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Application of Gis in Flood Hazard Zonation Studies in Papanasam Taluk, Thanjavur District, Tamilnadu

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ABSTRACT

Flood is an inevitable natural phenomenon occurring from time to time in all rivers and natural drainage systems, which not only damages the lives, natural resources and environment, but also causes the loss of economy and health. The impact of floods has been increased due to a number of factors, with rising sea levels and increased development on flood plain. Recurring flood losses have handicapped the economic development of both developed and developing countries. Heavy rainfall due to the cyclone name of NISHA has thrown normal life out of gear with many low-lying areas flooded in Cuddalore, Thiruvarur, Chithambaram, Karur and neigbouring areas. Cyclones are among the most awesome events that nature can produce. They pose a major threat to lives and property in many parts of the world. Every year these sudden, unpredictable, violent storms bring widespread devastation to coastlines and islands lying in their erratic paths. A windstorm's destructive work is done by the high wind, flood-producing rains and associated storm surges. An attempt has been made in this research paper to demarcate the flood hazard prone areas in the papanasam taluk using Geographic Information System. The main problems encountered in papanasam taluk with respect to floods are inundation, drainage congestion due to urbanization and bank erosion. The problems depend on the river system, topography of the place and flow phenomenon. Being a vast low lying area, the flood problems in papanasam. Finally the Papanasam have been broadly divided into five zones of flooding, viz. (a) Very low, (b) Low, (c) Moderate, (d) High(e) Very high.

Key words: Flood problems, flooding zones, Hut damages, Agriculture damages and GIS.

INTRODUCTION

Floods are the most common natural calamities that India has to face almost every year in varying degrees. Damages to property and miseries caused due to destruction of basic, civic amentias as a result of floods are enormous. Floods also cause substantial loss of human life and huge loss of cattle heads apart from untold miserly to a large section of people. Floods are the major disaster affecting many countries in the world year after year. It is an inevitable natural phenomenon occurring from time to time in all rivers and natural drainage systems, which not only damages the lives, natural resources and environment, but also causes the loss of economy and health. The impact of floods has been increased due to a number of factors, with rising sea levels and increased development on flood plain. Recurring flood losses have handicapped the economic development of both developed and developing countries. Heavy rainfall due to the cyclone Name of NISHA has thrown normal life out of gear with many low-lying areas flooded in Cuddalore, Thiruvarur, Chithambaram, Karur and neigbouring areas. Cyclones are among the most awesome events that nature can produce. They pose a major threat to lives and property in many parts of the world. Every year these sudden, unpredictable, violent storms bring widespread devastation to coastlines and islands lying in their erratic paths. A windstorm's destructive work is done by the high wind, flood-producing rains and associated storm surges.

The work has been initiated to
1) Understand the general topography, nature of soil and the kind of vegetation in the study area.
2) Demarcate the area of vulnerability and appreciate the effect of resultant flood.
3) Prepare a flood hazard zonation map, through GIS software.
4) To demarcate the river overflow and breaches that lead to free flow of water into the rural as well as urban areas and damages caused to men and materials using GPS and integrate with GIS.
4) To design a flood zonation map using the Spatial Information Technology and suggest a flood control and disaster reduction model taking all the detrimental indicators for flood situation, which can reduce the flood disaster in the study area.

II. Literature Review

Amit Kumar [1] has applied GIS techniques in Flood Hazard Management in North Indian Plain. This system constitutes of the Ganga, and its largest tributary the Yamuna, other Himalayan rivers- Ramganga, Gomati, Ghaghara, Gandak, Rapti, Gandak and Kosi, and some peninsular rivers, like Chambal, Son and Punpun. It is also examines the potential of GIS to meet the purpose. The alternative plan requires a proper integration of physical, socio-cultural, economic and demographic data. As data management and map representations tools of GIS helps in exploring new potions its integration with Remote Sensing, enhance the ability for preparing flood hazard map and forecasting. Besides its constraints like technological knowledge requirements, hardware and software requirements, thus GIS can be very useful to minimize flood hazard

Ramalingam.M and Vadivukarasi M. [4] has used SAR data for flood inundation studies. Two hours of rain in November 2002 was enough to create total chaos in several parts of the city and its outskirts. The study area comprises of Velachery and it's surrounding. They used data such as RADARSAT SAR - November 2002, IRS LISS III and PAN merged imagery-2002, Maps of Adyar and miscellaneous watersheds (4C2C2), Survey Of India Toposheets, Rainfall level data - November 2002. The SAR data was displayed using the ENVI 4.0 image processing software. Base Map is prepared using survey of India Toposheet. Since the reflectant characteristics of the flood inundated areas are not known, only unsupervised classification has been done initially. After detailed studies the training sites have been given and supervised classification has been made. The best one was identified as the Wavelet Transformation Classification to classify. This information is assigned as the component of the feature vector of a pixel. The classification using this method was successfully applied to Merged SAR image. Results indicate high classification accuracy for all classes. This class is contained with texture information that does not provide a unique feature. It is also seen that the information at the higher level can improve the classification accuracy.

Venkata Bapalu.G and Rajiv Sinha [6]has tried to identify areas of risk and prioritize their mitigation/ response efforts in the flood-hazard areas in the Kosi River Basin, North Bihar, India in a GIS environment. The primary data used for this study were obtained from three sources. The first set of data includes topographic maps, district level maps, and census data of 1991 for the regional divisions of Bihar are obtained from the Survey of India, National Atlas and Thematic Mapping Organization (NATMO), and District Statistical Office, Saharsa respectively. The second set of data includes the digital elevation data (GTOPO30), a global digital elevation model (DEM) from U.S. Geological Survey's EROS Data Center in Sioux Falls, South Dakota and the DEM derived from the toposheets of the study area. The third set of data is the digital remote sensing images for the study area in IRS-1D, LISS III. The primary decision factors considered in this study are geomorphic features, elevation, vegetation, land cover, distance to active channels, and population density. They have prepared flood Hazard Index. This study formulates an efficient methodology to accurately delineate the flood hazard areas in the lower Kosi River basin, North Bihar, India. This study represents some exploratory steps towards developing a new methodology for inexpensive, easily-read, rapidly-accessible charts and maps of flood hazard based on morphological, topographical, demographical related data.

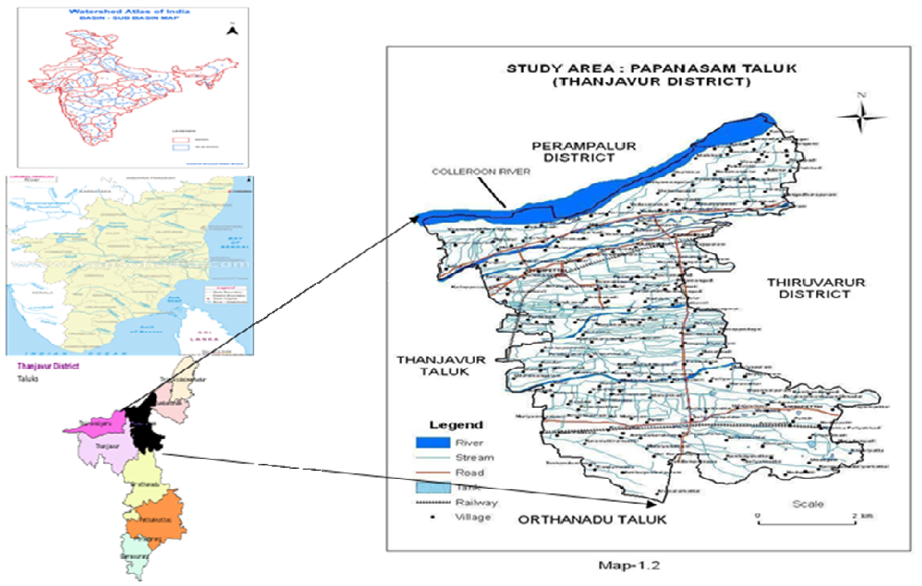
Sanyal Joy and Xi Xi Lu [5] have designed a Flood Hazard Mapping which has vital component for appropriate land use planning in flood-prone areas. It creates easily-read, rapidly accessible charts and maps which facilitates the administrators and planners to identify areas of risk and prioritize their mitigation/ response efforts. An efficient methodology is used to accurately delineate the flood-hazard areas in the Kosi river .

Vinu Chandran et.al . [7] has used the Airborne Synthetic Aperture Radar (ASAR) images in mapping the flood inundation and causative factors of flood in the lower reaches of Baghmati river basin for the period July– October 2004. Integration of the flood inundation layer and land cover layer derived from LISS III data indicate that 62 percent of the agricultural area was inundated. Floodwater drained faster in the left bank, whereas it was slow in the right bank. The Digital Elevation Model of the area shows that the flood-prone right bank of the Baghmati River is a topographic low sandwiched between Kosi and Burhi Gandak highs (mega fans). Area under flood inundation for various land cover classes has been shown comparative bar graph. Spatial maps such as fluvial geomorphology of the study area, drainage configuration of Baghmati river during pre-flood, flood and post-flood, Transverse spatial profiles across Kosi–Ganga transect, Bhirkhi–Ranka transect and Bharath–Bachhauta transect and, Longitudinal spatial profiles along (*a*) Chanha nadi and (*b*) under fit channel of Baghmati, and difference image (pre-post) showing flooding from tributaries and embankment failure has been prepared by them. In this study, they observed that the right bank of the Baghmati river undergoes frequent flooding due to topography, channel morphometry and discharge characters. The embankment constructed along the course (Baghmati and Burhi Gantak) is found to impede the recession of floodwater.

L. T. K. Ho et.al. [3] A case study was conducted in the alluvial plain of the Vu Gia – Thu Bon River system, central Vietnam. The extraction of moist soil by MNDWI can help to detect flooded sites and this result is compared with the landform classification map, SRTM DEM elevation ranges and land cover classification. The comparison reveals close relationship between water saturated areas, elevation ranges, and flood condition that the areas with elevation lower than 4m and classified as flood basin and deltaic lowland are inundated deeply and for rather long duration. Higher areas such as terraces and sand dunes are not flooded and natural levees are less flood-affected. Moreover, this study proves the significance of MNDWI for separating moist soil for flood prediction.

III. Location of study area

The study area is situated in the northern part of Thanjavur District in Tamilnadu. It is one of the eight taluks of Thanjavur district. This taluk occurs in between Kumbakonam and Thanjavur, Thiruvaiyaru taluk to the eastern and western direction. The area is bound between 10° 43' N to 11° 0' N latitude and 79°8' E to 79°22' E longitude. Papanasam taluk extends over an area of about 377521 ha (2001). It has been divided into 120 revenue villages.(Map 3.1)



LOCATION MAP OF PAPANASAM TALUK

Fig.3.1 Location of the study area.

MATERIALS AND METHODS

IV. Methodology

Method:

The detailed methodology to be adopted for the study is given below (Fig.4.1 flow chart).The toposheets in a scale of 1:50,000 and 58 N/1, N/2 ,N/6, N/5, M/8, and satellite image that cover the study area was collected. The base map of village boundary showing all the prominent geographic features of the basin was prepared by integrating toposheets and satellite image. Field visits to different parts of the basin made to observe the landforms. Based on the observations made from the field base map was prepared. The amount of rainfall in the study area for various seasons like pre-monsoon, monsoon and post-monsoon were collected from the metrological department and an annual average for each season were arrived at. Contour map already prepared through GIS with the field data by GPS.

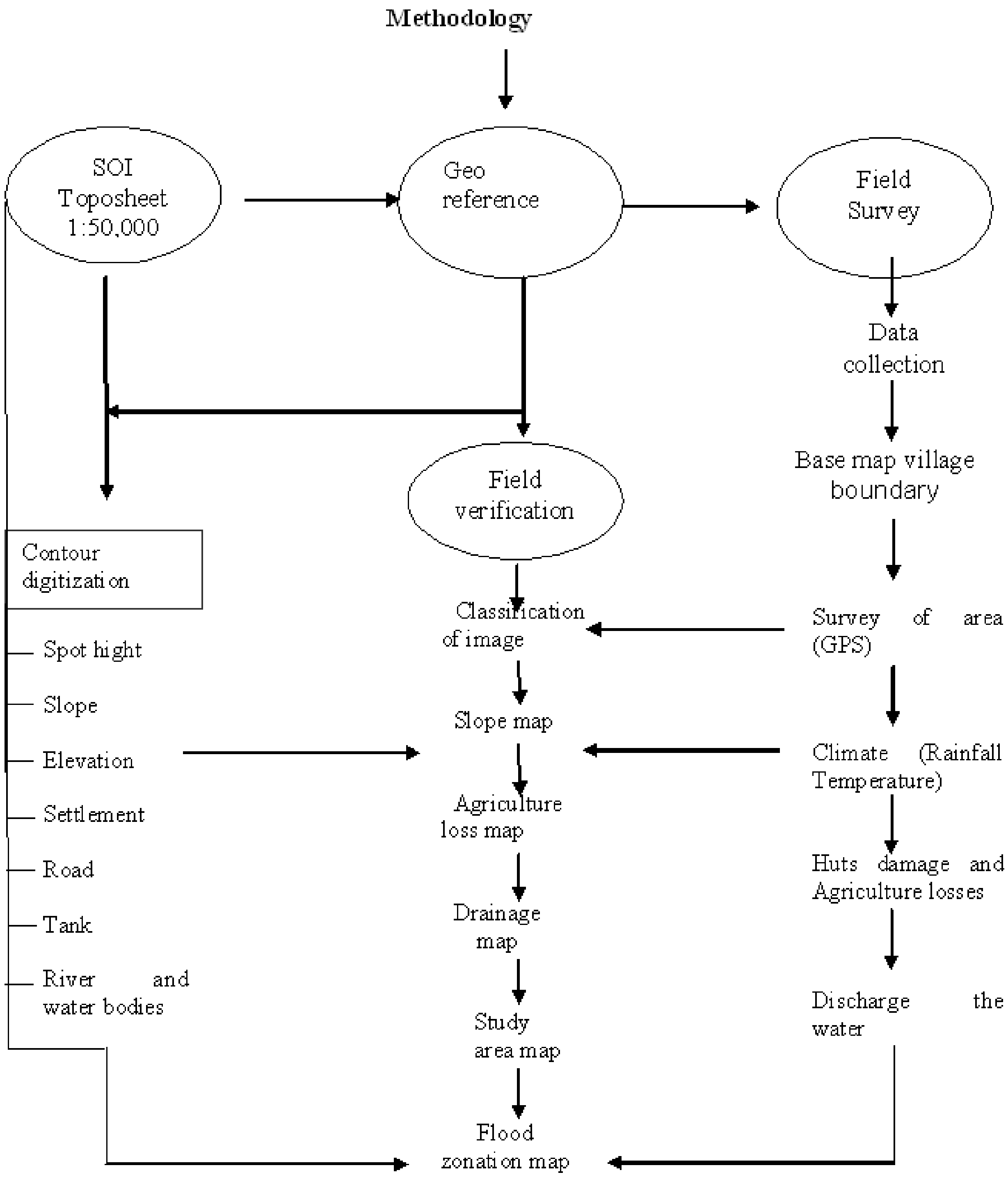


Fig.4.1 Flow chart

Data collection

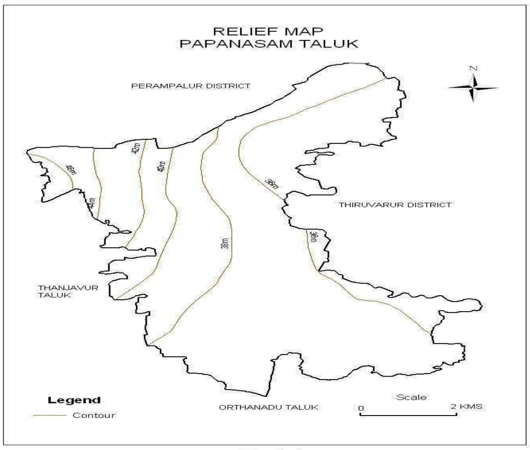
The data collection was done from both primary and secondary data sources. The primary data collected were the Survey of India toposheets and the personal visit. The maps were collected from taluk and district head quarters of Papanasam and Thanjavur.

Tools: The present study is used the software's are Arc gis 9.2, Gps , Sufer pack 8.

DISCUSSION

Relief

Cauvery delta is a plain region in the study area. The terrain dips towards the direction of the eastern flow of Cauvery and its distributaries .The entire land area lies well below the 48 meters on the western side and 36 meters on the eastern side in Papanasam taluk.(Fig 5.1).



Map-1.4

Fig 5.1.Relief

Agriculture

Crop rotation is adopted in lesser degree and generally in few place the lands remain fallow after the harvest of paddy from February to June .The prominent crops raised in this district are food crops chiefly Paddy, Pulses Groundnut, Onion, Sugarcane Cotton in the order. Agriculture uses more then 70 per cent of geological structure, distribution of temperature availability of water resources and the natural flora and fauna in different aspects of agriculture like type of land use cropping, wet land agriculture activities about 192,528 ha and dry land agriculture activities about 1,056,500 ha. Sugarcane has been introduced to a larger extent recently in Papanasam taluk. Summer crops such, as cotton is grown from February to June. Tamarind trees, Jack trees, Plantation, Guava trees, Coconut trees occur in this taluk. The land under paddy has been grouped as single crops and double croplands. In the single cropland long duration variety grown and in the double crop area is short duration variety uses in this taluk.

Climate

The Climate throughout the year is moderate. The variation between maximum and minimum temperature is not much. Though summer is hot,occasional rainfalls and water stagnation in the wet fields due to irrigating channels of Cauvery give much relief from sweltering heat. The year can be broadly divided into the following three seasons:

(a)Winter - December to February **(b) Summer-** March to May **(c) Monsoon -** June to November.

Temperature

Climate is the most important factor of environment controlling the agricultural activities of the study area. Summer season maximum temperature recorded about 36.6°c. Minimum temperature recorded 32.5°c. Maximum cooler 23.5°c, minimum cooler 22.8°c in the winter season. The study area has a high mean temperature and a low degree of humidity. Even though this area is not subjected to extremes of climate the summer months are quite hot and the difference between maximum and minimum temperature are moderate. The first two months of the year are very pleasant with warm days and cool nights. By the end of February the climate becomes very sultry and as the temperature shoots up.

Drainage Pattern -Cauvery:

The Course of the Cauvery in Tamilnadu is toward the east and from the Hogenkel falls, it turns south and reaches the Mettur reservoir. After Mettur, the Cauvery flows a head, leaving behind the Eastern Ghats and 45 kms down stream it meets its main tributary, the Bavani from here, flowing east, the river assimilates the waters of the Noel and Amaravati before entering the Tiruchirapalli district.

Here, the width of Cauvery is great and it is called the Aahanda Cauvery. After Tiruchirappalli the Cauvery gets divided into streams, the flow of which is controlled through an anicult. The northern branch is the Colleroon in which the flow of water is more flowing in a north eastern direction , it flows into the Bay of Bengal near porto Novo. The southern stream is called the Cauvery which gets divided into many streams further ahead of which the Vennar is the main. Here there is a huge anicut built near the Srirangam island from where irrigation in the delta region and coastal Tamil Nadu takes place. Finally the Cauvery as a small and sluggish or languid stream flows into the Bay of Bengal near Cauverypattinam. (Fig 5.2)

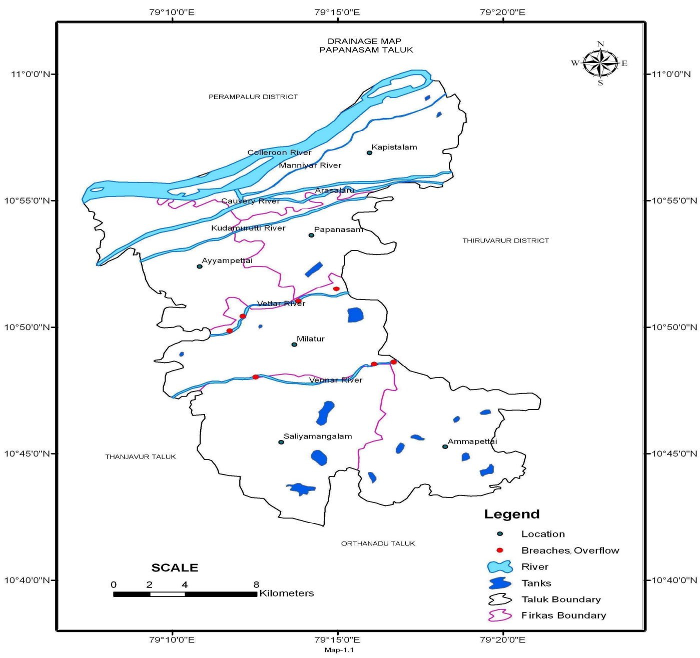


Fig 5.2 Drainage Pattern

Cauvery River passes through the northern part Papanasam taluk; discharges passed through the tail and regulators on October 2.78 TMC in Cauvery sub basin. Arasalar River deviates from the Cauvery River. Thirumalairajan River deviates from the Kudamuruttiyar.

Water discharge :-

The details of discharges water given in (Table 5.1)

November in 2008 (Cusecs)

Table 5.1 Water discharge

Date	Vettar river	vennar river
25.11.08	4225	Nil
26.11.08	3888	2001
27.11.08	6306	6363
28.11.08	13,100	17,600
29.11.08	6965	7009
30.11.08	Nil	1083

(A) Observations:

In Papanasam taluk of Thanjavur district the parameters like Soil, Cropping pattern, Topogaphy and Drainage have been observed.

1) Soil

Alluvial Soil occur in most part of the along Colleroon and Cauvery river bank. Black Soil and clayey soil are seen in most part of Papanasam, Milattur, Kapistalam, southern part. Alluvial soils are found in Kapistalam northern side along Colleroon and Cauvery river bank. Black soil is found in Ammapettai firka.

2) Cropping Season

There are three cropping seasons. Samba – Single Crop; Kuravai – Double Crop, Thaladi - major paddy cropping, Summer crops like cotton, pulses, sunflower, chillies, cummbmer, Brinjal, Ladies finger etc are also grown here.

3) Topography

Levees are formed due to deposition of sediments during flood periods when the water overflows the river banks and spread over the adjoining flood plains. Long ridges of low heights are formed parallel to the river valleys, Average heights of natural embankment is 5-7 metres in Puttur, Edakudi Villages, Vazhkkai, and Sathyamangalam. Natural levees are more or less stabilized landforms. People are living along river and natural levees. Mostly natural levees are also used for agriculture horticulture purposes in the study area, because water table is very high. Breaches in the natural embankment in such situations are caused by sudden catastrophic floods, destroying life, and property and Agriculture in study area.

4) Cyclone

In the month of November there is sudden spurt of rainfall in Papanasam taluk. This monsoon due to cyclone name of NISHA (fig.1.3). Cyclonic storms are the main weather phenomenon of northeast monsoon.

Floods are the most affected natural calamity in the study area due to breaches and overflow of flood water along the river bank, poor drainage, absence of well developed natural embankments, heavy rainfall, etc. In the year 2008 the floods are mainly due to heavy rainfall in association with tropical, lows, depressions and cyclones name of NISHA (Fig.1.3)Cyclonic disturbances varying in intensity and horizontal extent originate in the Bay of Bengal and the Arabian sea, mostly during the period April to December.

The cyclones tracks followed by the cyclone of NISHA in the Bay of Bengal (fig 1.3) The cyclones which form during the months April to May are called *pre- monsoon cyclones*. Those which form during the months October to December are called *post –monsoon cyclones.*

5) Cyclones.

Usually cyclone form between latitude **$10^{0\circ}$ N and 14^{0} N** . In the earlier stages they move in a North – westerly or westerly direction. The cyclone disturbances are usually of high intensity. They form in the north Bay of Bengal and follows a west, north – westernly course. They do cause heavy rains and floods and strong winds. Terra satellite image taken from 26 November during cyclone season (Fig 5.3&5.4)

Fig 5.3 Track Cyclone of Nisha

Fig 5.4 NASA's Terra satellite 26 Nov,2008
Full resolution (6,400 × 8,400 pixels, Intensity 85 km/h(50 mph) 996 hpa (mbar))

In Tamilnadu, 189 people have been killed by the heavy rains and floods caused by the Nisha.Some places have recorded extreme rainfall, notably Orathanadu, Thanjavur District where over 660 mm of rain fell within a period of 24 hours and broke the 65-year old record of highest rainfall registered in 24 hours in Tamilnadu. In two days, Orathanadu registered 990 mm of rainfall. Previously the highest amount of rainfall in a day was 570 mm registered by Cuddalore on May 18, 1943. Damage in India totaled to 3789 crores, or 800 million in 2008 USD (Table 5.2.)

Table 5.2 Tropical Cyclone Nisha

Formed	November 25, 2008
Dissipated	November 29, 2008
Highest winds	85 km/h (50 mph) (3-min sustained) 100 km/h (65 mph) (1-min sustained)
Lowest pressure	996 hPa (mbar)
Fatalities	204
Areas affected	Sri Lanka, India
Deaths	192

(Sources –www.http// tropical cyclone of Nisha)

Causes of floods in study area:

1) Land changes (Water Permeability of soil) from normal land condition due to human activities.
2) Cement concrete using in surface of street line. Such as roof & roads in the land (Control the permeability of soil)
3) Changes of Water ways because of encroachments of trees and splits in the center of river.

4) The natural river channel is often constricted, thus reducing its carrying capacity. This increases the frequency with which high flows overtops or breaches the river banks.
5)Urbanization is one of the causes because increasing urbanization has led to more storm runoff, many sewerages systems cannot cope with the resulting peak flow without investment in greater capacity. This results in frequent sewer failures, including number of actual collapses, major, cause of concern in low – lying urban areas.
6) No trees cultivated along the river and channels cause of increased flood runoff and an associated decrease in channels capacity due to sediment deposition.

(B) Major problems:
a)Rainfall
Rainfall amount 111.37mm average in the raining season. The hot season starts from March and heat subsides after June when water is let into the canals and southwest monsoon bring in showers. Maximum rainfall during November 2005 has occurred in the date 8 and 24. During the year November, 2008 maximum rainfall has occurred in the date 24 to 26. (Fig.5. 5)

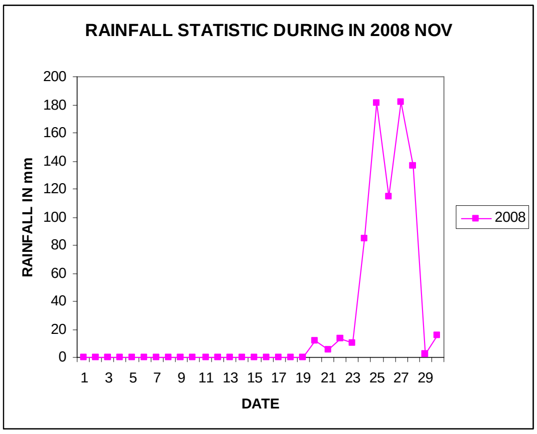


Fig 5.5 Rain fall 2008.

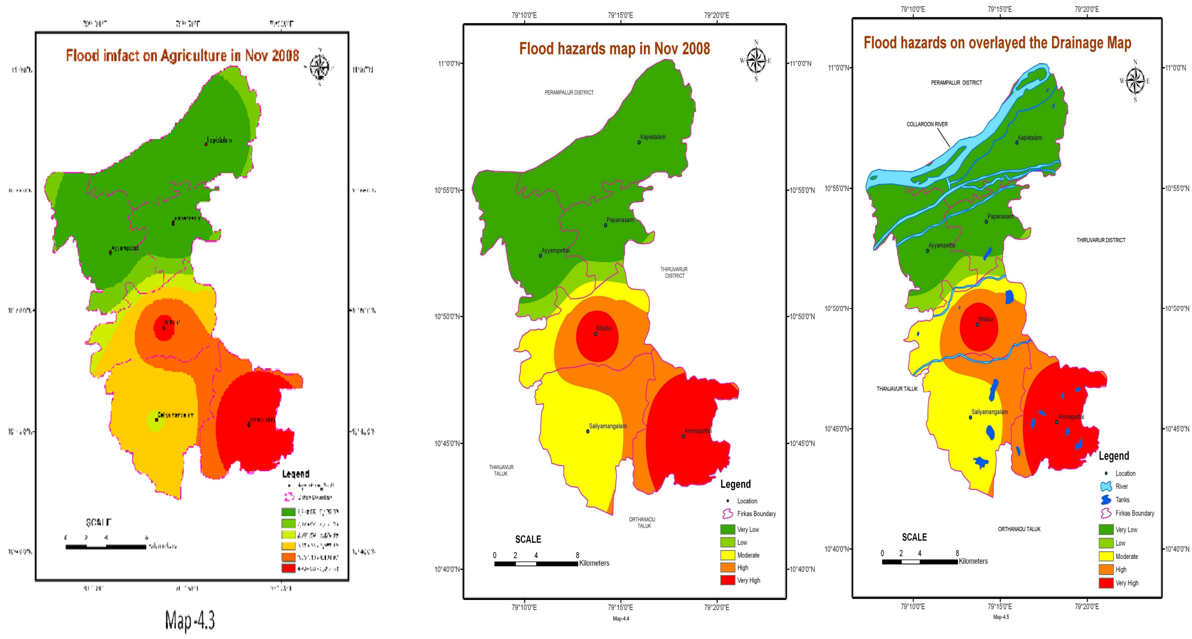


Fig.(5.6 ,5.7 & 5.8) Flood hazards -2008

Papanasam Taluk was affected due to cyclone in Nov. 26th named as Nisha.(shown figure of 3.1 and 3.2) The study area was affected heavily with the losses of human property, cattle, and agriculture losses. Agriculture was affected about in about 18,295.075 ha overall 120 villages were destroyed. Cattle loss numbered to 82 in this taluk. Mostly affected in the Ammapettai Firka, Milatar Firka, Nelithottam, Kottangudi, Neithalur, Irumbuthalai villages, so many huts was marooned in the flood period. More details given a Figures(5.6 ,5.7 & 5.8)

b)Huts Damages:

Heavy damages in Ammapettai firka , Milttur firka about in fully damage about 10 , about 9,008 partly damages . Because low lying area in southern part of study area(fig 5.9 &5.10).

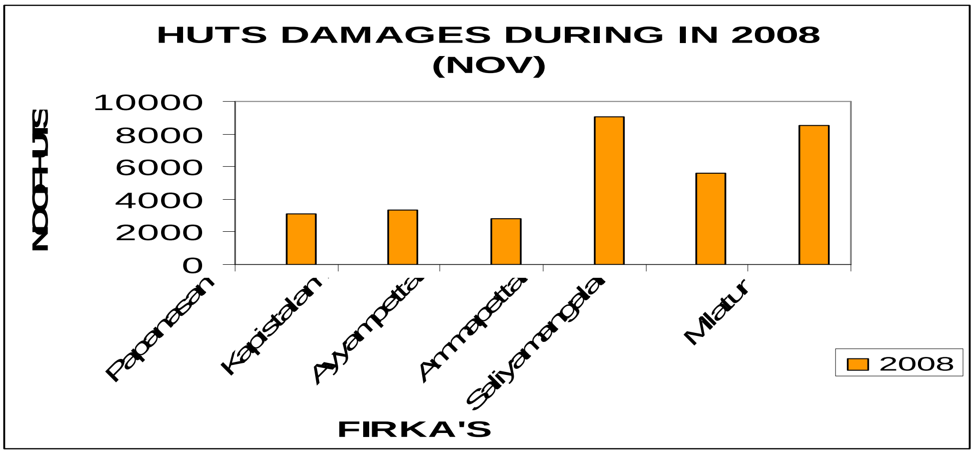


Fig.5.9. Huts Damages (2008)

S.No	Name of Firkas	Party	Fully	Total
	Papanasam	3	3,069	3072
	Kapistalam	2	3,325	3,327
	Ayyampettai	4	2,776	2,780
	Ammapettai	10	9,008	9,018
	Saliyamangalam	3	5,617	5,620
	Milatur	9	8,492	8,501
Total		**31**	**32,287**	**32,318**

Fig5.10 Huts Damages-2008.

c) Agriculture Loss:

Agriculture losses in the area small farmers were affected in about 9.968 hectares; large farmers were affected in about 8, 327.075 hectares. In paddy crops total losses were about in 15966.345 hectares. In horticulture total losses were in 2,328.73 hectares. (Fig 5.11)

Papanasam Taluk -Agriculture Loss during Nov in 2008

S. No.	Name of Firkas	Large Formers (In hec)	Small Formers (In hec)
1	Papanasam	866.01.58	946.96.0
2	Kapistalam	957.6136	1026.70.4
3	Ayyampettai	816.05.33	857.24.8
4	Ammapettai	2231.65.61	2781.07.02
5	Saliyamangalam	1523.85.47	1734.432
6	Milatur	1931.8814	2621.58.4

CONCLUSION

Floods are natural phenomena which cannot be prevented. However, human activity is contributing to an increase in the likelihood and adverse impacts of extreme flood events. Firstly, the scale and frequency of floods are likely to increase due to climate change - which will bring higher intensity of rainfall and rising sea levels - as well as to inappropriate river management and construction in flood plains which reduces their capacity to absorb flood waters. Secondly, the number of people and economic assets located in flood risk zones continues to grow.

The state and central governments have already initiated flood protection measures but concerted and co-ordinated action at the level of the people would bring a considerable added value and improve the overall level of flood protection. Given the potential risk to human life, economic assets and the environment, we cannot afford to do nothing. The country's commitment to sustainable development could be severely compromised if appropriate measures are not taken. In addition to economic and social damage, floods may have severe environmental consequences as for example mixing up of waste water/effluents domestic or industrial with that of fresh water. Floods may also destroy wetland areas and reduce biodiversity.

Flood risk management aims to reduce the likelihood and/or the impact of floods. The most effective approach is through the development of flood risk management programmes incorporating the elements are prevention, protection, preparedness, emergency response and recovery.
The present study on the mapping of the flood affected zones would serve as a basis for all the above five said elements of flood risk management. The primary purpose of producing these kind of maps is for public dissemination of flood maps which will serve to increase public awareness. This is to empower individuals and officials to take appropriate preparatory and response measures, and to inform them regarding decisions such as the purchase or otherwise of a property, or the assignment of use, layout and design of an area of land. The public dissemination is essential (single-point update, low-cost dissemination, reducing risks of use of superseded (aged) data, etc.), although hard copies of maps should also be available in public offices (e. g. in local libraries, local authority concerned offices, and government departments) to make the information available to those who need them most.

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