



VULNERABILITY & RISK ASSESSMENT OF FLOOD & CYCLONE PREPAREDNESS PLANNING OF GANJAM DISTRICT, ODISHA

Dr. Ashis Chandra Pathy
Asst. Professor, P.G. Dept. Of Geography, Utkal University, Bhubaneswar.



ABSTRACT:

Floods and Cyclones are the most destructional and widely spread disasters among all the Natural Disasters along the coastal plains of Orissa. It is clearly understood by Looking at disaster events in Orissa of the last few years, It is evident that Natural Disasters are inevitable and it is almost impossible to fully recoup the damage caused by the disaster. But it is possible to minimize the potential risk by developing disaster early warning strategies, preparing and implementing developmental plans to provide resilience to such disasters and helping in rehabilitation and post disaster reduction. Some of the lessons learned in the last several years given clear indication that the availability, management and presentation of Geo-Information plays a crucial role in disaster management. Today Geographical Information System (GIS) takes an important role for Intelligent mapping through analysis and data sharing which is vital for preparing pre-plans to reduce the problems and better monitoring when disaster takes place and post disaster management. The analytical capabilities of GIS support all aspects of disaster. In this paper an attempt has been taken to delineate the vulnerable Flood prone areas and Cyclone prone areas with its risk assessment basing on secondary source data and finally with some suggested measures on its pre-plan preparation to minimize the problems of Ganjam District in GIS Environment.

KEYWORDS: *Floods and Cyclones , post disaster reduction , secondary source data.*

INTRODUCTION:

Although the Natural disasters can and do happen anywhere in the world, the greatest no. and those with the most negative consequences, occur in developing countries. The statistics that can be advanced will vary depending on the criteria used. But probably 70-85% of all disasters happen outside of developed societies. Some such events receive National and International attention such as 1999 Super-Cyclone in Orissa, 2001 Tsunami in India, 2001 Earthquake in Gujarat, 2006 floods in Orissa to mention a few in the last few years. India has been facing every year the natural calamities like Floods, Cyclones, Earthquake, Landslides, Drought etc. Same problems are also experienced by people of Orissa every year particularly Flood & Cyclone. These 2 disasters are creating havoc in all aspects and the development process of the state is getting delayed. State Government has been taking both temporary/permanent relief measures in these calamities affected areas with financial assistance from the Central Government. All the measures are taken so far without a proper and required spatial pre-plan linked with a strong non-spatial database.

The use of GIS and Remote Sensing has become an integrated, well-developed and successful tool in disaster management. GIS and Remote Sensing can be a very useful tool to complement conventional methods involved in Disaster Management Mitigation. The occurrence of disasters, their intensities, areas of their occurrence and their impact need to be assessed. It is also required to have the information / data about the damage they cause to the area and population. By analyzing the

occurrence of disaster the identification of vulnerable areas and a proper preplan can be prepared for better & immediate relief and rescue operation/monitoring. As the data collection, storage and retrieval becoming highly technological and scientific, new specialized techniques like Geographical Information Systems (GIS) are increasingly used for disaster mapping.

OBJECTIVES

- To identify the vulnerable blocks of the district basing on the previous occurrence of Cyclone & Flood from last decade and its effect in different fields such as infrastructure, Water supply, Health etc. with affected population
- To develop a micro level spatial and non-spatial database for vulnerable areas for assessing the critical situation, which can help for immediate and effective relief and rescue operation after Flood/Cyclone.
- To help the district administrators and planners to identify areas of more risk and prioritize their mitigation/response efforts

DATABASE AND METHODOLOGY

Both Primary and secondary data are used in the present study. Secondary data are collected from National Informatics Center, OSDMA, IMD, Census of India, District NIC, Toposheet from Survey of India and LISS-III Satellite imagery from NRSC, Hyderabad. This study sought to engage with emergency professionals throughout the research process i.e. both pre and post tool completion. Preliminary interviews with professional stakeholders (i.e. Category One Responders) were conducted to elicit; i) Professional views on vulnerability, its application in decision making and how it should be assessed; ii) As the target end-user of the tool, responders were asked to rate a number of design ideas and make further suggestions on how a tool of this nature might be packaged together. From these discussions, the tool was designed and constructed and then demonstrated to a sample of responders originally interviewed.

Datasets are stored within a Personal Geodatabase constructed in ArcCatalogue and the tool itself, has been designed within, and launches from, the ESRI product ArcMap. Rather than simply allowing layers to be added and removed, this tool enables users to manipulate these layers to suit their needs and perform calculations on the data to produce vulnerability and risk profiles of the study area. This interactive nature seeks to engage the end-user to become actively involved in the assessment process and map production. The tool provides a means for integrating the informed subjectivities of the end-user, with the objectivity of the 'scientific expert' that is inherently built within the tool.

STUDY AREA

The district got its name from the word "*Ganj-i-am*" which means the Granary of the World. The district is named after the old township and European fort of Ganjam situated on the northern bank of river Rushikulya which was the head quarter of the district. It extending from 19° 4' north latitude to 20° 17' north latitude and 84° 7' east longitude to 85° 12' east longitude & spreading over the geographical area of 8070.60 square km with a population of 31,61,000. The District has 3 Sub-Divisions, 475 GPs and 3212 no of Villages. . The Detail administrative set-up of Ganjam is shown in **Table-1** & Location Map is shown in **Fig-1**.

Administrative Set up of Ganjam

Table-1

ITEM	CENSUS=2001
Geographical Area in Sq Km	8070.60
No of sub divisions	3
No of Tahsils	14
No of Blocks	22
No of Municipalities	1
No of NACs	17
No of P.S	29
No of GPs	475
No of Villages	3212
No of Constituencies	12

Ganjam district is broadly divided into two divisions, the coastal plains in the east and hill, tablelands in the west. The Eastern Ghats run along the western side of the district. The plains lies between the eastern ghats and the Bay of Bengal. The plains are narrow because of the absence of big rivers. The coastal plains in the east contain more fertile and irrigated lands. Towards the centre and south it is hilly with beautiful well watered valley. The south eastern portion is fertile. A portion of the famous Chilika Lake occupies the extreme northeast. The Bay of Bengal touches the eastern frontier of Ganjam district and its coast extends over 60 Kms. The elevation of the district lies between 10 and 900 meters and slope gradually from north west to south east.

FIGURE 1



Since last decades, Ganjam experienced disaster episodes in the year 1990 (Flood), 1995(Flood), 1996(Drought), 1999(Cyclone), 2002(Drought),2003(Flood),and recent in 2006(Flood). Most of the flood hazard is occurred during the month between June and October and Cycone is experinced in the month of April & May and September and October.So it is a perennial problem in Ganjam and the Probabilities of Flood & Cyclone during the months are given in Table-2.

Disaster Probabilities

Table-2

Type of Hazard	Month of Occurrence												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	
Flood						←—————→							
Cyclone				←————→					←————→				

(SOURCE: DISTRICT EMERGENCY CELL, GANJAM)

Climate

The district is characterized by an equable temperature all through the year, particularly in the coastal regions and by high humidity. The cold season from December to February is followed by hot season from March to May. The period from June to September marks the South West Monsoon and 70% of annual precipitation is received during this period. The normal rainfall of this district is 1444 mms. May is the hottest month. With the arrival of the monsoon by about the second week of June the day temperature decreases slightly while the night temperature continues as it was in the summer. Towards the end of September, after the withdrawal of southwest monsoon, temperature decreases progressively. December is the coldest month. The relative humidity is high throughout the year specially in coastal areas. Winds are fairly strong particularly in coastal regions in summer and monsoon months.

River System

The rivers like Rushikulya, Dhanei, Bahuda, Ghodahada are the main river system. Rushikulya, which covers major portion of the district and Loharkhandi, Bada Nadi, Bahuda, Ghodahada rivers enlarge the Basin Catchment area. **Table-3, Table-4** show different rivers flowing in different blocks and its carrying capacity. The River Map is shown in **Fig-2**.

Table-3 River flowing in blocks.

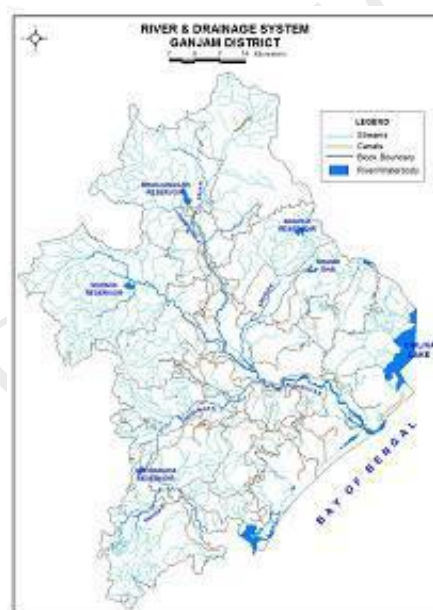
Name of the Block	Name of the Rivers Flowing
Chhatrapur	Rushikulya
Ganjam	Rushikulya
Purussottampur	Rushikulya
Hinjilicut	Rushikulya & Ghodahada
Khallikote	Kharakhari
Polosara	Baghua & Dhanei
K.S.Nagar	Baghua & Dhanei
Rangailunda	Bahananala & Sapuanala
Chikiti	Bahudanala
Paatrapur	Ganjunal
Sanakhemundi	Taptapaninala & Ghodahada
Bhanjanagar	Loharkhandi & Badanadi
Surada	Rushikulya & Jarau
Jagannathprasad	Badanadi & Jarau

(Source: DEC, Ganjam)

River Carrying capacity**Table-4**

Sl. No.	Name of the River	Gauge Station	Zero level in Mtr.	Danger Level in Mtr.
1	RUSHIKULYA	Surada	79.25	81.99
		Aska	33.34	34.75
		Janivili	48.92	53.18
		Hiradharabati	18.59	23.16
		Purushottampur	12.00	16.835
2	BADANADI	Madhaborida	55.78	60.65
		Aska	32.06	35.42
		Nuagam Bridge	68.03	70.93
		Gallery anicut	98.60	102.11
3	BAGHUA	Kabisuryanagar road bridge	31.01	34.06
4	LOKARKHANDI	Bhanjanagar	68.65	72.31

(Source: DEC, Ganjam)

FIGURE 2**FLOOD AND CYCLONE HAZARD**

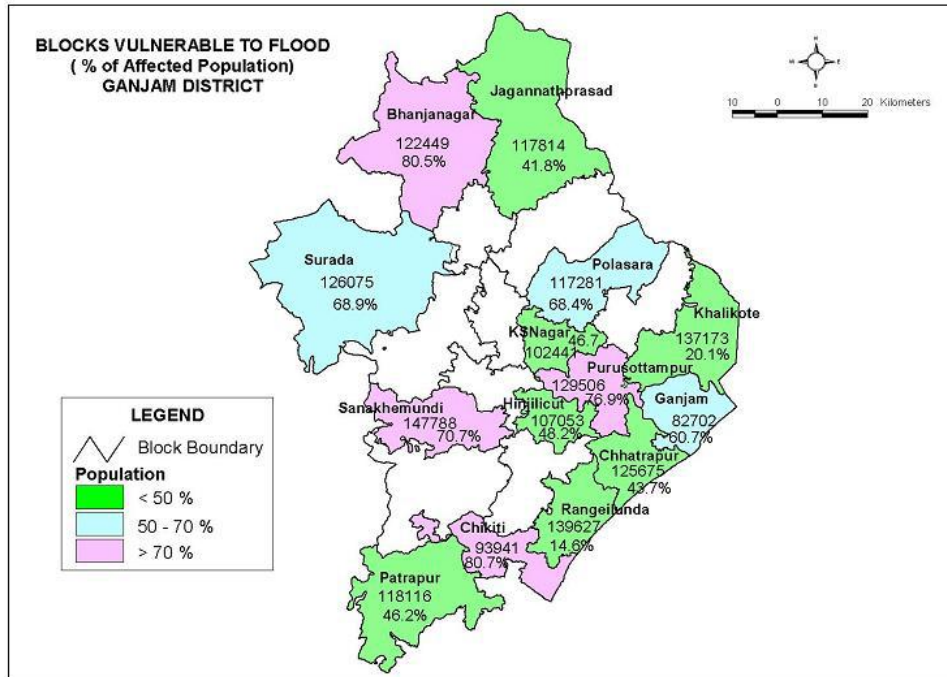
Ganjam district so far experienced repeated natural calamities such as Floods, Cyclone, Drought, Sunstroke, Village Fire, Earth Quake and Industrial disaster. The entire coast of Ganjam which covers 60 Kms along the Bay of Bengal is vulnerable to cyclone and flood hazard of varying frequency and intensity. Cyclone and Flood are the most recurring natural disaster in Ganjam district of Orissa. Cyclones are caused due to storm surge problem in the area. Floods are caused due to the hills are close to the sea, the rivers flowing from hills are not very long and are subject to sudden floods,

Vulnerable Blocks and GPs due to flood and Cyclone.

Floods are the perennial problem in Ganjam District. Out of 22 Blocks, 14 blocks consisting of 168 GPs are vulnerable to flood. The total vulnerable affected population is estimated 9,01,56 which is

54.08% of Block total and 28.53% of district total. The most Vulnerable Block is Chikiti, which is 80.7% of the Block total and 2.39% of the District total. The least population affected in the block of Rangeilunda, which is only 14.6% of the block total and .67% of district total. The Statistics regarding the Blocks vulnerable to Flood along with No. of GPs and population affected and the thematic Map is presented in **Table-5** and in **Fig-3** respectively..The Blocks /Gps vulnerable to Flood with weak Embankment & Gauge Point locations are shown in **Fig-4**.

FIGURE 3

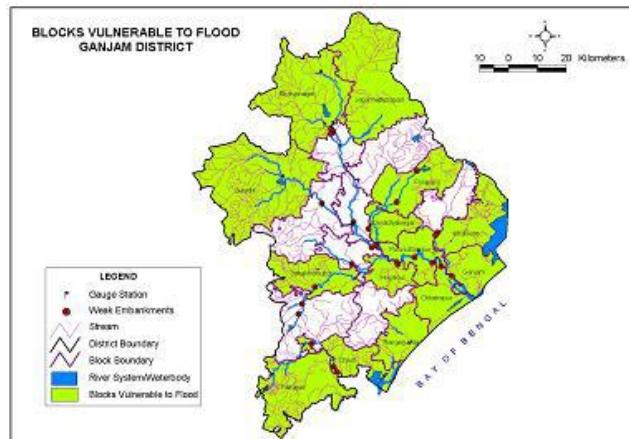


Vulnerable Blocks/GPs of flood & % of Population affected

Table-5

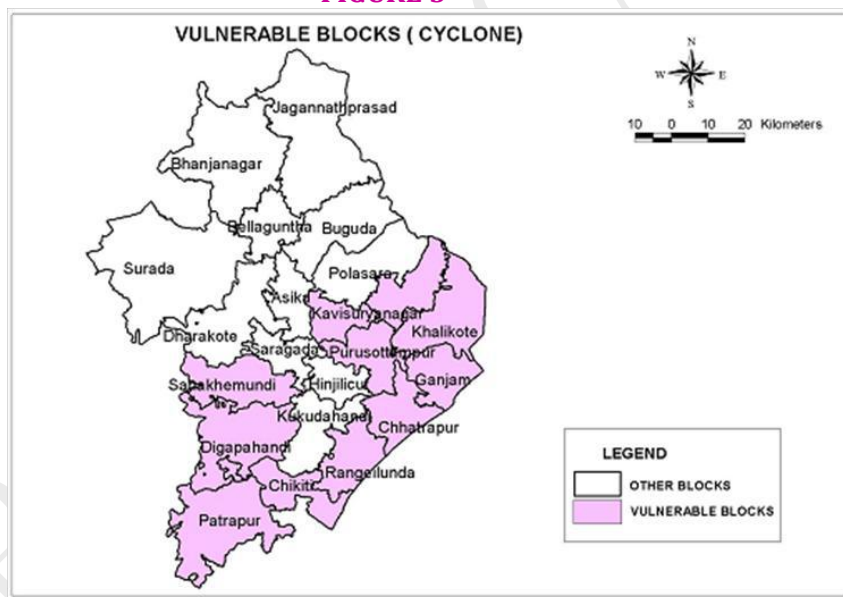
Block Name	NO. of GPs	Affected Gps (No.)	Total Population	Affected Population	% of affected population(Block)	% of affected population(Dist)
Bhanjanagar	20	16	122449	98574	80.5	3.11
Chikiti	17	14	93949	75838	80.7	2.39
Ganjam	14	10	82702	50221	60.7	1.58
Hinjilicut	21	11	107053	51628	48.2	1.63
J.Prasad	24	9	117814	49285	41.8	1.55
K.S.Nagar	21	11	102441	47835	46.7	1.51
Khalikot	26	5	137173	27610	20.1	0.87
Patrapur	23	10	118116	54550	46.2	1.72
Polsara	26	18	117281	80163	68.4	2.53
Purusottampur	26	22	129506	99608	76.9	3.15
Rangeilunda	24	4	139627	20347	14.6	0.64
Sanakhemundi	21	14	147788	104479	70.7	3.30
Sorada	25	16	126075	86925	68.9	2.74
Chatrapur	17	8	125675	54893	43.7	1.73
Total	305	168	1667649	901956	54.08	28.53

FIGURE 4



Generally Cyclone are caused due to storm surge problem. The entire coastal blocks are vulnerable to flood. Out of 22 blocks 11 blocks are vulnerable to cyclone. The blocks are Khallikote, Ganjam, Chhatrapur, Rangeilunda, Chikiti, Patrapur, Digapahandi, Sanakhemundi, Purusottampur, Kavisuryanagar & Beguniapada. Most of the Population of these blocks are vulnerable to cyclone. Vulnerable Cyclone prone Blocks are shown in **Fig-5**.

FIGURE 5



Risk Assessment and Vulnerability analysis.

A Major emergency in flood and cyclone hazard is that, which has the potential to cause serious injury or loss of life. It may cause extensive cause to property and serious disruption. It would normally require to assistance of emergency services to handle it effectively. Hence an emergency preparedness should be planned properly and documented for ease of implementation at the time of need. Due to flood and cyclone hazard the potential impact would be loss of Crop, Human and bovine life, Infrastructure, Houses, livelihood system etc in Ganjam district. The Potential impact and vulnerability analysis of cyclone and flood hazard of Ganjam District is shown in detail in **Table-6**.

Table-6

Type of Hazard	Potential Impact	Vulnerability
Flood & Cyclone	Loss of crop, Human & Bovine Life, Infrastructure, houses, livelihood system, Pvt. Public property etc.	#Road & Tele. Communication network #Private & Public Infrastructures Crop loss - Agriculture/ Horticulture #Loss of Irrigation systems i.e. Private LI- points, Govt. LI points, Electrical Installations. #Drinking Water Sources i.e. Tube wells, Wells, PHD Stand Posts. #Loss of Livestock & Vulnerable people. #Other vulnerable assets i.e. Flood embankments, Canal embankments, #Irrigation projects Small Sale industries, PMRY units, Handloom units, Fishing Boats, Fishing nets, Textile Units, Cashew plantations, Sericulture Units, Casuarinas plantation trees/ orchards/ plantation.

(Source: DEC, Ganjam, 2007.)

Vulnerable Infrastructures

The Vulnerable infrastructures of Ganjam district due to flood & cyclone are mainly Road network, Water supply, Sewage, Hospital, Food stock and supplies, Communication system, Embankments and bridges. The most vulnerable infrastructure is road network and water supply, about 80% of the population along with 22 blocks are vulnerable to cyclone and about 90% of the population and most of the blocks are vulnerable to flood. Another most vulnerable infrastructure is Food stocks and supplies, about 80% of the population along with 13 blocks are vulnerable to cyclone and all the coastal districts of the district is vulnerable to flood. The vulnerable infrastructures of Ganjam District in detail is shown in **Table-7**.

Vulnerable Infrastructures

Table-7

VULNERABILITY	CYCLONE		FLOOD	
	Pop	Area Name	Pop	Area Name
ROAD NETWORK	25,45,800 (80.53%)	Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (Some part), Rangeilunda, Chikiti, Patrapur, Digapahandi, Sankhemundi, (Some part) blocks & Chatrapur, Ganjam, Rambha, Khallikote, Kodala, Purushottampur, Digapahandi, Chikiti, Polosara, Hinjili & Berhampur Municipality.	28,97,000 (91.64%)	Aska, Bhanjanagar, Bellaguntha, Sheragada, Surada, Kukudakhandi, Ganjam, Chatrapur, Khallikote, Hinjili, Polosara Purushottampur, Beguniapada, Kabisuryanagar (Some part), Rangeilunda, Chikiti, Patrapur, Digapahandi, Sanakhemundi (Some part) Blocks. & Berhampur Municipality, Bhanjanagar, Aska, Bellaguntha, Surada, K.S.Nagar, Chatrapur, Ganjam, Rambha, Khallikote, Kodala, Purushottampur, Chikiti, Digapahandi, Polosara, Hinjili.
WATER SUPPLY	25,45,800 (80.53%)	Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (some part), Rangeilunda, Chikiti, Patrapur, Digapahandi, Sanakhemundi (some part), Blocks. & Chatrapur, Ganjam, Rambha, Khallikote, Kodala, Purushottampur, Digapahandi, Chikiti, Polosara, Hinjili & Berhampur Municipality.	28,97,000 (91.64%)	Aska, Bhanjanagar, Bellaguntha, Sheragada, Surada, Kukudakhandi, Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (Some part), Rangeilunda, Chikiti, Patrapur, Digapahandi, Sanakhemundi (Some part) Blocks. & Berhampur Municipality, Bhanjanagar, Aska, Bellaguntha, Surada, K.S.Nagar, Chatrapur, Ganjam, Rambha, Chikiti Khallikote, Kodala, Polosara, Purushottampur, Digapahandi, Hinjili.
SEWRAGE	8300 (0.26%)	Rangeilunda, Kukudakhandi, Digapahandi, Sanakhemundi, Khallikote, Purusottampur		Rangeilunda, Kukudakhandi, Digapahandi, Khallikote, Sanakhemundi, Purusottampur

HOSPITAL	11,65,000 (36.85%)	Khallikote, Rangeilunda, Ganjam, Chatrapur, Chikiti, Aska Block. Digapahandi & Chatrapur, Chikiti, Aska, Ganjam, Khallikote, Digapahandi & Berhampur Municipality.	8,58,000 (27.14%)	Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (some part), Rangeilunda, Chikiti, Patrapur, Digapahandi, Sanakhemundi (some part) Blocks & ULBs.
FOOD STOCKS & SUPPLIES	25,45,800 (80.53%)	Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (some part), Rangeilunda, Chikiti, Patrapur, Digapahandi, Sanakhemundi (some part) Blocks.		All the costal areas of the district.
COMMUNICATION SYSTEM		Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (some part), Rangeilunda, Chikiti, Patrapur, Digpahandi, Sanakhemundi (some part) Blocks.		All the costal areas of the district and some portions of the ULBs
EMBANKMENTS		Ganjam, Chatrapur, Khallikote, Purushottampur, Hinjili, Polosara, Beguniapada, Kabisuryanagar (some part), Rangeilunda, Chikiti, Patrapur, Digpahandi, Sanakhemundi (some part) Blocks.		All the costal areas of the district.
BRIDGES		Aska, Digapahandi, Ganjam, Kabisuryanagar, Chatrapur, Hinjili, Purushottampur.		Aska, Digapahandi, Ganjam, Kabisuryanagar, Hinjili, Purushottampur, Chatrapur.

(Source: DEC, Ganjam,2007.)

Existing Facilities

The existing Health Centers, Shelters, Boat landing center, PDS center are depicted in fig-6, Fig-7, fig-8, fig-9 respectively. From **fig-6** it is clear that health centers are available through out the district but in surada, Bhanjanagar and Jagannathprasad Block health centers are not sufficient. **fig-7** shows the shelters locations for flood and cyclone hazard with road and railway connectivity which is easier for the administration to evacuate the people to the shelter center at the time of disaster, From **fig-7** it is clear that most of the shelter center is

Located in the coastal blocks of the district but there is no shelter center in the blocks of Surada, Bhanjanagar and Jagannathprasad block which is vulnerable to flood. **Fig-8** shows the availability of Country, Private and Power boats. The boats landing center are located in Prayagi, Kantiabada, Gokharakuda, Nolianuagan, Badaaryapali, Newboxipali, Newgolabandha Ramayapatana, Sonapur and Patisonapur villages. All the private and country boats should be kept ready before the disaster takes place. It is evident from **Fig-9** that food storage center are not sufficient in the district. So more PDS centers should be built by the administration in the district.

FIGURE 6

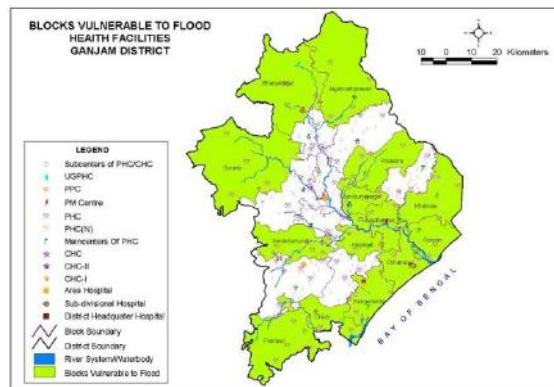


FIGURE 7

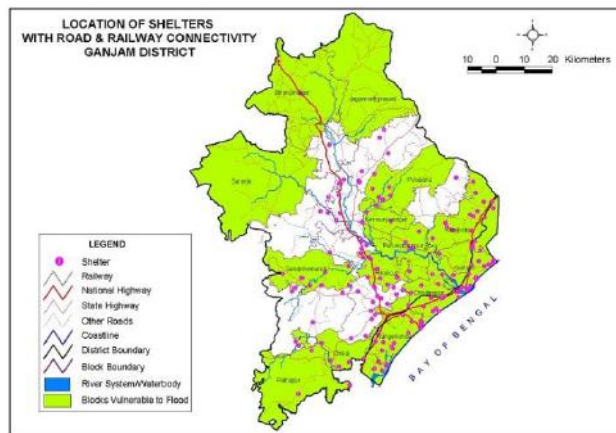


FIGURE 8

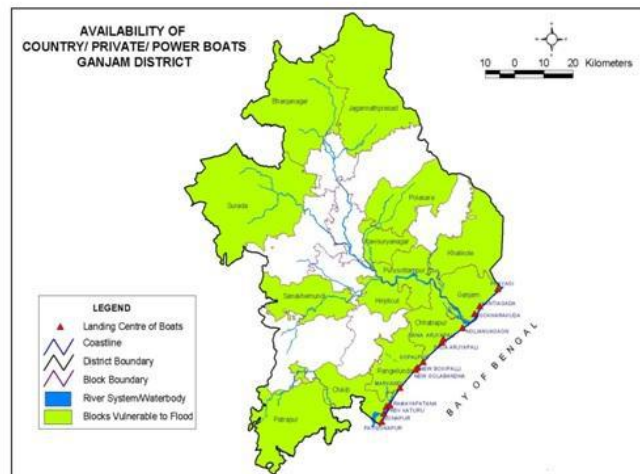
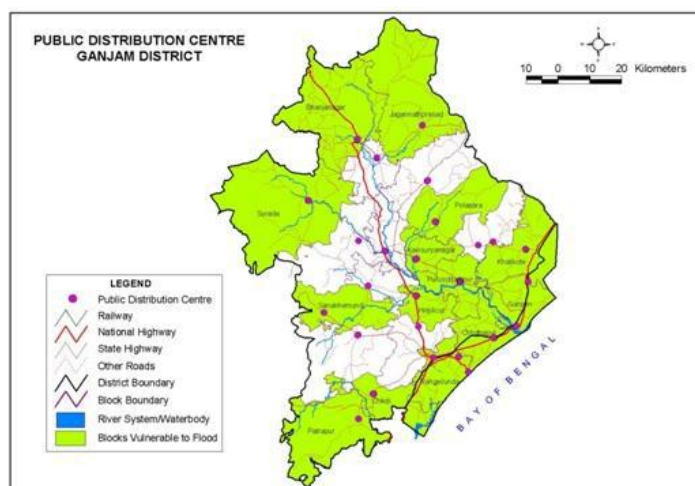


FIGURE 9



Keeping in view, all the available facilities in the district the following measures would be considered immediately to tackle the cyclone and flood problems of the district.

The following suggestions can be incorporated during the disaster takes place.

SUGGESTIONS

1. Immediate steps should be taken to strengthen the weak embankments
2. Though more than 60% population of Suruda, Bhanjanagar and Jagannathprasad blocks are vulnerable by flood, sufficient shelter centres are not found at present. So, more shelter centres should be built before monsoon to support the population.
3. Minimum shelter centres are not available right now in Patrapur block which is vulnerable by Cyclone & Flood both. Immediate steps should be taken to construct more shelter centres.
4. A Flood & Cyclone prone region should be equipped with minimum no. of Emergency Centres & it must be located in the safest possible zones within a region.
5. Sufficient food and medicines should be kept ready at the PDS centers before the disaster takes place.

CONCLUSION

Taking into consideration, all the above discussed matters it would be appropriate to prepare a proper Micro-Level pre-plan basing on both Spatial & Non-spatial database for Flood & Cyclone vulnerable areas of each district. This plan can help the Administrators and other related organizations involved to minimize the problems and risks like relief/rescue operations, rehabilitations and post disaster damage reduction. Data availability, integrity, compatibility & reliability play crucial role in the use of GIS for vulnerability and risk assessment and to prepare a proper management plan for Cyclone and Flood prone areas. This work could be thought as a standard model which can be used for other districts with required modifications.

REFERENCES

1. Alexander, M., Viavattene, C., Faulkner, H. and Priest, S. (2011) Methods for creating a flood risk assessment tool. Guideline report submitted to the Flood Risk Management Research Consortium (FRMRC2). July 2011.
2. Blaikie P, Cannon T, Davis I, Wisner B (2014) At risk: natural hazards, people's vulnerability and disasters. Routledge, London
3. Brown, J.D. and Damery, S.L. (2002) Managing flood risk in the UK: Towards an integration of social and technical perspectives. Transactions of the institute of British Geographers. 27 (4). 412-426

4. Department for Environment Food and Rural Affairs (2005) Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England. Defra Publications: London
5. Greene R, Devillers R, Luther JE, Eddy BG (2011) GIS-Based Multiple-Criteria Decision Analysis. *Geography Compass* 5:412-432
6. HM Government (2008) Identifying people who are vulnerable in a crisis – Guidance for emergency planners and responders. Civil Contingencies Secretariat. February 2008
7. Kangas A, Kangas J, Pykäläinen J (2001) Outranking methods as tools in strategic natural resources planning. *Silva Fennica* 35:215-227
8. Khalid F, Babb R (2008) Hazard and Risk Assessment from Hurricane Ivan (2004) in Grenada using Geographical Information Systems and Remote Sensing. *Journal of Maps* 4:4-10
9. Khan MSA (2008) Disaster preparedness for sustainable development in Bangladesh. *Disaster Prev Manag* 17:662-671
10. Li Y, Ahuja A, Padgett JE (2011) Review of Methods to Assess, Design for, and Mitigate Multiple Hazards. *J Performance Constr Fac* 26:104-117
11. Showalter PS (2001b) Remote sensing's use in disaster research: a review. *Disaster Prev Manag* 10:21-29
12. Tapsell, S., Penning-Rowsell, E., Tunstall, S. And Wilson, T. (2002) Vulnerability to flooding: Health and social dimensions. *Flood risk in a changing climate. Philosophical Transactions of the Royal Society of Mathematical, Physical and Engineering Sciences.* 360 (1796). 1511-1525
13. Wilson, T. (2008) Defining and Mapping Societal Vulnerability and Resilience: A Literature Review. Deliverable 3.7a for FRMRC2, from FHRC at Middlesex University.
14. Zerger A (2002) Examining GIS decision utility for natural hazard risk modelling. *Environmental Modelling & Software* 17:287-294. doi:http://dx.doi.org/10.1016/S1364-8152(01)00071-8



Dr. Ashis Chandra Pathy

Asst. Professor, P.G. Dept. Of Geography, Utkal University, Bhubaneswar.