor	Kowoimari Gaon	Nigam Gaon	Tinsukia Gaon
Chanimari Gaon	Garaguri Choudhung No.1	Kukuraphuia (Santipur)	Niz Bhekulajan	Tipomia
Chapatoli No.1	Garpara Konwar	Kuli Gaon	Niz-Khanikar	Tipomia Bangali
Charing Pather	Gharahi	Kuli No.2	Niz-Tengakhath Gaon	Tipomia Dighalia
Chekoli Baria Gaon	Ghalon	Kumar Gaon	Nowjan Habi	Tipomia No.1
Cheleng	Gharbandi Borpather	Kushia Khana Gaon	Ouguri Kapahua No.1	Wilton 22/157 ORR
Chiring Khat Gaon-1	Ghogulani		Ouphulia	
Chiringhola No,1	Ghortong Bangali Gaon		Pani Gaon	
	Gondhia N2		Panimoli Gaon	
			Panitola Khowa Gaon	
			Paniyebura Pather No.1	



Goalpara
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	30599
2	Low	16662
3	Moderate	11988
4	High	10544
5	Very High	7194

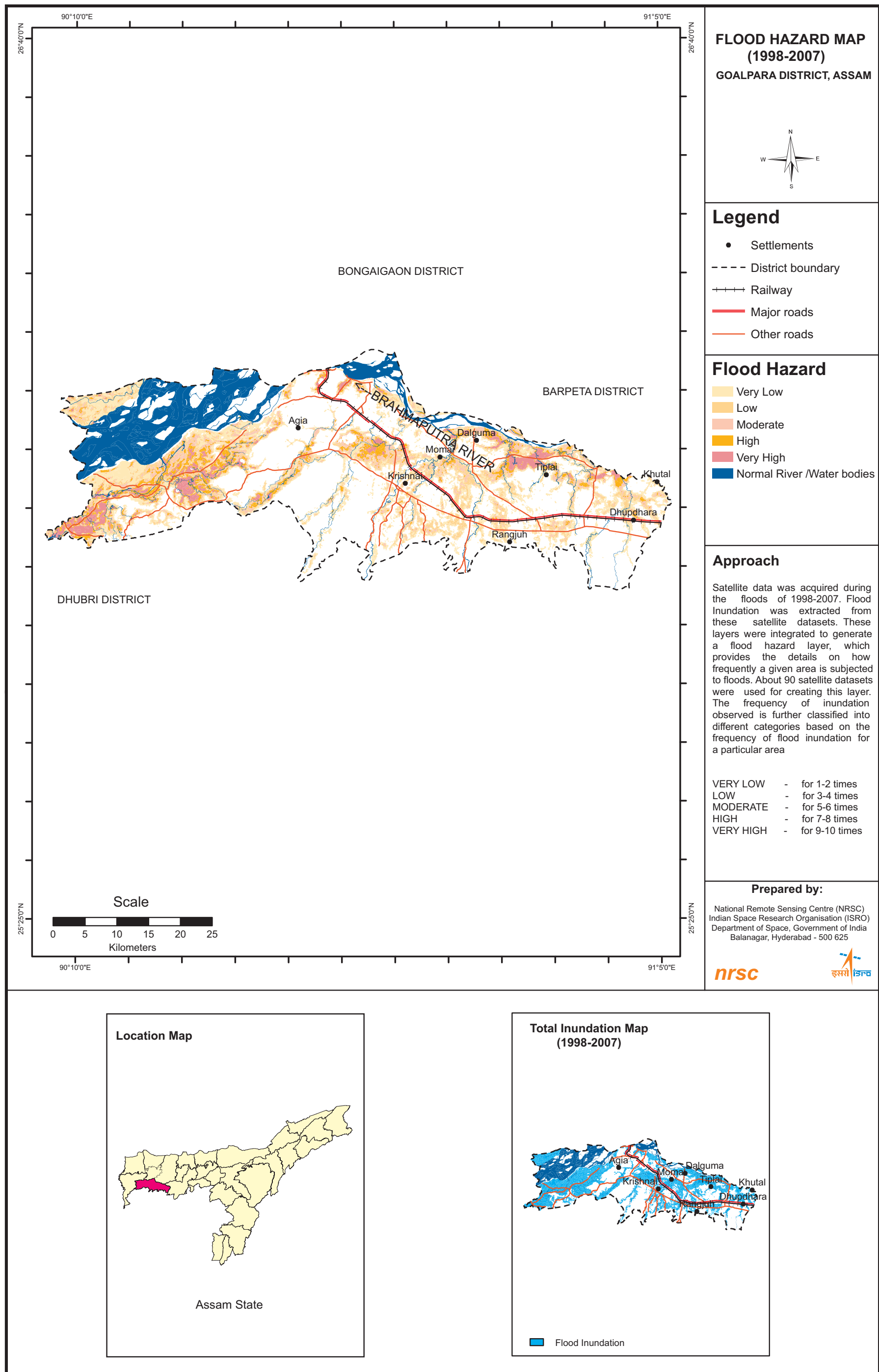
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (154 nos)

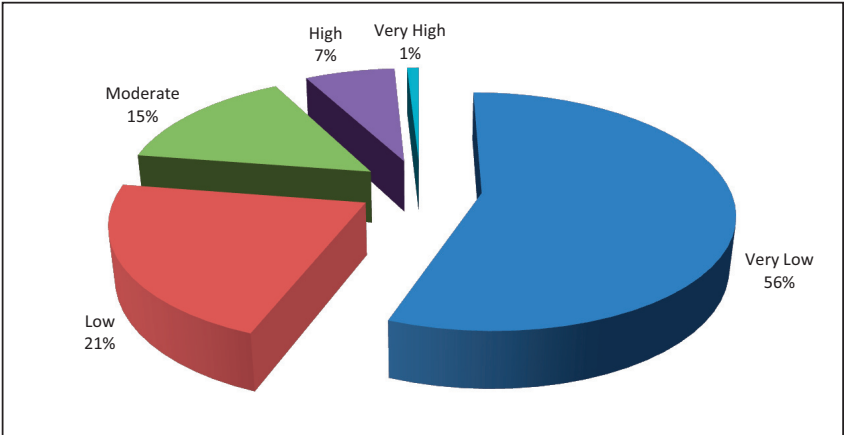
Alli Bari	Chilarvita	Kadomtola	Pahar Singh Para
Ambari	Chinabari	Kahibari Garopara	Pandoba
Ambari Part-ii	Chota Damal	Kankata Part-I	Panikamritari
Amjonga Part-I	Choukatola	Kankata Part-II	Panisali
Ashudubi	Chowktola	Kari Para Part-II	Paschim Matia
Azagar Pahar	Dahela	Kasima	Pokalagi
Badhapur	Daigaon	Katartari	Polashbari
Baghmara	Dakhin Satvendi	Kathal Guri	Puthimari
Baguan Part-II	Dalak	Kathuri	Raja Para
Baida Part-I	Damas (Dhaigaon)	Katlitari	Rakhaldubi
Baida Part-II	Damribhasa	Kayasthapara	Rakshasoni Jhara Part-I
Bakpara Dinerlga Part-I	Dapkarvita	Khagra Bari Khamar	Rangsa Para
Bala Para Part-I	Debottar Bapu Para	Khamar Manikpur	Roumari
Balachari Anguri	Deuli	Khenmohona	Rowarvita
Balarvita	Deuli Ejara	Khilamara	Saldhowa
Bamundanga Part-I	Dhamar Reserve	Khudra Paitari	Saptibari
Bamundanga Part-II	Dhantola Part-I	Khutamari	Sardar Para
Bamundoba	Dhobakura	Kishori Dubi	Satbaini Pahar
Banbabu Para	Dibottar Bapupara No 1	Kongai Pub Par	Shialkanda
Bandra	Erabandha	Kurshakati	Sikijuli Ghagramari
Bangaon	Fakirpara	Kushdhowa	Silapani
Barjhora Part-II	Fofonga Part-I	Chechapani-I	Simlitola
Barvita	Gadimpathar	Kushdhowa	Simulkandi
Baye Chandina	Garokuta	Chechapani-II	Soari Paitari
Bhaismari	Garuchotka Part-II	Lalabani	Solmari
Bhati Part-I	Golokerpam	Latapara	Soulmari
Bherbberi	Govindapur	Latima	Suter Para
Bhojmala(Mornoi)	Guabari Part-I	Majkuri Islampur	Takimari
Bijoypur Bangaon	Gutipara Pt Iii	Maladhara Part-I	Taparvita
Bjerbheri Bil	Halua Para	Mamudpur Part-I	Tarangapur
Uttar Satvendi	Hatigaon	Moijanga	Tharka
Boko Garo Para	Hatighapa	Mona Kocha	Tiplai Part-I
Bolaikhamar	Hatimura Part-I	Mornoi	Tiplai Part-II
Bonmohona Part-II	Hatisila Ravapara	Mostam Part-II	Tiplai Part-III
Boro Kashi Khagra	Jagana Rajbongsi Para	Nabagota Simlitola	Ulubari Vaitora
Boumohona Part-I	Jaleswarbil	Nalanga Pahartali	Chowtarabill
Chalakura Part-II	Janga Bari	Narayan Para	
Chamaguri	Jinkonia Para	Naya Para Part-II	
Chatabari Part-II	Jungle Block No 1	Nayapara	
Chatna Ozagnar		Niz Kursa Kati	
		Nizborvita	



Golaghat
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	58482
2	Low	22692
3	Moderate	15431
4	High	7260
5	Very High	949

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (80 nos)

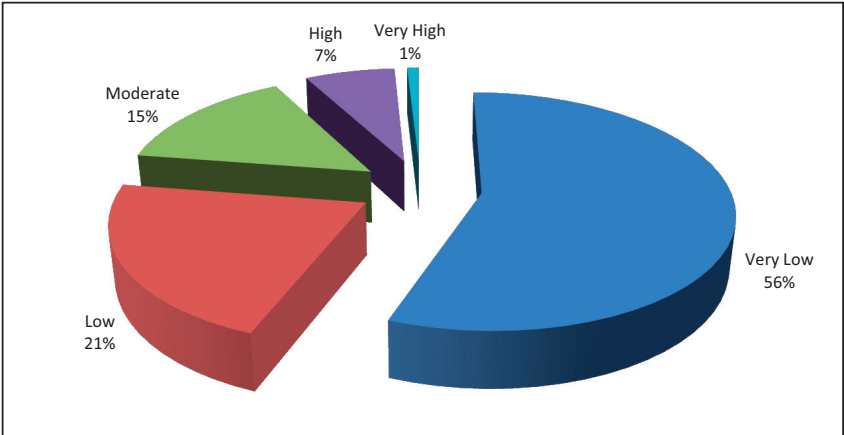
Afala Gaon(b)	Da Dhara Ahom Gaon	Kuruabahi Gaon
Aka Gaon	Da_Barahi	Misa Mora
Akaiguri	Dagaon	Mohimelia
Athgaon	Dhansiri Temera	Mohpora
Auniati Jungal	Dibbolu Pathar	Molia Gaon
Bamun Gaon	Dihingia	Moutgaon N.C.
Barichowa	Domjoria Kachalial	Na_pamua(a)
Barua Gaon	Ekorani	Nalani Pathar Gaon
Bebejia	Ekorani Gaon	Nam Temera
Bengenakhowa	Goal Gaon Pt.II	Nikori
Betoni Pathar	Goal Goan Pt.I	No.1 Sildubi
Betonijan	Golaghat Town	No.2 pathori Miri
Bilotia	Gorimari	Purana Melia
Bocha Gaon	Guganiati	Raidangia Gaon
Bohikhowa	Habi Chukia	Rengmai
Bokolai	Hatikhali T.E.	Rowdoor Pather(a)
Bongaon	Japori Pathar	Rupkolia
Borphukonar Khat	Kachamari	Sarar Gaon
Bortika	Kacharihat Gaon	Saru Kachari
Bosagaon Budhbari	Kanfala	Sialikhati
Chakar Dhora	Kaziranga National Park	Sital Pather
Chakial	Kazironga N.C.	Tengabari
Charia Khat	Kherjan	Tengaholla No.1
Chatia Goan	Kumar Gaon	Tengrajan
Chawdang	Kupuhating	Tirual Gaon(a)
Chukia Pathar		Tirual Gaon(b)



Hailakandi
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	13627
2	Low	5478
3	Moderate	3495
4	High	3935
5	Very High	6126

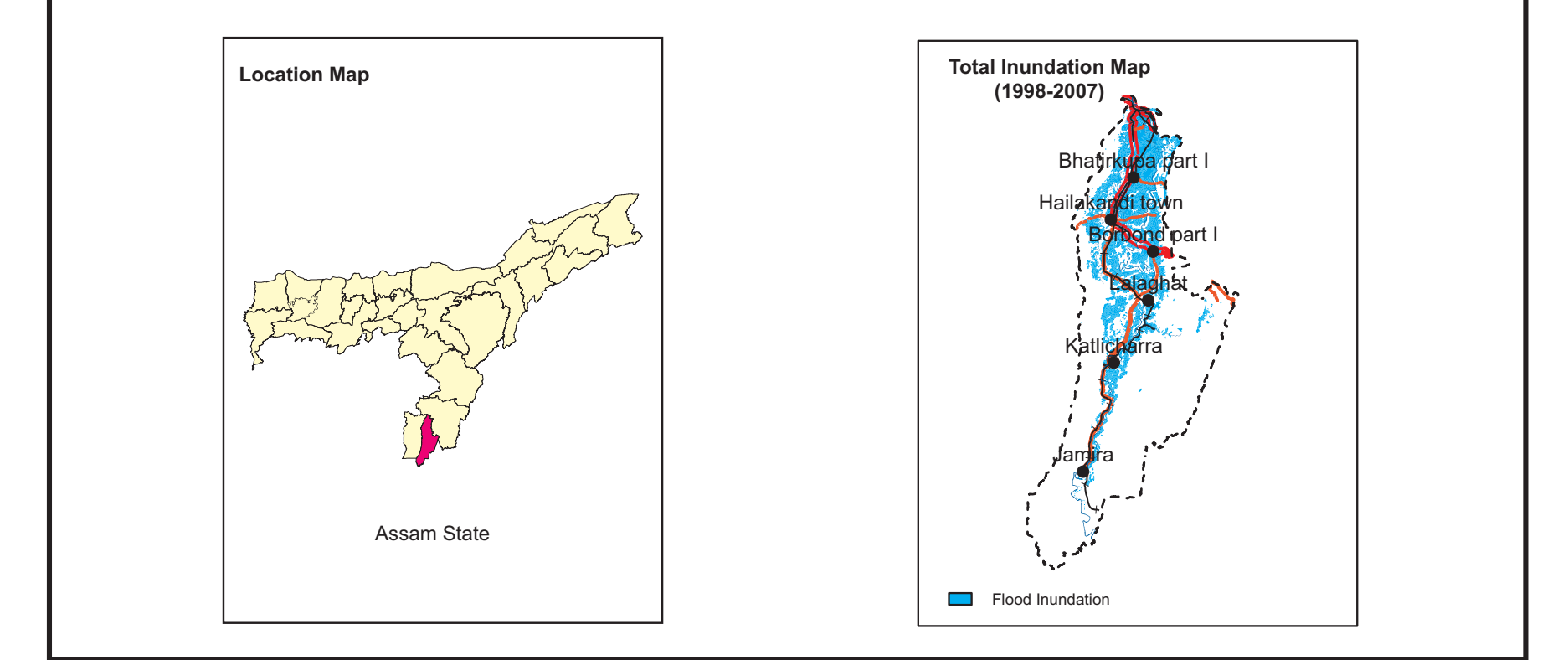
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (101 nos)

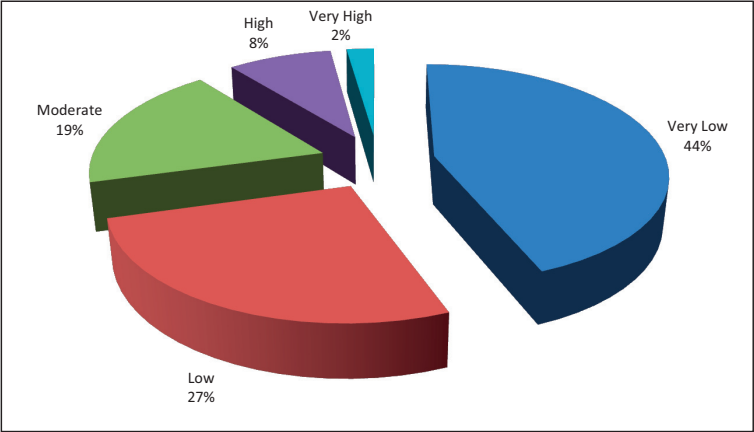
Aenakhal	Bash Dahar Part I	Itarkandi Part I	Nischintapur Part i
Algapur Part I	Bash Dahar Part II	Jalalpur	Nischintapur Part III
Algapur Part III	Bhajantipur Part I	Kalachsa Grant	Nitai Nagar Part II
Apin Grant	Bhajantipur Part II	Kali Nagar Part I	Nityananda Pur Part II
Bagalapur	Bhatirkupa Part I	Kalinagar Part III	Nityanandapur Part I
Bakrihowar Part II	Bhatirkupa Part III	Kalinagar Part IV	Pachim Kitton Bond Part II
Bakrihowar Part III	Bhatisang Jurai	Kalinagar Part VII	Paikan
Bakrihowar Part IV	Bishnu Ghar	Kalyanpur N.C.	Podmar Par
Bakrihowar Part IX	Bishnupur Part I	Kanchonpur Grant	Polarpar
Bakrihowar Part V	Borbond Part I	Kapnar Par	Rajyeswarpur Part III
Bakrihowar Part VI	Brajapur Part I	Lakhinagar Part I	Rajyeswarpur Part VII
Bakrihowar Part VIII	Burnibrease Grant	Lakhir bond Part II	Ramchandi Part III
Bakrihowar Part XI	Chak Chand Pur	Lala Part I	Ratanpur Part I
Bakrihowar Part XIII	Chandipur Part I	Lalpani F.V.	Sahabad Part II
Balikandi Part I	Chandipur Part III	Matir Gram	Said Bond Part I
Balikandi Part II	Chandrapur	Mohan Pur Part I	Sibuttar
Bandook Mara	Chandrapur Part I	Mohanpur Part IV	Sudarshanpur Part II
Bandook Mara Grant	Chandrapur Part II	Mohanpur Part V	Sudarshanpur Part III
Bangal Nagar Grant	Chepti Brajapur	Mohanpur Part VI	Sudorshon Pur Part I
Bans Bari Grant	Chipar Sangon	Narainpur Part II	Ujankupa Part III
Bans Bari Part I	Chipar Sangon Part II	Narainpur Part IX	Uttar Badarpur
Bans Bari Part II	Dakhin Sonapur Part II	Narainpur Part VI	Uttar Josnabad Part I
Baolipar Part I	Dali Dahar	Niamatpur	Uttar Josnabad Part II
Baolipar Part III	Dalidahar Grant	Nimaichandpur Part I	Vichingcha Part II
Bar Hailakandi Part I	Gangpar Dhumkar Part III	Nimaichandrapur Part II	



Jorhat
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	53345
2	Low	32235
3	Moderate	22441
4	High	10321
5	Very High	2732

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

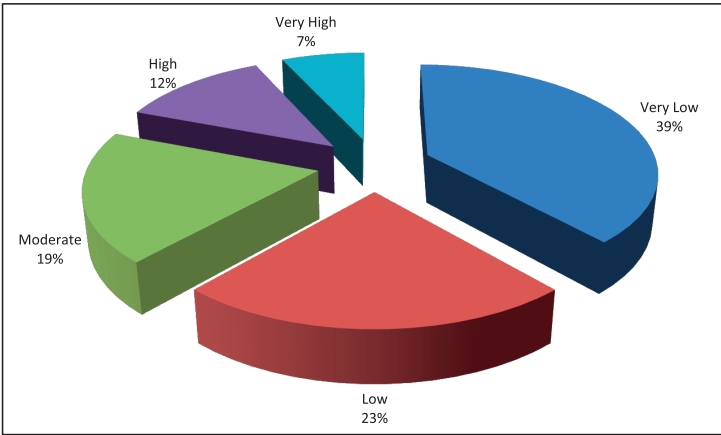
Following is the list of villages under Very High & High Hazard categories (109 nos)

Abhoypuria Gaon	Daini Gaon	Khatarpathar Gaon	Patia Gaon
Alengi Gaon	Dakukura Chowa	Khatowal Gaon	Phenhuma Kali
Alikhoria	Daria Gaon	Kherema Kachari	Phukanar Khat
Auria Gaon	Desoikash Bamun Gaon	Kuhiar Bari	Pohardia
Bajalbari Gaon	Dhekia-khowa Gaon	Kuhum Jugunia	Purani Gohain Gaon
Balijan Gaon	Dorikamari Gaon	Kumar Gaon	Raidangjuri Gaon
Bamun Gaon	Dulia Gaon	Kumar Khar Gaon	Rajabahar Gaon
Barapaik Gaon	Ekorani Gaon	Laholial	Rajabari Gaon
Barhoipam	Gharchowa Pathar Gaon	Makori Khuti Gaon	Ranga Chahi
Bebejia Gaon	Gharfalia Gaon	Mandal Gaon	Ranga Garah Chapari
Bengena Kalia	Gual Gaon	Manika Pathar	Rangdoi Bamun Gaon
Bhakat Pamua	Hukumora	Mohkina Gaon	Rowmuria Pathar Gaon
Bhogpur Pathar	Jagunidhari	Molapindha Chilakala Miri	Sarucharai Gharfalia
Bhogpur Satra	Jogi Gaon	Molual Koibarta Miri	Sodial Kachari Gaon
Bhurakala No.1	Jorbeel	Molual Miri	Sologuri Gaon
Bhurakala No.2	Kachari Gaon	Moran Gaon	Sonari Gaon
Birinasayak Gaon	Kaibarta Salotdia	Moriasayak Gaon	Tamuli Gaon
Bogar Gaon	Kakoti Kuri Gaon	Motia Bari	Tanti Gaon
Bokajan Miri	Kaliani Pathar	Nangal Gaon	Thengal Gaon
Borgharia Pathar Gaon	Kamar Khatowal Gaon	Newpeta Gaon	Tingtingia
Boria Gaon	Kamar Pathar Gaon	Niz Bali Gaon	Tipomia Gaon
Borkhat	Kawpati Habi Gaon	No.1 Borgoya	Tirakuri Gaon
Bosa Gaon	Kawrichook Gaon	No.1 Kawoimari Gaon	Turung Gaon
Chakalani Pathar	Kenduguri Pathar Gaon	No.2 Borgoya	Urangial Gaon
Charingia Gaon	Kerela Gaon	No.2 Kawoimari Gaon	Uttar Dulia Gaon
Chawrekia	Khahuani Bamun Gaon	No.3 Mohkhuti	
Cherili Gohain Gaon		Nowbaisha Gaon	
Cherili Pathar Gaon		Pakajara Miri	
Chilakala Chapari		Pakajara Village	



Kamrup (R)
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	44889
2	Low	27080
3	Moderate	22449
4	High	14400
5	Very High	8031



Flood Hazard area under different flood hazard zones

Graph showing the percentage of various flood hazard categories

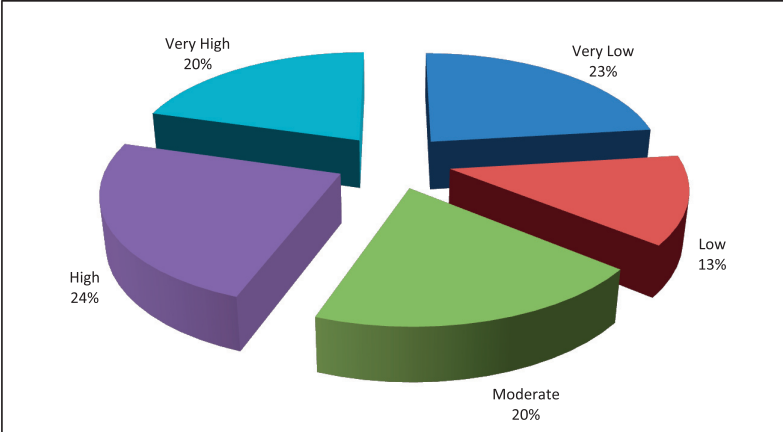
Following is the list of villages under Very High & High Hazard categories (157 nos)

Abhoypur	Dakhin Fullung	Keotarbari Pacharia	No 1 Bagta	Pub-Dadora
Alagjari	Dakshin Bankakata	Khopani Kuchi	No.1 Barua Pathar	Puch gumi
Amtala	Dala Gaon	Khudra Kulhati	No.1 Dalibari	Puran Kachiya
Athiyabari	Dari	Pacharia	No.1 Jugipara Pathar	Puthimari
Baihata	Deharkuriha	Kismat Kuriha	No.1 Khetri Hardia	Rakshashi Nisar(N.C)
Bansar	Dekachang	Kochpara	No.1 Kulhati	Rang Dakua
Bar Hazara	Deochar	Kokjhar Part	No.1 Rampur	Rangmahal
Bar Maroi	Dhantola Rangamati	Kukurmara	No.1 Sobanshah	Salmara
Bar Nizara	Dighalkuchi	Kumarpur	No.1 Ziakur	Saniadi
Barasara	Dokochi	Kumtibari	No.2 Barua Pathar	Sanpara Grant
Barauti Moniari	Gandheli Tari	Larua Jan	No.2 Dalibari	Sarabari
Baregaon	Gatuwa	Madanpur	No.2 Jugipara Pathar	Saraighat Salmara
Bargaon	Gauripur	Makeli	No.2 Khetri Hardia	Sarmosali
Barijani	Gopalpur	Maliata	No.2 Makeli	Sarpara
Barmaza	Guimura Pathar	Malibari Satra	No.2 Singimari	Sarubakara
Barni	Habilapather	Malong	No.2 Sobanshah	Sathisala Ghor
Bartari	Hahdia	Manahkuchi	No.2 Ziakur	Sathisala Pam
Batiamari	Hatipara	Maniari	No.3 Rampur	Satlabari
Baugara	Horopara	Maravita	No.3 Singimari	Satpokhali
Bazariguri	Howlitari	Marganda	Noiter Khola	Shilbharal
Bejartari	Jalah	Medhipara	Reserve	Singimari Habi
Bhakuradia	Jambari No.1	Nagaon	Pacharia	Sontala
Bihdia	Jamlai	Nagarlera	Pachim Dadora	Tamuldi
Bor Kukuria	Jamlai N.C.	Nalgaon	Pathar	Tezpur
Bordai Pakhia	Jarabari Gaon	Nanara	Paikana	Titkuchi
Borka	Jorsimalu Gochputa	Nichilamari	Pairanga	Trilochan
Chamaria Pam	Joukhata Gaon	Nij-Bansar	Palahartary	Tuhura
Champurapa Pathar	Kahibari	Nimurtari	Pally	Udiana
Changsari Chepti	Kalahikash	Niteni	Paneri	Uparhali
Choudhari Pam	Kalakuchi	Niz-Gandhmow	panikhati Bilarjan	Urput
Dagaon Katahi	Kalita Kuchi	Nizkathmi	Pingulaswar	Uttar Fullung
Dahajatia	Karaibilar Pathar	Niz-Sundari Ghopa	Pizupara	

Kamrup (M)
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	5073
2	Low	2802
3	Moderate	4338
4	High	5261
5	Very High	4513

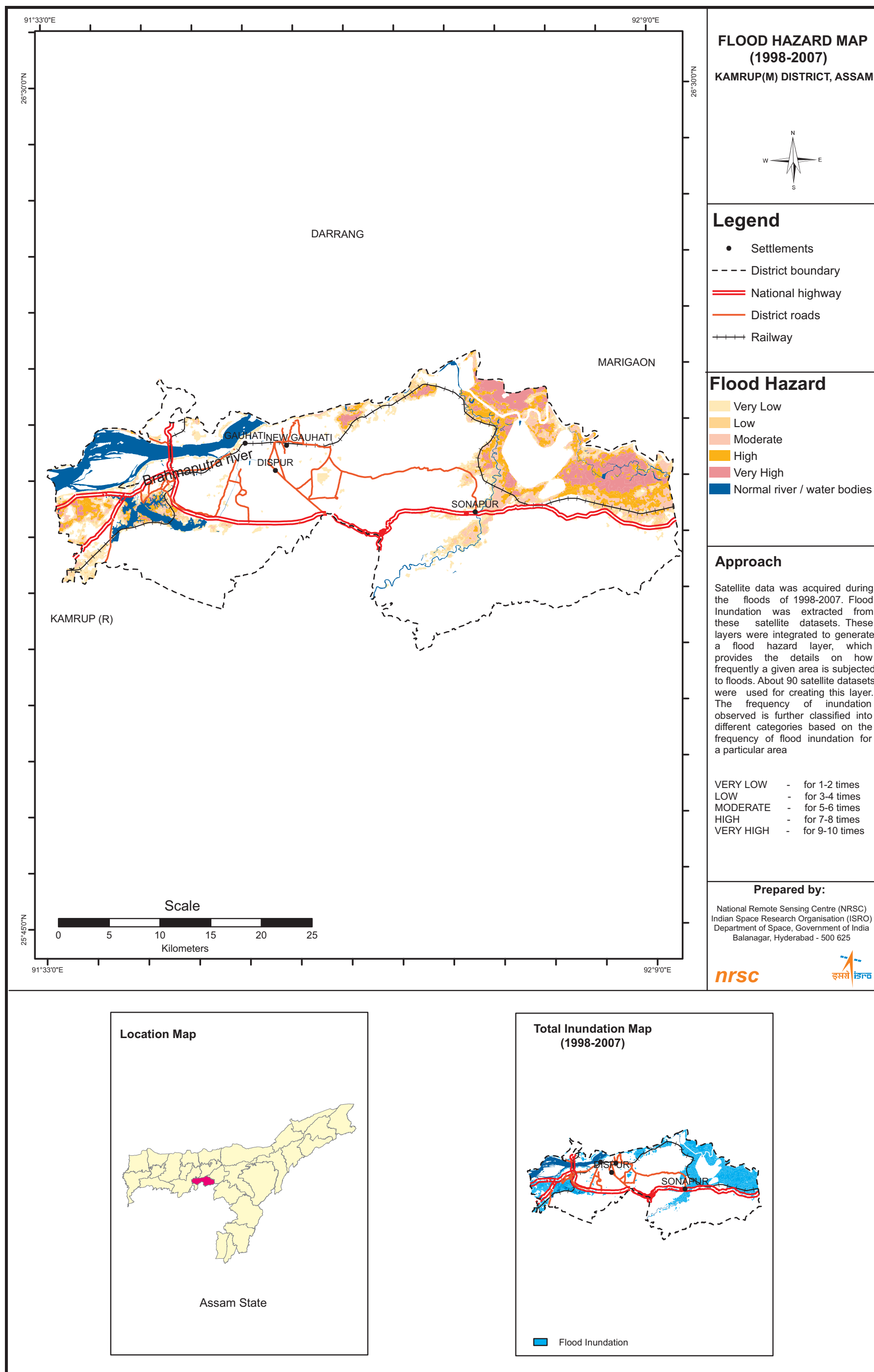
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (53 nos)

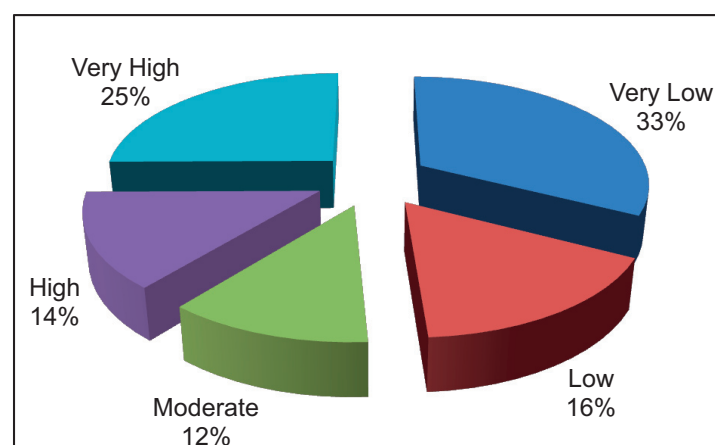
Agsia	Hajobari Gaon	Murkata Gaon
Ajurigaon No.3	Helagog	Niz-Dimoria
Amara Pathar	Jubai Gaon	Niz-Panbari Gaon
Aujurigaon No.2	Kahikuchi Gaon	Panikhaitigaon
Azara	Kasutali Pather	Pubmaloibari
Bagibari Pathar	Kenduban Gaon	Rajabari Grant
Barjhar	Kendukuchi	Rewa N.C.
Borbilabil	Kharguli N.C.	Salona Gaon
Borchapari	Kharguli No.2	Senabargaon
Chamata Pather	Kurkuria Gaon	Sukhurabari Gaon
Dakhin	Lumsum N.C.	Tamahalong Gaon
Jalukbari(GMC)	Majir Gaon	Tetelia Pathar
Digarupar N.C.	Maloibari Janghal	Teteliguri Gaon
Dimoriagaon	Maloibari Pathar	Teteliguri N.C.
Durung Gaon	Maloibarigaon	Teteliya(GMC)
Garal	Mikirpara Chakorda	Ullani Gaon
Gomoria Pathar	Mirzapur	Ullisam Gaon
Hahara Pathar	Mitni N.C.	Uttar Dimoria



Karimganj Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	16915
2	Low	8560
3	Moderate	6183
4	High	7248
5	Very High	13062

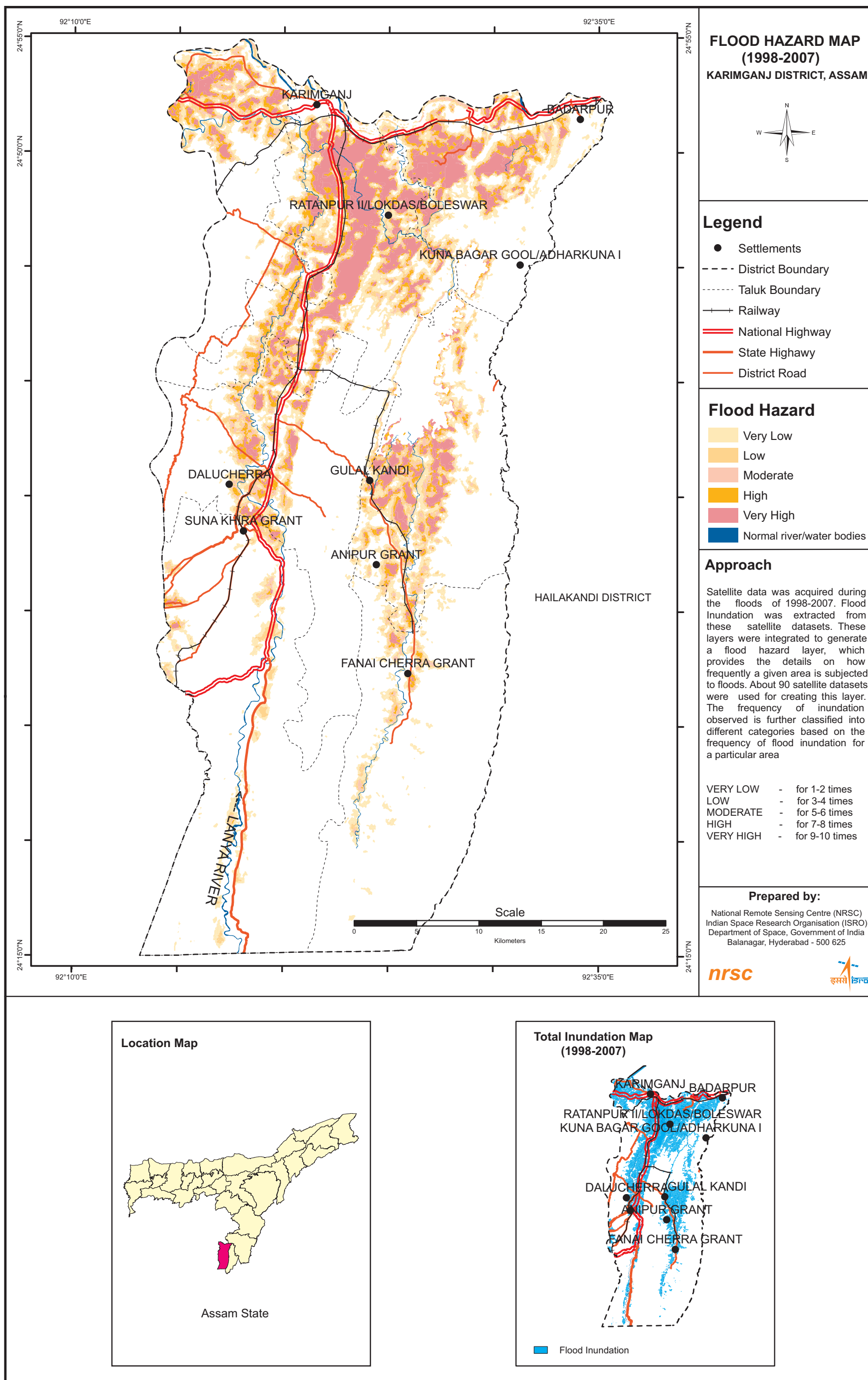
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (195 nos)

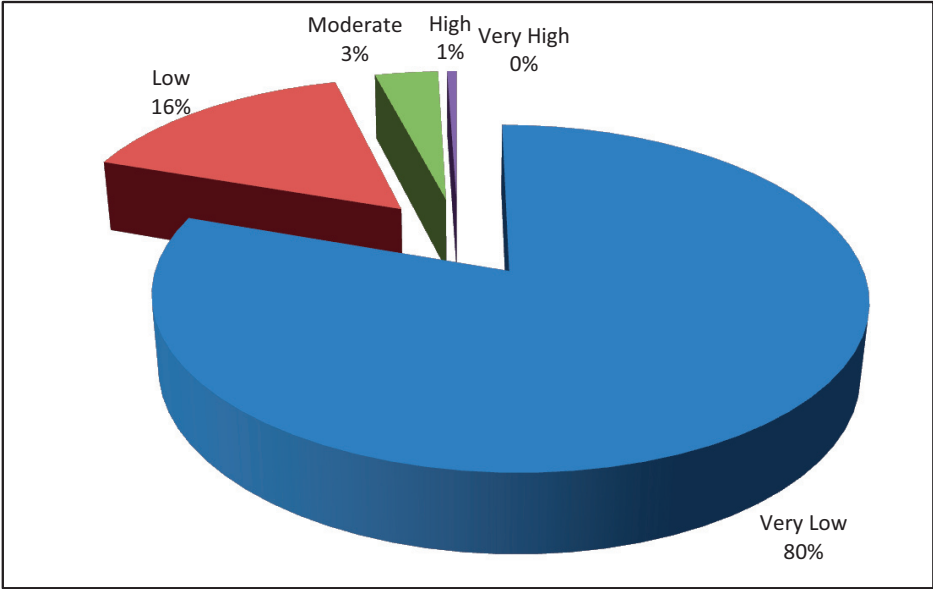
Alam Kandi li	Choudhuri Tilla	Jarapata	Meda li	Putni Gaon
Alam Kandi lii	Choykut	Kaibarthkapan	Meda Mail	Raj Pasa
Alamkhani I	Dakhin Gram	Kala Rani	Medal Chak	Rampassa I
Alampur	Dalgram	Kalakori	Medal li Medal lii	Rampassa li
Angura	Dalu li	Kalinagar li	Meghna I	Rampassa lii
Angura Dunguri	Dalur Par	Kalkali	Meghna lii	Rata Bari li
Awalala	Dargar Bond	Kalkali Bari	Mirjapur li	Ratan Pur I
Baagan	Dasgram Pt I	Kamalpur	Mohakal li	Ratan Pur li
Bachar Bond I	Daya Dishna	Kamar Gram	Mohakal lii	Routh Gram I
Bagisagi	Defolala	Kamar Gram I	Mohakal Iv	Routh Gram li
Bahadurpur	Dhali Beel I	Kamar Gram li	Mohakal Vi	Saidambar I
Bakar Shal lii	Dhali Beel li	Kamkalas li	Mona Debpur	Saidambar li
Bakar Shal Iv	Dhuliarhal	Kanakpur	Monna I	Saidpur
Balepara	Dimpur	Kandi Gram	Moujkorni li	Sarangdeopur
Bandarkuna	Duhalia Khall Kalibari	Kandigram Chaitranyg	Mugrapur	Sarkar Bari
Baraigram	Dutta Para	Nagar	Muliala I	Satrishal
Baran Tar	Duttapur	Kandigram I	Muraura	Sekhi Kani Sail
Barbadi	Eraligool V	Keot Kuna I	Nabipur	Siber Chak
Baruail	Fanai Cherra Grant	Keot Kuna li	Nag Kapan	Sikarpur
Basattihall	Farampasa I	Keshor Kapan Pt li	Nagkapan	Singaria I
Bashail	Farampasa li	Khagail	Nairgram	Singir Par
Batarashi	Farampasa Pt li	Khagail I	Nalar Par	Singlar Par
Bazailala	Fathepur I	Khagail lii	Nali Bari	Sonatula Basti
Bazar Ghat I	Fathepur lii	Krishna Nagar Colony	Narikall	Srimanta Kanisail
Bazar Ghat li	Fetipath	Kujab	Nathupur I	Surja Das
Berajal	Galla Sail	Kuna Para	Naya Gram	Sutar Kandi
Bhitar Gool	Gandhak Chak	Kurikhala	Nizmalua	Taltala
Bilbari	Gangpar	Kutra Para	Others	Tatir Bond
Binya Tikri li	Ghorua	Lamajuar li	Pachim Jarail Bari	Tikor
Boleswar	Ghuramara I	Lamajuar lii	Pachim Tongibari	Tikor Para
Bosla	Ghuramara li	Lamar Bahadur Pur	Patharkandi li	Tongi Bari I
Brahmansasan I Block	Golaikandi	Lilachilla	Pathu Pt li	Tongi Bari li
Brahmansasan li	Gozar Dimgi	Loharpara Pt lii	Patiala T.S.	Tongi Bari lii
Buja	Haitar Kha	Madan Pur	Pecha-Ala	Tun Du Rail
Chanala	Hajipur	Maligaon	Pechakuna	Umapati
Chand Khira	Hamindpur	Marera	Pirotikar	Umarpur lii
Changuri Par	Hanya Dhik	Marzad Kandi	Podhmar Par	Umarpur Iv
Chengjur	Harinagar li	Matir Gool P.S.	Purba Baruala	Umarpur Pt I
Chini Patan	Ilaspur	Meda I	Purba Jarail Bari	Umarpur V



Kokrajar
Flood Hazard Statistics

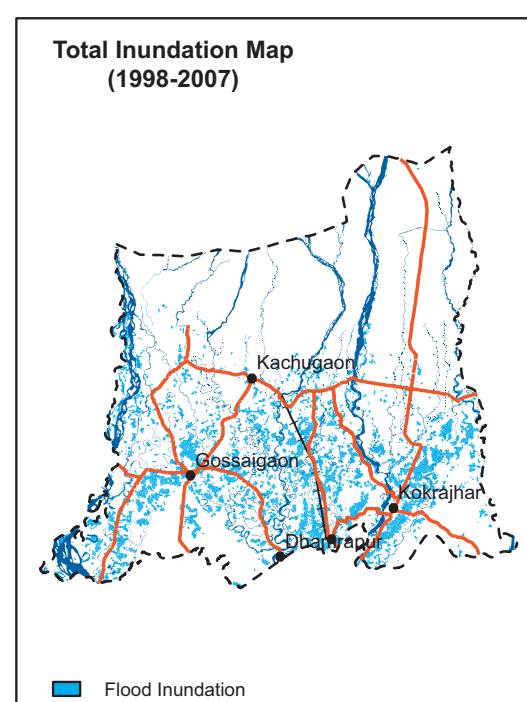
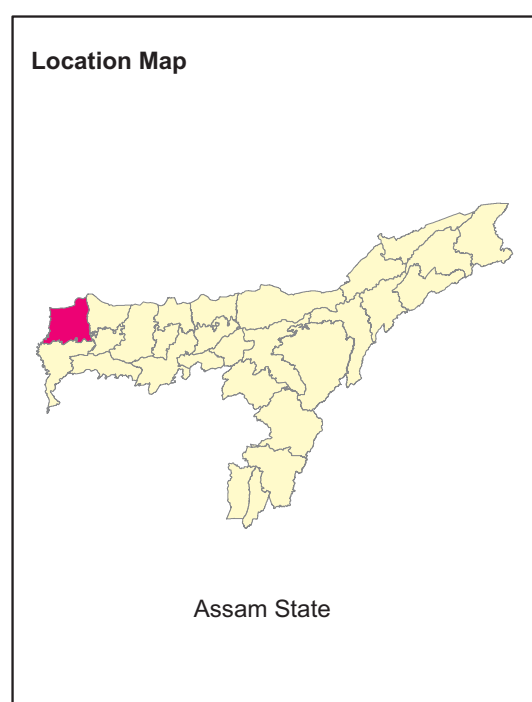
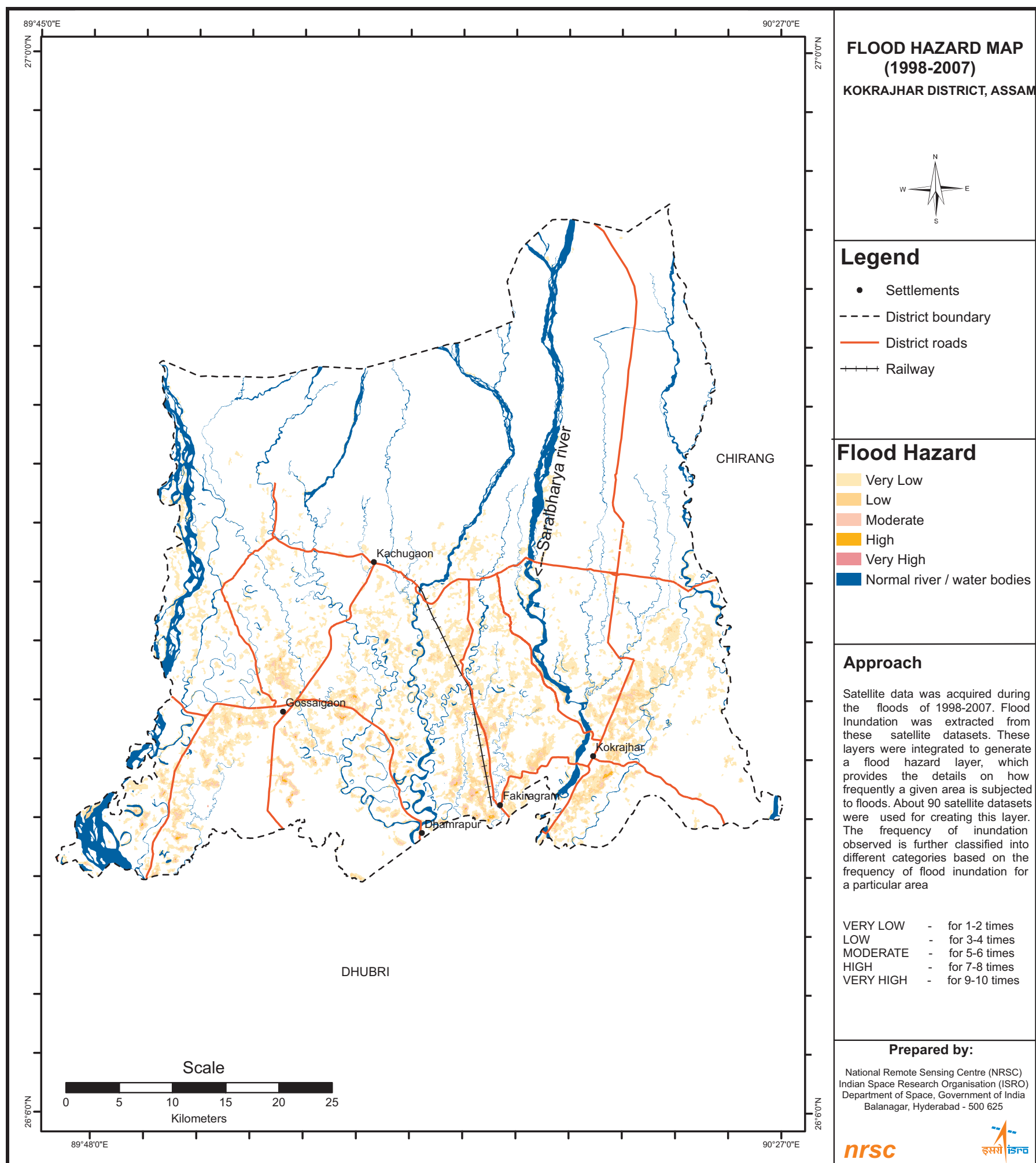
Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	27043
2	Low	5259
3	Moderate	1184
4	High	178
5	Very High	1

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

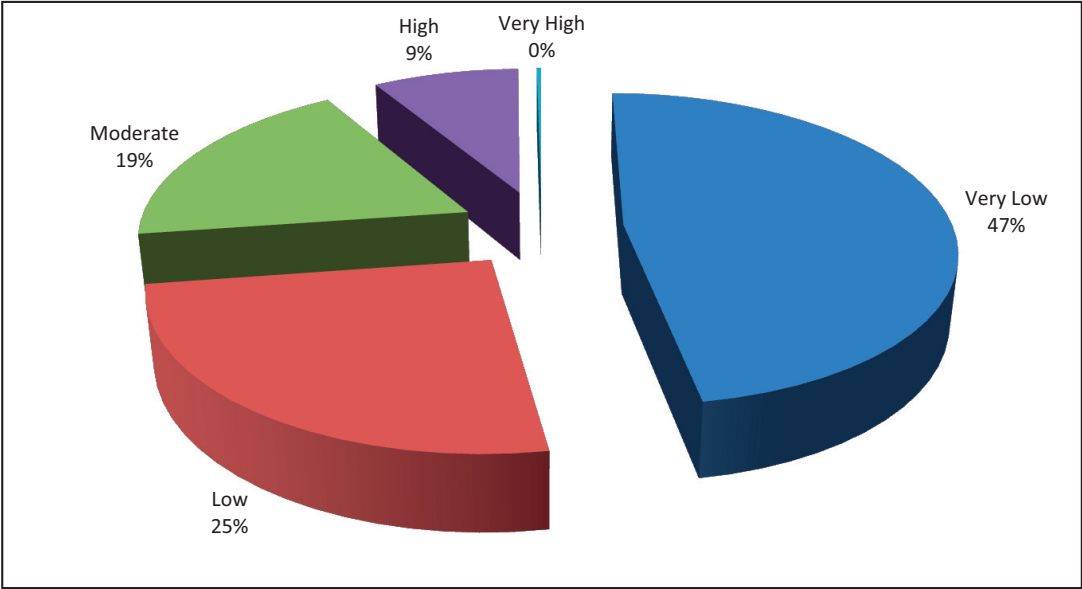
Villages under Very High & High Hazard categories - NIL



Karbi Anglong
Flood Hazard Statistics

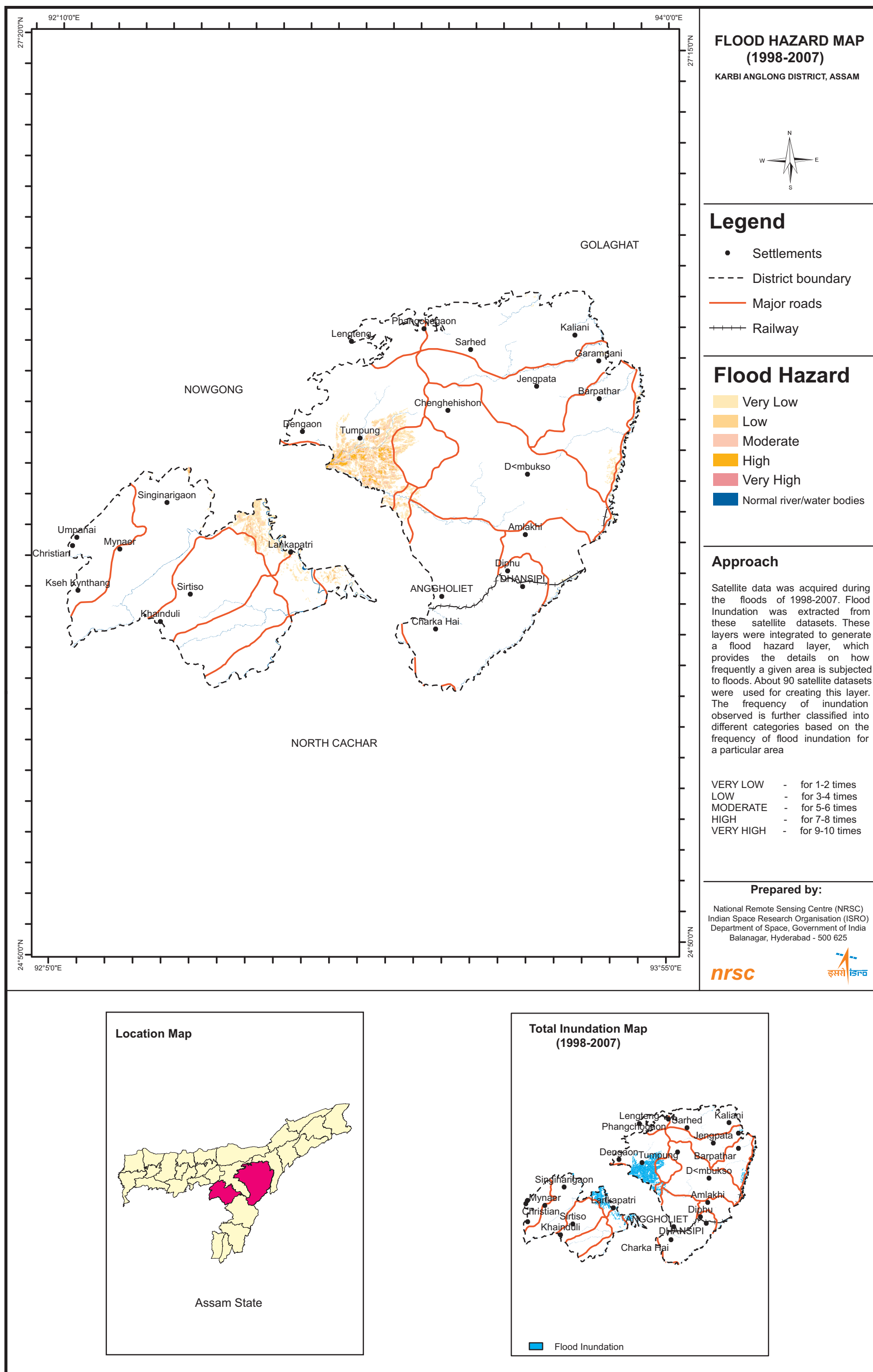
Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	21933
2	Low	11756
3	Moderate	8625
4	High	3912
5	Very High	111

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

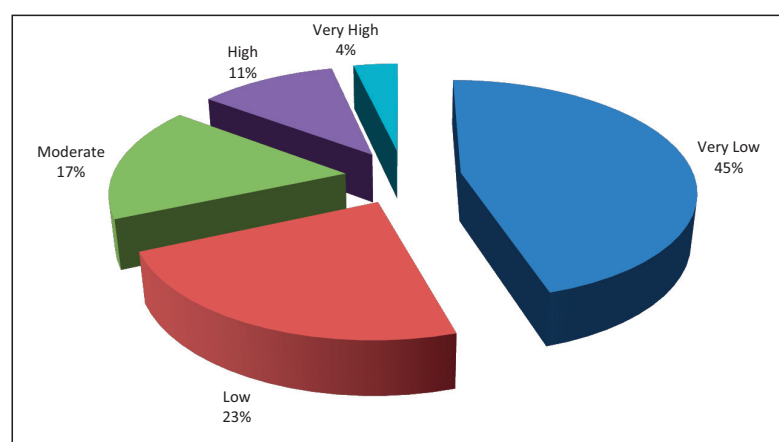
Villages under Very High & High Hazard categories - NIL



Lakhimpur Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	69555
2	Low	35524
3	Moderate	25711
4	High	17173
5	Very High	5564

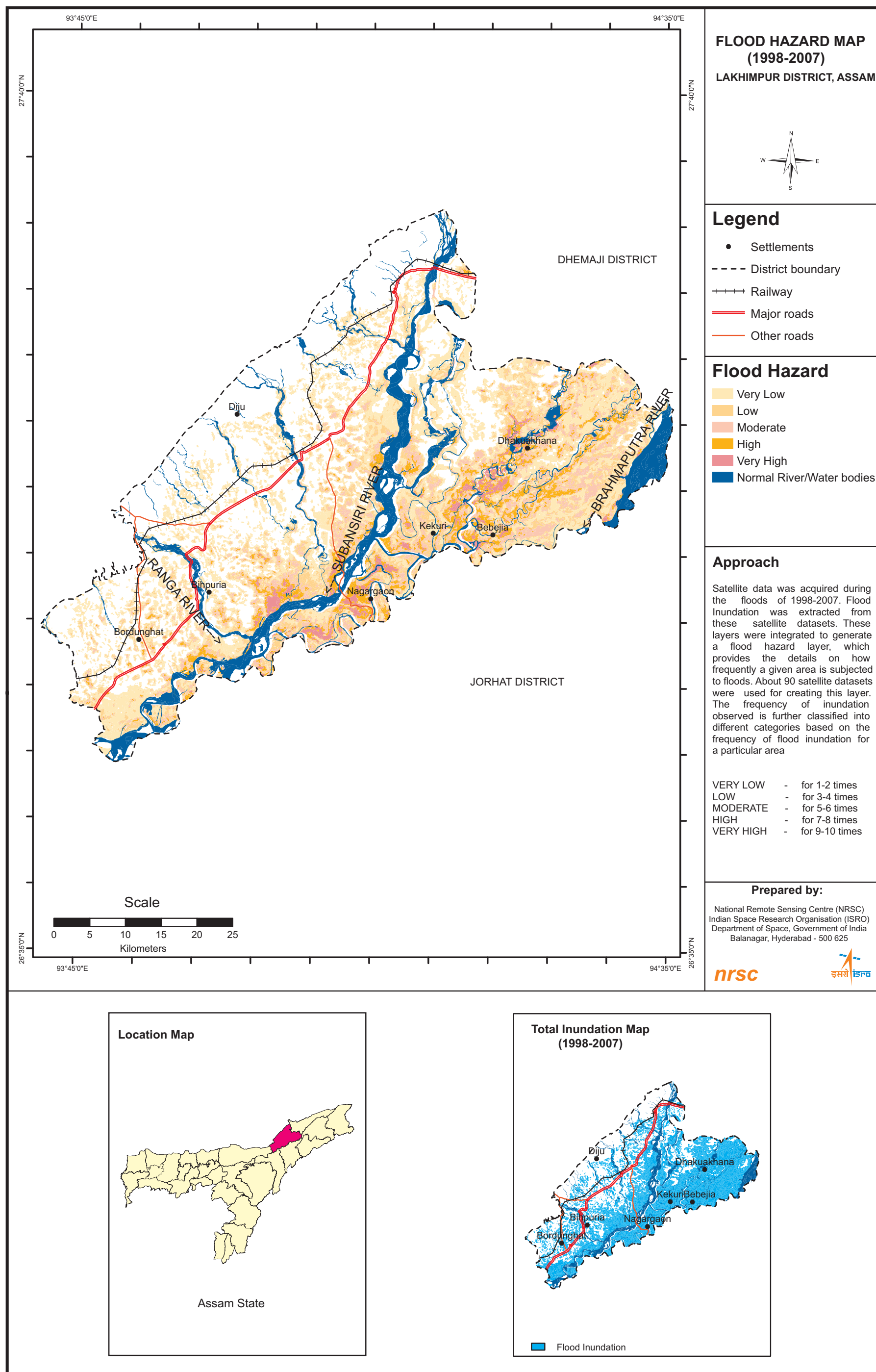
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (208 nos)

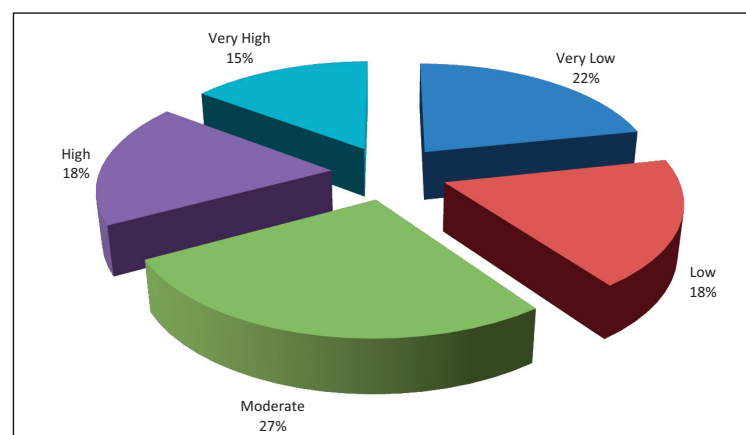
Abhoypur	Charikoria	Gosai Pukuri	Lamudeolia Kachari	Patia Chapari No.2
Adhakhona	Chawruk Borpatra	Gubindapur	Lashmon Batomari	Patiemora N.C.
Adhakhona No.2	Chelajan Kachari	Harhi Chapari	Lathibor Chuk	Patrisuk Miri
Adhakhona Vgr	Chiring Gaon	Hatiemora No.1 (A)	Lawkuth Murutia	Pavo Adhakhona
Adisuti N.C.	Daffala Kata Miri	Hengulia Pathar	Lehera Miri	Ressrve F.V.
Ahmedpur	Dahghoria Block	Homora No.1	Ligiramukh	Pavo-De-Reserve
Akhoiphutia	Dahghoria P.G.R.	Homora No.2	Mahanibari	Pavo-Vekeli
Alimur Bosagaon	Dakhin Chapari	Howborah	Mahdhowa N.C.	Poma Moderguri
Amtola Telahi N.C. Pgr	Dhanguloi Pathar	Huj Gaon	Mahora Borchapori	Proposed Buffer Area
Aunibari	Dhela Pathar	Indurgaon	Mahtoli	Rantijan
Aunibari No.1	Dhenukhana Gaon	Jalbhari Dimoruguria	Mainapara	Ruhagaon
Aunibari No.2	Dhenukhanapathar	Japjup	Malual Koibarta Miri	Sakala Satra
Badati Jamuguri	Dhola Miri	Jaroni Chapari	Mazor Chapori	Sessa No.2
Badati Miri	Dhunabari	Jengrai Miri N.C.	Meromukh N.C.	Shingia No.1
Baghedhapolial Gaon	Dhunaguri Khanikar Gaon	Jiamoria	Moderguri Chapari	Somdia
Baghedhapolial N.C.	Dighala Hiloidari	Juyepura	Mohaijan & Ghagor Pgr No.1	Somdirimukh
Baghmora	Dikrongmukh	Kachikata Pathar	Mohaijan No.2	Achacakota
Bahgora Deori Gaon	Dulia Pathar No.2	Kalakata Chetia	Mohaijan No.3	Sonapur No.2
Bahgora Pathar	Dulia Perabhari	Kaldwani Batumsuk	Mohemari	Sonari
Bahpara Chapari	Duliagaon	Kalyam	Mohghuli Chapari	Sonaribari Chapari
Balahi Tamuli N.C.	Dulpata No.2	Kandali Pathar	Molabari	Sonaribari Block
Bali Dewri	Fatehpur	Kaniduar Miri N.C.	Molohakhathi	Sonaribari Block 2
Bangaligaon No.2	Forest	Kankan Chapari	Mornoi Bebeija	Sonaribari Block 3
Bangla Chapari	Garmur Chapori N.C.	Kathalpara Gaon	Mornoi Chapari	Sonaribari Block 4
Banmukh Balijan	Garmur Dabukial	Kekuri Bebeija	Moukhowagaon	Sonarigaon
Bantow Gaon	Garmur Nagargaon	Kekuri Digholi	Mudoibil No.1	Tamargaon
Boralimora Miri N.C.	Ghagormukh Gualbari	Kekuri Kachari	Mudoibil No.2	Tarajan Gaon
Borbari	Ghagormukh N.C.	Kenduguri	Na-Ali Koiborta No.2	Tekeli Phuta Gaon
Borbari Chenimari	Ghahi Gaon	Khaboli F.V.	Na-Ali Miri N.C.	Tekeliphuta
Borbari Mayengia	Gharmora	Khoga Chandrapur	Na-Ali No.1	Telia Chapari
Borbari Miri	Ghatapara Gaon	Khoga Chapori No.2	Na-Ali Pgr No.1	Temera Miri
Borbeel N.C.	Ghilamora Parghat No.2	Koibarta Gaon	Naharani N.C.	Thekeraguri Dakhin Chapari
Borbil	Gohain Handique	Kondolguri	Naharoni	Thekeraguri No.1
Borbil Mazgaon	Gondhia Gaon	Kongbong N.C.	Namoni Jokaibowa	Thekeraguri No.2
Borchapori	Gondhia Gaon No.2	Konwar Ghati	Namrupia Jalbhari	Tinikuria Sonari
Borhola Chapari	Goroimari N.C. No.2	Koreiguri Kachari	Nemutengani Miri	Tulshijan
Borigaon	Goroimari No.1	Koroiguri	Neogarghuli	Ubhota Ayengia
Borkhamukh N.C.	Goroimari No.1	Krishnapur	Nepali Gaon	Ujani Cherpai No.2
Borkhamukh No.1	Gorojmari Chapari	Kukurajuja	Ohani N.C.	
Borkhamukh No.2	Gorokhla Chuk	Kulamua Miri	Pakania Miri	
Borkheliagaon	Gorpara Miri	Kumolia Chapori	Palaspasa N.C. No.2	
Chakuli N.C.	Gorukhuti Kachari	Kushimari Chapari	Pandhowa	
Charan Chuk	Gosai Chapari	Kutubpur		
Modergurj		Laguabara Gaon		



Marigaon Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	23377
2	Low	19838
3	Moderate	29154
4	High	19550
5	Very High	15915

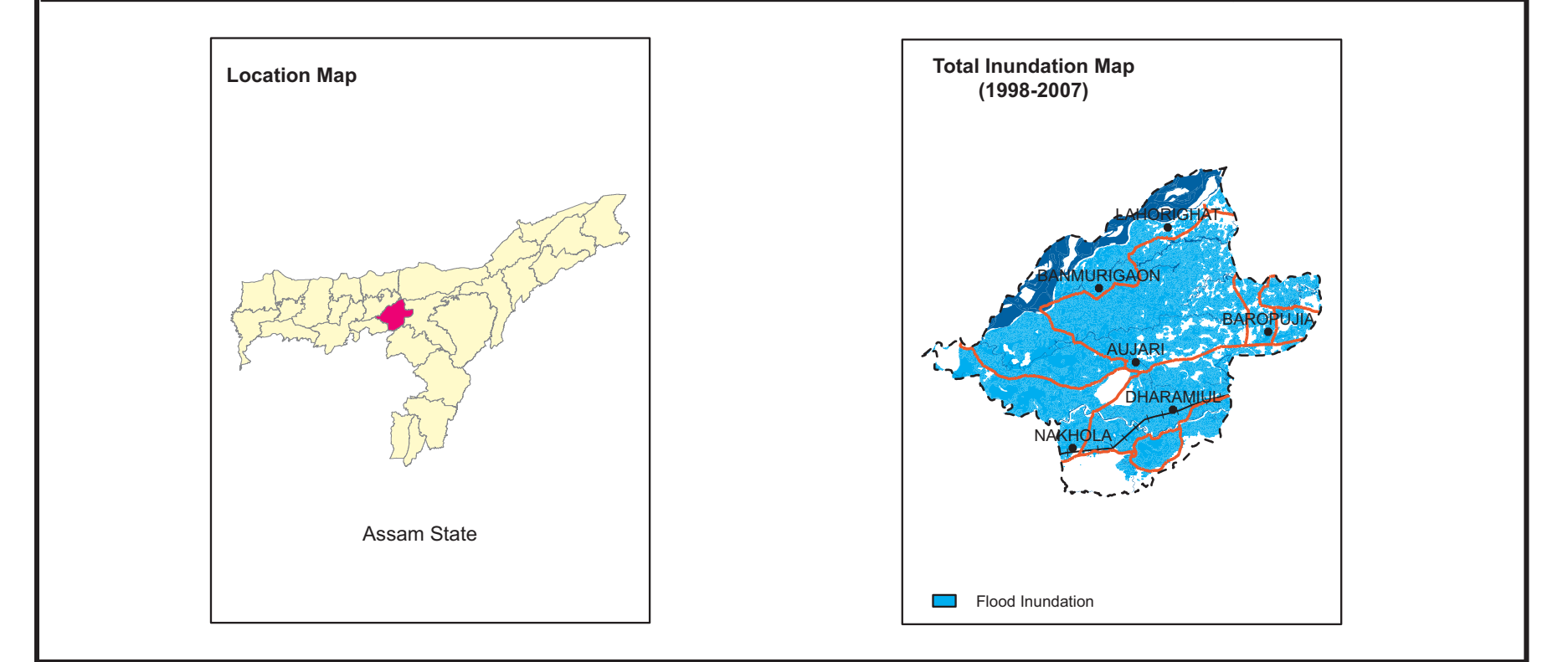
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (265 nos)

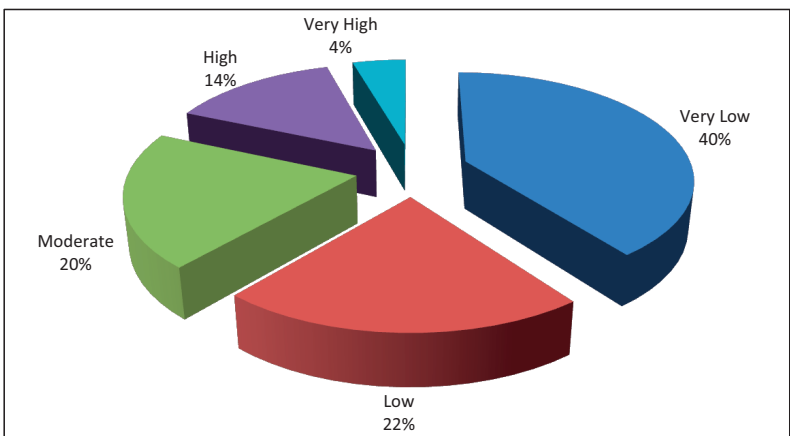
Achighar	Bhalukaguri	Ghagua Mori Gaon	Khatar Bari	Parajari
Ahatguri Gaon	Bhehguri	Ghobali	Kherkatagaon	Pat Komai
Alichinga	Bheibari	Ghorajann Grant	Khula Gaon	Patiabandha
Amaraguri	Bhogduba Beel	Ghoramora Pathar	Khulani Gaon	Patidaya
Amjari	Bhogduba Habi	Ghumatigaon	Kuhiguri	Patrabari
Baghjap	Bhumuraguri	Ghunusha	Kujadal	Patuakata
Bahakajari Pathar	Bihubari	Ghurabak Pathar	Kukuari	Phakali
Bakari Chapari	Block No.8	Gobardham Grant	Kuranibari	Pobitara R.F.
Bali Pathar	Boal Guri	Gosaibari	Lachanabari	Pub -Dharamtul
Balimukh P.G.R.	Boalgari	Gunamara No.1	Laokhua Bari	Pukarkata
Bamun Gaon	Bogoriguri	Gunamara No.2	Latha Bari	Rahdhala
Bamunbori	Bori Gaon	Haibor Pathar	Lecharipar	Raina Pathar
Bamunjari	Borjari No.2	Haladhiati	Lecheribari	Raja Gaon
Ban Para	Borpathar No.1	Haloakanda	Lelaibori	Ranga Daria
Bangal Para	Borpathar No.2	Hariapar	Lengeribori	Raomari Bill
Bangfar	Bualguri	Hati Utha Gaon	Lengerigaon	Raumari
Banmuri Beel	Bura-buri Gaon	Hatia Mukh Pathar	Lengribori	Rupah Bari
Banpara Darapani	Chaharia Gaon	Hatiboagora	Lochana Bari	Saku Maku
Baralimari	Chalabari	Hatigarh P.G.R.	Mahdala Bari	Salkhati Pathar
Barashi Bandha	Chalsingabari	Hatimuria	Mahmara Beel	Salmara Pam
Barati	Charai Hagi	Hatkhol	Maj Jaiari	Salmari
Barchalagaon No.1	Chatanguri	Jagi	Majorbori	Salmari No.2
Barchalagaon No.2	Chatiantoli	Jaluguti	Manaha kachari Gaon	Sapkati
Bardampur	Chengmari Pathar	Jamadari	Marisuti Pam	Saru Bari
Barduba Tup	Chutia Khal	Japari Gaon	Marisuti Tup	Saru Duani
Bargaon No.1	Da Panbari	Jengarbori Gaon	Mati Parbat	Saru Manaha Beel
Barhaitari	Dachika Bari	Jhargaon	Merua Gaon	Satari Bori
Barkoloi	Dahuati Padum Pukhuri	Jur Beel	Mikir Gaon	Satsapar Dalani
Barkurani	Dahuti Habi	Jurgaon	Mikirbhet	Satsapari Doloni
Barmari	Daloi Chuba	Kachamari Pathar	Mikirgaon	Sidhabari
Barmur Pathar	Dandua Bilor Tup	Kachari	Morakolong	Sil Pukhuri
Barpak Jungle	Darangi Gaon	Kachari Jan	Muladhari Gaon	Singi Mari
Barsaloni Pathar	Darangia Gaon	Kachodhura Bill	Murkata Pathar No.1	Sipiri
Barshila	Deosal	Kahua Habi	Murkata Pathar No.2	Sonabari Diksang
Barukata	Dhankhunda No.1	Kakor Jalah	Naba Hatia	Sonaikutchi R.F.
Barukata Chaharia	Dhekiabari	Kal Bari	Nabhang	Sunabari Pathar
Barukati	Dibika	Kalbari	Nagaon	Surat Bori
Barunguri	Dighaliati	Kaliajari	Naljai	Sutirpar
Basana Ghat	Dimaruguri	Kalikajari	Nandinibari Naokata	Tabtala
Basundhari Gaon	Dongabori No.2	Kamarkuchi	Nijghagua, Hatimura	Tamuli Bori
Bata Bari	Dungarpar	Kamarpur Pahar	Parbat nc.	Tara Bori
Batobori	Dura Bori	Kanjuli Pathar	Niz Dandua	Tarajan
Bebejia Habi	Durabandhi	Kapahera Kapao Jari	Niz Gerua	Tengaguri
Bechamari Duba	Gabhura Tup	Karai Bari	Niz Ghagua	Teteliguri Gaon
Belar Bari	Gagal Mari Pam	Karati Pam	Niz-Mikir Gaon	Thekera
Belarguri Gaon	Gagalmari Achegar	Karchuwa Bari	Ouguri	Titatala
Belguri	Gaon Galia Gar Jan	Kariguri	Pabitara P.G.R.	Tup Gaon
Besapati	Garapar	Kashadhara	Pachim Nagaon	Udari
Bhagamur	Garmari	Kata Jari Pather	Pakamura	Udkati
Bhakat Gaon	Garoimari	Katah Jari	Palahjuri	Udmari Pathar
Bhakatgaon	Garumara Doloni	Katahguri	Paliguri	Uttar Dharamtul
Bhakuamari	Gashbari N.C.	Katalamara Bari	Pambargaon	
Bhaluka Guri	Gerua Beel	Khar Beel	Pani Kaori	



Nowgong
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	75955
2	Low	41290
3	Moderate	38594
4	High	26807
5	Very High	8547

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (331 nos)

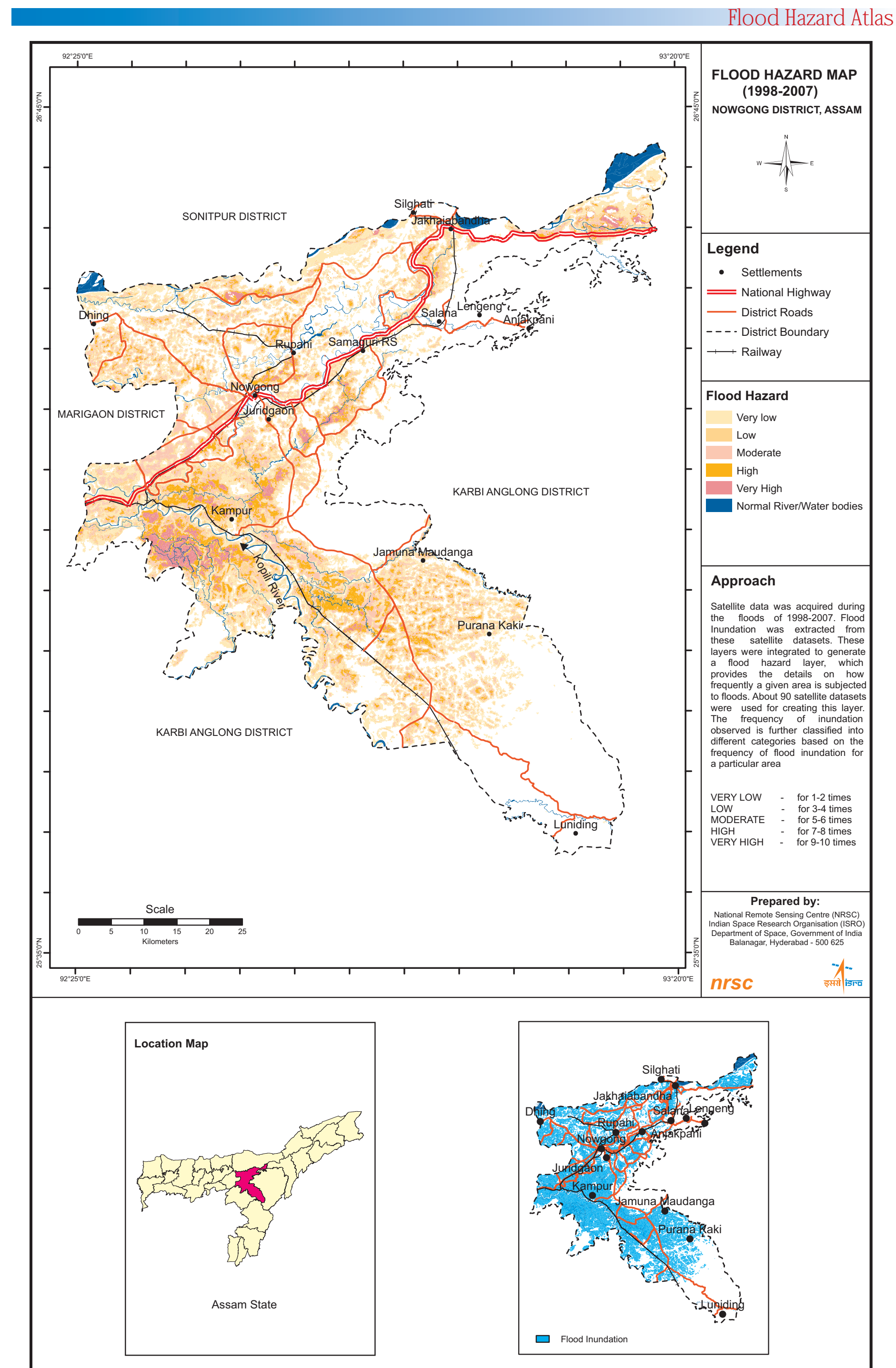
Afutoli
Ahomar Doba
Ahomgaon
Ahumpura
Ai Bheti
Alapia Bebejia
Alinagar
Alitangani
Ambari
Amlı Pukhuri
Amlokhigaon
Amtola
Ato Atika
Auniati Jalah
Auniati Satra
Bachamari
Bagalajan
Baghmari
BAGSER R.F.
Bahaka Bari
Baj Batamari
Balichara
Balichara Mikirgaon
Balijui
Balijuri
Bali-Naria Bill
Baliram
Baliram Gaon
Baluhandar
Bamun Gaom
Bamunijan
Bandar Dubi
Barafuti
Bar-Fakoli
Barghuli No.4
Barhawar
Barjari Gaon
Barpaka
Barunguri
Bata Bari
Bezarchuk
Bhalukaguri
Bhatikuri
Bhedeo Ati
Bheloguri Pathar
Bher Bheri Bill
Bher-Bheri
Bhoraguri No.1
Bhurbandha No.3
Block No.48
Borbheti
Borboha
Borghat
Borhula
Borjoha
Borpeta Habi
Borpukhuri
Boruabali
Boruntoli
Brajapur
Bundura
Bundura Ati
Burungat Ati
Chakorigaon
Chalchali Jalah
Chandanpur
Chang Juri

Chang Majimikir Pathar
Changmaji Gaon
Chankhola
Charai Juria
Charaihagi
Charinghi Pather
Charlock
Chatialgaon
Chengajan
Chengmora
Cheoguri
Chola Pathar
Chutiagaon
Dabakanala
Dabalu Bill
Dablong Gaon
Dablongati
Dakhin Bhedeo Ati
Dakhin Changchaki
Dakhin Kadura
Dakhin Kumurakata
Dakhin Nawabil
Dakhinasinagar
Dakhinpat
Dakshin Laskar Pather
Dalaniguri
Dalimbari Grant
Dangari Bill
Danki Pather
Dapara
Darangi Gaon
Darigaji
Darrangi Gaon
Deb Narikali
Debasthan
Deuri Ati
Dhananjai Duba
Dhania Bheti Gaon
Dhemajigaon
Dhigali
Dighalballi
Dighaliduba
DighalJarani
Digholi Bil
Digholi Pather
Dimarupar
Dimow
Diphalu gaon
Dulalmadhab
Dumaihagi
Dwarika Fakali
Etapara
Fakali Fakali Pathar
Fakira Basti
Fatepur
Gakhirkhaiti No.4
Garubandha
Garubat Gaon
Gatanga
Gehua Chal Chali
Gendhua Pathar
Gereki
Gerekonigaon
Gerjai Pam
Ghilani
Ghugargaon
Godai Mari Pathar

Godharia
Gopalnagar
Gorhagi
Guimari
Hagaltoli Bill
Halowagaon
Hathi Pukhuri
Hatigarh
Hatijujua Pathar
Hatikhali
Hatikhuti
Hatimura Bill
Hirabasti
Hyangbasti
Islampur
Itagaon
Jakarowa Bill
Jalah
Jamuhandal
Janghal Block
Jayantia Basti
Jorduba
Jugijan
Jugijan Gaon
Jurirpar
Kachari Gaon
Kachari Khanda
Kachua No.2
Kajalajan
Kakatigaon
KakiR.F.
Kamargaon
Kanchanpur
Kandapara
Kandhulimari
Kandulimari
Kapahbari
Karaiyani
Kathalpur
Kawaimari
KawaimariLalung Gaon
Kayeemari
Kaziranga
KAZIRANGA R.F.
Kekuribari
Khaliha Mari
Khaliha Mari No.1
Khalihamari
Khapari Jarani
Koach Gaon
Kocharipara
Kubai Katagaon
Kumargaon
Kumurakata D. Reserve
Kuwaritol
Lakhipur
Laogaon
Laokhowa R.F.
Laophulabori
Loan-motiJallah
Lutumari N.C.
Madha Para
Magurgaon
Magurmari
Mahgarh
Mahpara
Maina Pather

Mairadhwas
Major Ati
Mano Ram Pathar
Manuhpura
Marisuti
Mathigaon
Matikhola
Mikirgaon
Milik Basti
Missa Mari No.2
Mohsara
Moudanga
Mubarak Basti
NA
Na-Bebejia
Nagaya Pam
Nam Kahanda
Nam Pathari
Nam Rangagara
Namdabaka Gaon
Nartumgaon
Nedhargaon
Nelipar
Nilbagan
Niz Chahari
Niz Jagial
Niz Jarabari
Niz Kampur
Niz Narikali
Nonoi-Numkuri
Owana
Pabijuri
Pachim Amtola
Pachim Bagari
Pachim Balukmari
Pachim Jarmani
Pachim Kathiatoli
Pachim Kawaimari
Pachim Khaloi Bhanga
Pachim Nambor Lalung Gaon
Pachim Nandalalpur
Pachim Nilbagan
Padum Pukhuri
Padumani
Padumoni Bil
Pagla Basti
Pahupuri Khaiti
Palasoni
Pamgaon
Pamila Ati
Pamila Jaroni
Panbari Satra
Panigaon
Pashbandar
Patia Pathar
Phukanarkhat
Pub Bagari
Pub Deopani
Pub Dhaniram Pather
Pub Guimari
Pub Jugijan
Pub Kandura
Pub Kawaimari
Pub Khaloi Bhanga
Pub Nandalalpur
Pub Solmarijan
Pub. Balukmari

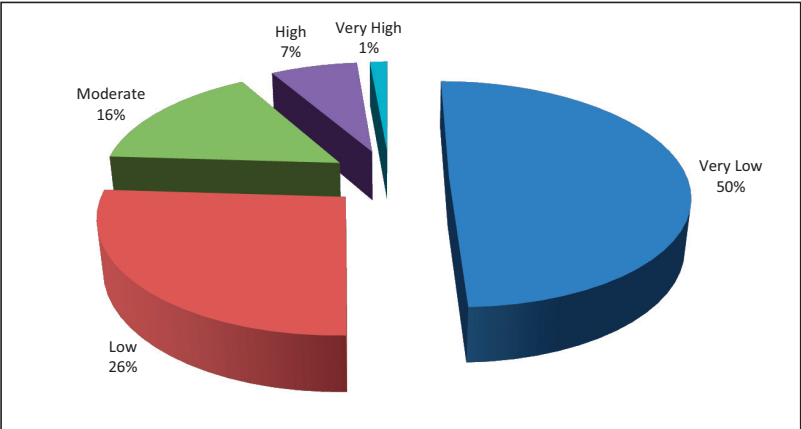
Pubjarani
Puthimari
Raja Ali
Raja Pukhuri
Rajabari
Rajabari Grant
Ramani Pather
Rangalu Basti
Rangolu Mukh
Rani Pukhuri
Rohin Pather
Roumari
Rowmari Doloni
Rupahi Bhakat Gaon
Sabajpur
Sadargaon
Saharan
Sahariagaon
Salmara
Salmari
Salmarijan
Salnabari
Samboria
Samgaon
Sankar Basti
Saotalbasti
Sapat Kara
Saragui
Sariyah Toli
Saru Pathar
Siale Khowa
Sibpur
Sibpur No.1
Sibpur No.2
Simaluguri
Sing Gaon
Singirpar
Solmari
Sonaruguri
Sowpur
Sukati Puta Bill
Sutarpur
Takala Tup
Tapat Karajialah
Telia Bebejia Pathar
Teliagaon
Tengatali
Tengeripur
Tetelisora Gaon
Thikadar Basti
Tubuki Bordowa
Tuli Basti
Upar Kahanda
Uriagaon Grant Rangolu
Uttar Asinagar
Uttar Dimarapur
Uttar Gamarigaon
Uttar Laskar Pather
Uttar Matikhola
Uttar Narikali
Uttar Petborha
Uzanmari



Nalbari
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	25621
2	Low	13689
3	Moderate	8095
4	High	3608
5	Very High	724

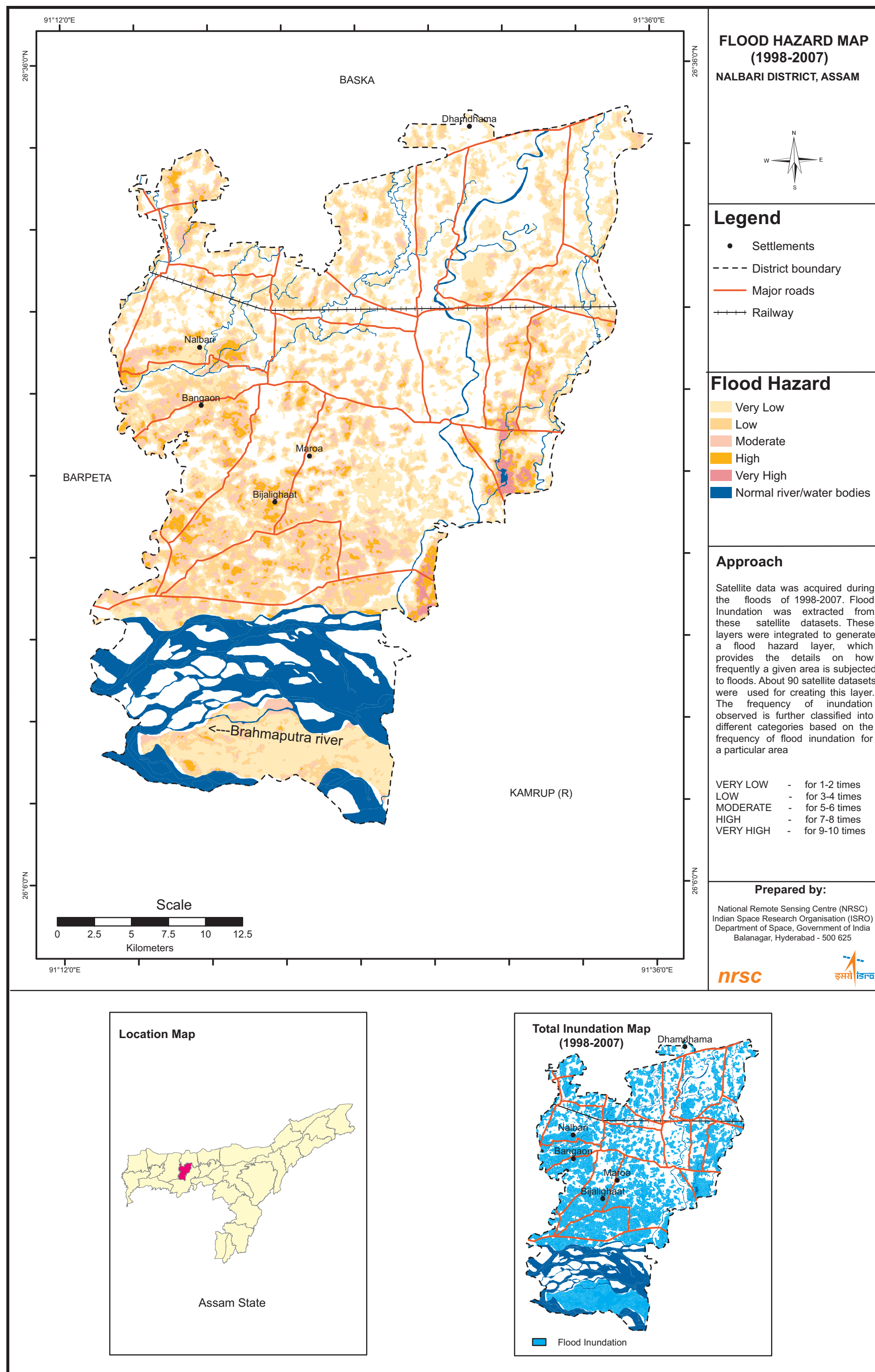
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (39 nos)

Adabari	Kaihati
Ahta	Kalag
Amrattari	Kandhbari
Ananga Mow	Kandu Bari
Bamun Angradi	Kotal Kuchi
Bamunbari	kundargaon
Bamundittari	Kundargaon Jubriuati
Bar Helacha	Lowthari
Barbukia	Mugodi (Mugdi)
Barni bari	Nadla
Barsimla	Naptipara
Batamara	No 1 Ghora Thal
Batshor	No.1 Joysagar
Bhojkuchi	Pachim Khatar
Bihampur	Kalakuchi
Bullitpar	Rana Kuchi
Darangipara	Solmara
Ghora Thal	Sonekuchi
Haribhanga	Sungarmari
Jagara	Uttar Kuchi



North Cachar

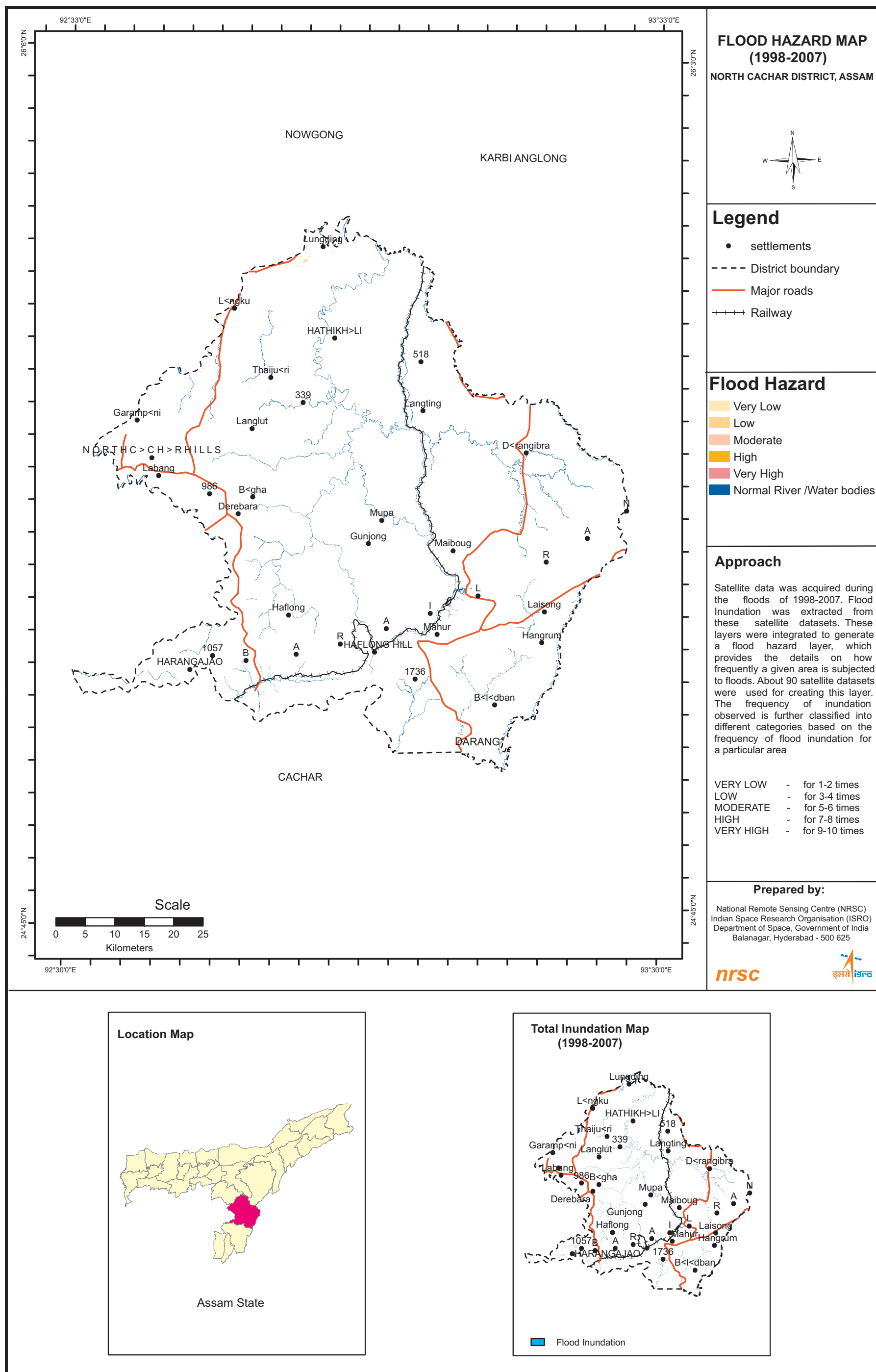
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	440
2	Low	22
3	Moderate	0
4	High	0
5	Very High	0

Flood Hazard area under different flood hazard zones

As flood hazard area is very less, the graph is not shown

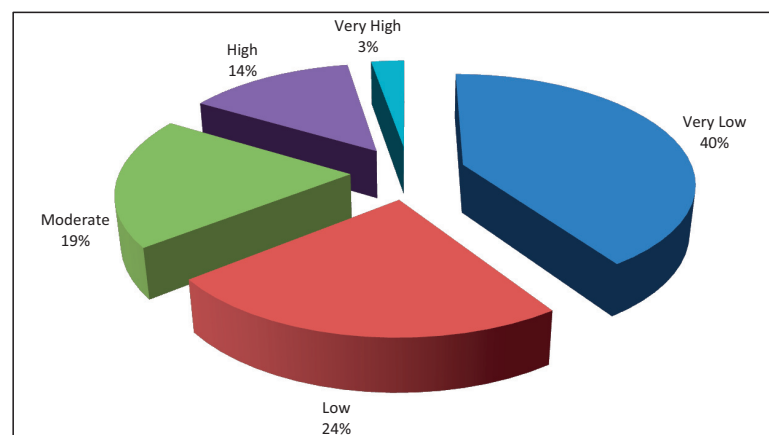
Villages under Very High & High Hazard categories - NIL



Sibsagar Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	49716
2	Low	29118
3	Moderate	23533
4	High	16810
5	Very High	3342

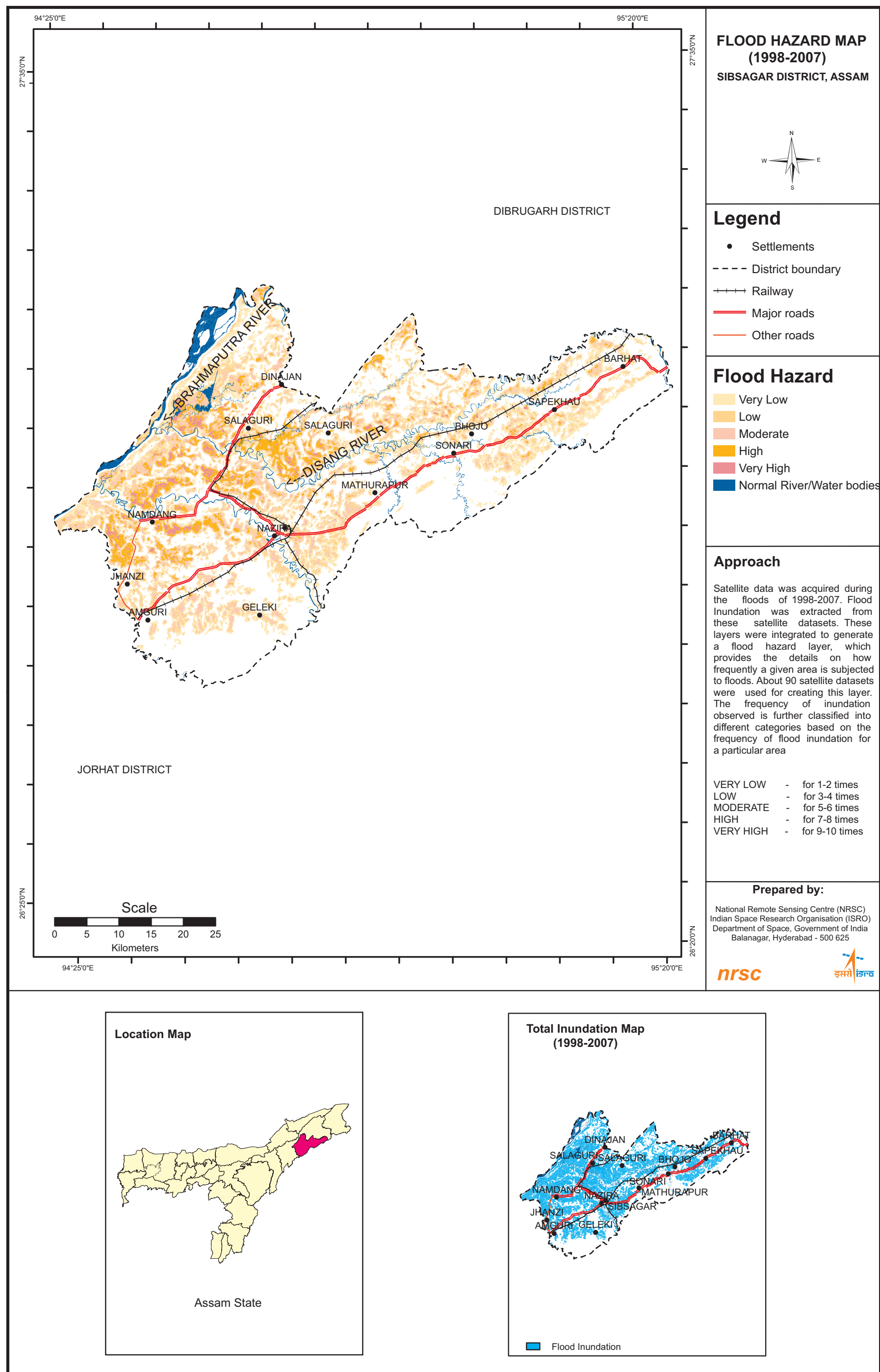
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (280 nos)

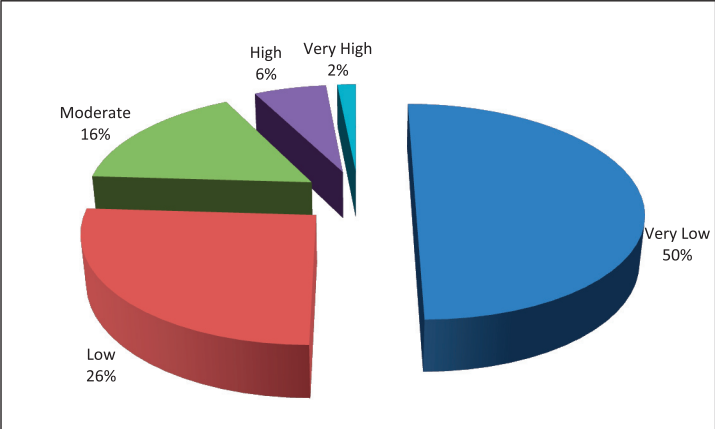
Abhoypuria	Chaulkara No.2	Gohain Gaon	Khargharia Deodhar	Na-Ramua Bokajan
Ailamukh	Chechur Khowa	Gohain Pathar	Kharkharijan	Nazira Town
Akhoiphutia	Chengelibari	Gorkasaria	Khatarpathar	Nimaijan Habi
Alichiga	Cheni Mora	Gorkush	Khelua Gaon	Nowjan
Amkotia Gohain Gaon	Chetia Changmai	Goskata	Khemdoipukhuri	Nowjan Block
Amolaguri	Chetia Gaon	Gotanga Gaon	Khona Grant (288 & 313)	Nowjan Gaon
Athabari Grant	Chetia Kaiborta	Gozpuria Kakaty Gaon	Koijan	Nowsalia Gaon
Auguri Pathar	Chirakhuada	Halaguri	Kopouting	Oil India (Moran)
Bagagohain	Chungia Pathar	Halua Bhakat	Kori Gaon	Pachi Pathar
Bagagohain Gaon	Chutia Gaon	Haluating Grant	Kowamora Handique	Pachim Nalbari
Bagalhabi	Chutia Katani	Handique Gaon	Kowar Dehingia	Pahuchungi Gaon
Bagpara Gaon	Daba Grant	Hatibarua	Kowar Gaon No.1	Palengi P.G.R.
Bailung Gaon	Da-Dhora Grant	Hatighuli Gaon	Kowar Gaon No.2	Panbesha
Bakulduba	Da-Gaon	Hatimara Pathar	Kowarpur P.G.R.	Parasanighabi
Balikhettia Gaon	Dakhin Barpathar	Hatimaria Gaon	Kukurachua Deodhai Gaon	Patia Gaon
Bamun Moran Gaon	Decial Gaon	Hiloidari	Labang Gaon	Patra Chetia
Banmukh Chutia	Deghal Dariali	Hingrajan T.E.	Laipleg Deodhar	Patuachala Gaon
Banmukh Dehingia	Dehajan Habi	Hingrajun T.E. No.1	Lal Bill	Phakum Kamar Fadia
Bara Gaon	Demow Pathar	Jabala Ting	Longchai Habi	Phukanfadia Gaon
Barhoiting	Demowmukh	Jagara Habi	Longpatia Gaon	Phukon Fadia
Barpathar Gaon	Demowmukh Gohain	Jagarahabi Mamol Miri	Loraputa	Pub Nalbari
Bartimon	Deolia Gayan	Jajali Gaon	Machoi Gaon	Rahan Pathar No.1
Baruati	Deoriting Grant (T.E.)	Jajali Pukhuri	Maduri Gohain Gaon	Raja Bagan
Belimukhia	Deroihabi	Jajalihabi	Mahkhuti	Rajabari Bagicha
Bezgaon	Desang Diroi	Janmiri	Maj-Nara Gaon	Rajmai Grant Rudra Sagar
Bhadhara Gaon	Dewdubi	Japidhara Gaon	Maj-Pathar Gaon	Rukang Grant
Bhakat Gaon	Dhanekhana Habi Grant	Japisajia Deodhai	Malia Bheta	Rupahi Bill
Bharalua	Dhemajibil	Japisajia Gaon	Mautania	Rupahi Pathar
Bhekuri Chapari	Dhiar Gaon	Jarabaripam	Mechagar Gohain	Rupahijan Gaon
Bhelelai	Dhopaboria	Jaradhara	Mer-Bil	Salaguri
Bhitarual Nara Gaon	Dhuliahabi	Jayapara	Mitong Na-Katani	Sapekhati Rly. Station
Bhojo Grant	Dhunder Mukh	Jaysagar Gaon	Mohondeodhai Mola Gaon	Saragua Gaon
Bokabill	Dighal Pachihabi	Jerenga Habi	Moranjan	Saragua Grant
Boliaghat	Dighali Habi	Jiamari	Mori Desang N.C.	Saral Pathar
Bor Patra Gohain	Dighali Pathar N.C.	Joykhamdang Khat	Mothadang	Saru Diroi
Borahi Kachari Gaon	Dighalijan Gaon	Kachari Gaon	Mothadung	Saru Palengi
Borapial Gaon	Dimoruguri	Kacharibam Pathar	Motok Gohain	Sarupathar Gaon
Borapial Habi	Dimual	Kachuani Pathar	Moudumuni	Sarupathar No.2
Borbil	Disangkochhabi	Kaibartta Dalani	Mout Bari	Senchua Namdangia
Bordeodhai	Disial Dhulia	Kakaty Gaon	Mout Gaon	Sesapukhurihabi
Borderoi Grant	Do-Alimaj	Kakatybari Habi	Mout Gharphalia No.1	Somorajan
Borduar Mukh	Domardolong Gaon	Kaliapani Grant	Mout Gharphalia No.2	Sripuria
Borpatradol Kalugaon	Duan Gaon	Kalmow N.C.	Nahar Pukhuri Khowar	Sukap Pukhuri
Buragohain Gaon	Dulia Puranimalia Gaon	Kataki Koch	Naharhabi Grant	Tamuli Pukhuri
Buragohainbari	Duponi Pathar	Katakya Papang	Nahartali Pathar	Tati Pathar
Chala Pathar	Ekora Tali	Kathal Bari	Nahat Goraimari	Telial Gaon
Chala T.E.	Erabari	Kathiakhunda No.1	Nakatani Gaon	Temon Bartani
Chaliha Kakaty Gaon	Fakalai Block	Kathpara	Namdang Kumar	Tenganihabi
Chamaguri	Fakalani Habi	Ketelachua Gaon	Namdangia Bengali Gaon	Teok Gaon
Chand Basa Chandmond	Forest	Khalagrazing No.1	Namoni Changmai	Tepor Gaon
Changmai	Gandhia Gaon	Khalagrazing No.2	Namti Gaon	Timonhabi
Charimuthia	Garakochhabi	Khalagrazing No.3	Namti Pathar	Tiphukhabi
Charingia	Gharachua Kamar	Khamon Gaon	Namtial	Tipomia Gaon
Charingia Gaon	Gharaswa Gaon	Khangia Grant	Namtial Gaon	Torani F.V.
Chaulkara No.1	Ghelgheli	Khanikar	Nara Gaon	
	Ghorajan No.2	Kharahat T.E.	Nara Kowar Bailung	



Sonitpur
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	80200
2	Low	41666
3	Moderate	26405
4	High	9687
5	Very High	2492

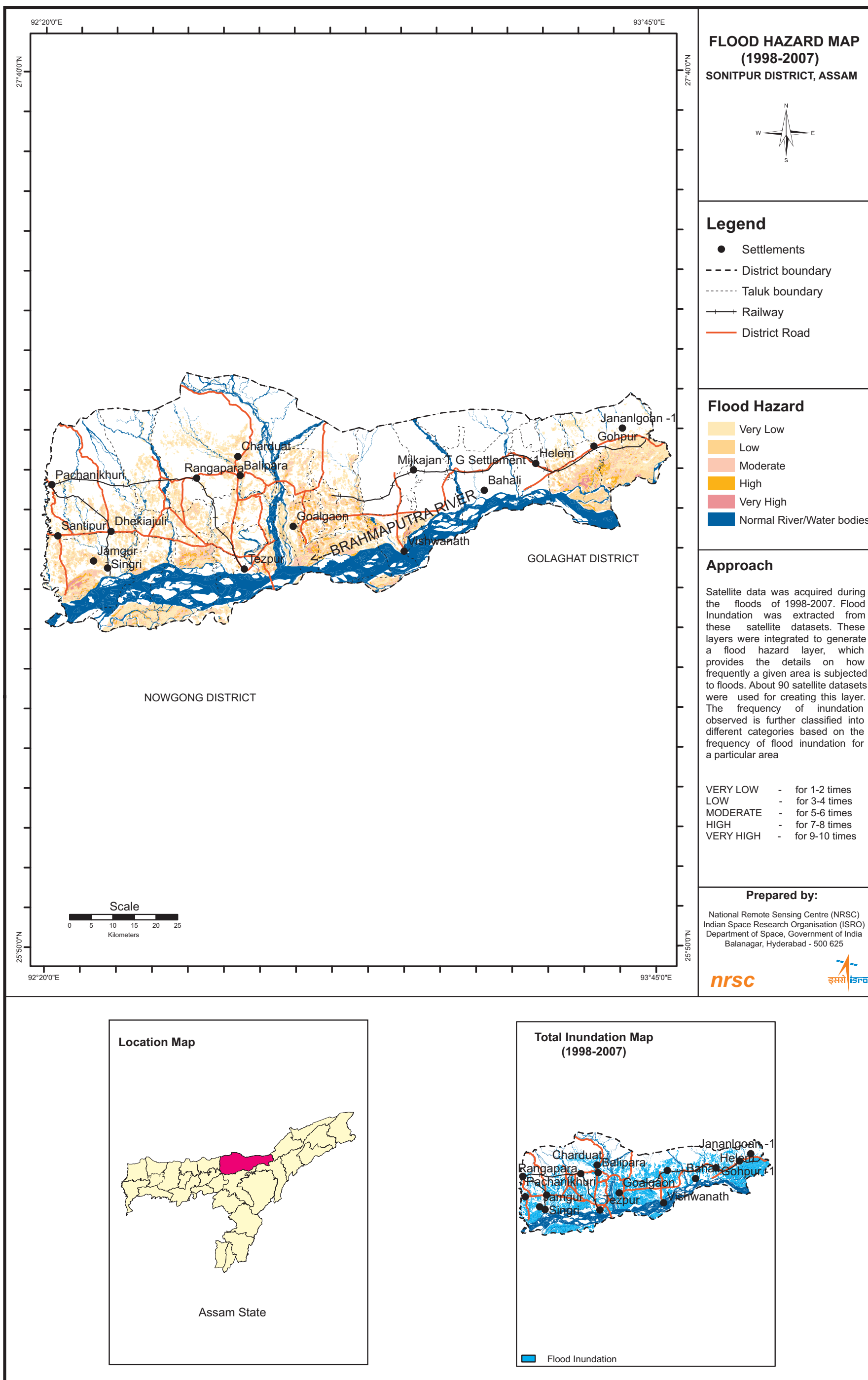
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (81 nos)

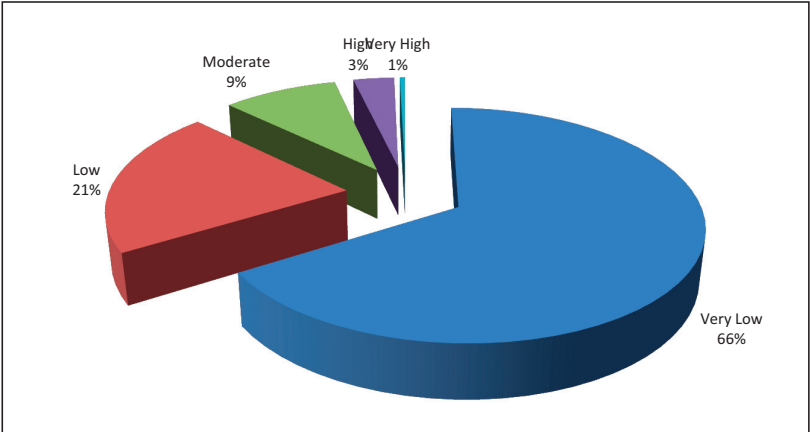
2 No. Rajabari	Durabarigaon	Maranabari
Bachhasimlu	Gamiripal Kumargaon	Metera
Bagali Basti	Garaimari Pathar	Metera Gaon
Bakara Pathar	Gareki Bil"	Moronakuri
Bali Chapari	Gari Kuri	Murhadal
Bamun Gaon	Geruapathar Gaon	N.C. Chirakhowa
Bapubheti Gaon	Habidalani	Nag Sankar Gaon
Bar Tamuli	Hatibarijan Gaon	Niz Barbhagia
Barakata Chapori	Hatijan No.1	No.2 Chalia
Barbheti	Hukaigaon Hukama	No.2 Nalbari
Batalagaon	Jakapara	No.2 Taltali
Batiamari	Kachari Pam Gaon	No.2 Upper Tinisukia
Bhalukekhowa Gaon	Kalachong Gaon	Pachigaon
Bhara Singri	Karhanagaon pathar	Palasani
Bhojkhowa	Kashuani Ali	Pithakhowa Gaon
Bhojkhowa Chapari	Kawari Mari	Purub Bari Kachari
Bhowalguri Gaon	Khatowal	Rajbharal Gaon
Bokabilgaon	Khelepia Pathar	Rangamati Gaon
Borakata Pathar	Kurua-Ati	Salaguri
Chalia Chapari	Kurukani	Simulbari
Chatiya Pathar	Luhit Mukh	Solagaon
Chengelimara	Madhab Barhampur	Talakabari
Da-gaon Pukhuri	Magurmara	Talakabari Bangali
Dalhousi dhangaon	Maj Gaon	Turipam
Deshwali Tapu	Maj Pichala	Uhanipathar Dhekidol
Dhekeri Gaon	Major Chuk	Upar Kuri
Dipotahatkhol	Mara Belsiri	



Tinsukia
Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	49219
2	Low	15587
3	Moderate	6811
4	High	2429
5	Very High	299

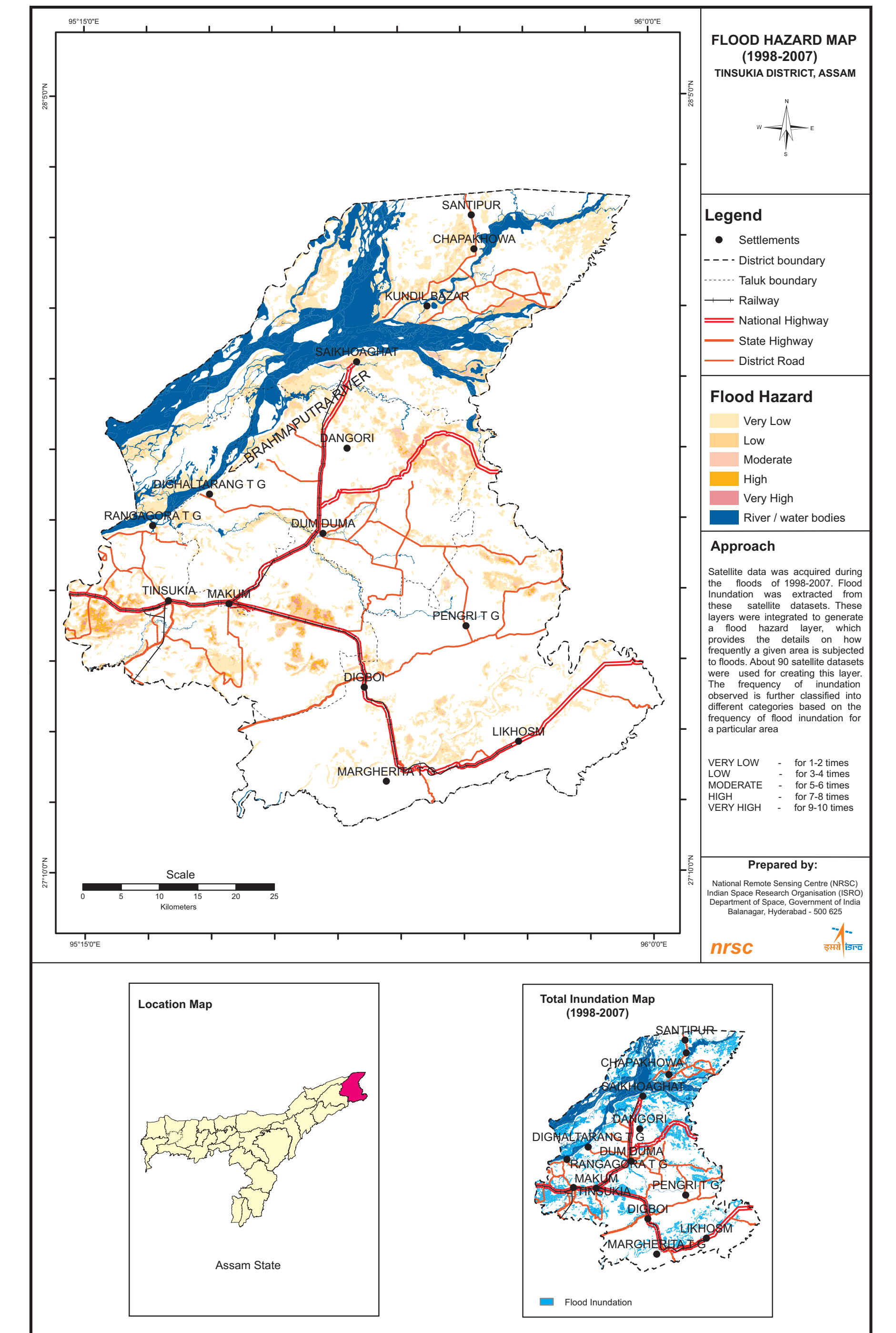
Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Following is the list of villages under Very High & High Hazard categories (28 nos)

Asamia Pathar Gaon	Nunpuria Bangali Gaon
Balijan Gaon	Nunpuria Kaibarta Gaon
Baruahola Gaon	Okanimuria Kachari
Betani Gaon	Gaon
Betoni Gaon	Panikhowa Bangali
Dharia Gaon	Gaon
Gaharipam Gaon	Panimudi Gaon
Hebeda Gaon No1	Panitola Gaon
Hollong Pathar	Raidang Bangali Gaon
Kasamari Gaon	Raidang Pathar Gaon
Katang Habi Gaon	Salaguri Gaon
Kukure Khowa Gaon	Simaluguri Gaon
Mamarani Gaon	Sukan Pukhuri Gaon
N.C.	Tengani Gaon
NA Gaon	Upur Mamarani Gaon

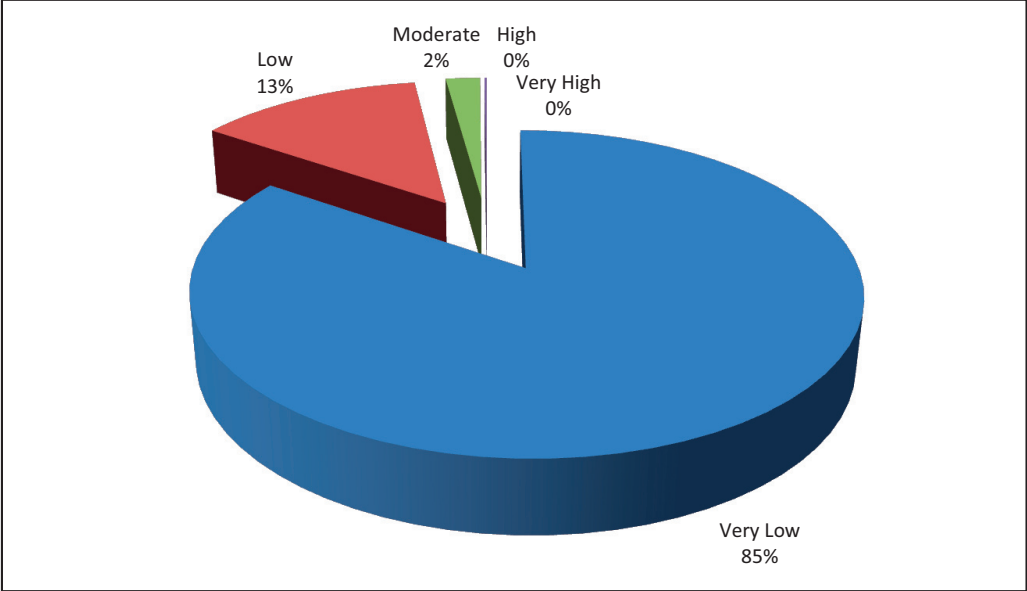


Udalguri

Flood Hazard Statistics

Hazard Code	Severity	Flood Hazard Area (hectares)
1	Very Low	41309
2	Low	6503
3	Moderate	997
4	High	58
5	Very High	0

Flood Hazard area under different flood hazard zones



Graph showing the percentage of various flood hazard categories

Villages under Very High & High Hazard categories - NIL

