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Flood Management in Andhra Pradesh and Telangana States of India

N. Sreedhara Naidu, Assistant Professor, Dept. of Civil Engineering, Sri. Indu College of Engineering and Technology, Seriguda , Ibrahim patnam (M) R.R District. Telangana State.

G.Ayyanna, Lecturer in Dept. of Economics, Govt. (UG &PG) College, Anantapur, Andhra Pradesh

M. Krishna Naidu , Post-Doctoral Fellow , Dept. of Economics , S.K. University , S.V. Puram , Anantapur , District, Andhra Pradesh.

Abstract: Floods are the most devastating natural calamities by their nature since time immemorial. Flooding is mainly caused by over spilling of river banks Severity increases where there is obstruction like encroachment in water ways in urban areas etc. The present paper analysed flood management. The main objectives are (i) To describe the river system, Rainfall, forecasting system and affected areas, (ii) To identify the causes vulnerability, impacts, losses, strategies, controlling measures of floods affected areas. The paper discuss the river basin wise flood situations rainfall , forecasting systems sites cause , losses, risk reduction measures strategies and flood management of the study area.

Key words: flood management, calamities, forecasting, river basin catchment, vulnerability, strategies.

Introduction:

Floods are one of the most devastating natural calamities, by their nature and since time immemorial. It is most commonly observed during monsoon season and severe floods occurring every year in one part or the throughout the country which has been causing recurrent tremendous extensive damage to Agriculture, life and property besides tremendous sufferings. Due to different climatic and rainfall patterns in different regions, is experienced with severe inundation. Thus, floods are the single most frequent disaster faced by the country. Flooding is mainly caused by over-spilling of river banks and severity increases where there are obstructions like effecting roads, railway networks, urban areas etc (Khanna et al. 2007). Flood waters are simply going as a waste in to seas and oceans. To control the floods and utilize the waters for irrigation and other purposes, Interlinking of rivers can be a substantial solution. A variety of mitigation measures can be identified and implemented measures include flood forecasting and warning, adopting proper land-use planning, flood-prone area zoning, and management.

Objectives:

1. To describe the River system, Rainfall, Flood Forecasting system of flood affected areas of the Both States between 1953 to2013.
2. To identify the causes, vulnerability, impacts, losses, strategies controlling measures of floods affected areas.

Methodology of the study

The Present study is based on Secondary data at both states Level, The data pertaining to 1953 to 1953 to 2013). The Analysis is confined to flood disaster during the period 1953-2013 weather related disasters in both states. and occurrence is calculated for floods (1953 to 2013) every ten Years and River wise, rainfall flood years.

About the study area

Andhra Pradesh and Telangana are divided into three physical regions based on the topography (Coastal Plains, Peninsular Plateau and Eastern ghats). The general slope changes from west to east and south-west to north-east. The peak summits in the both States are Tirumala (1150 mts) and Chintapalli (1680 mts). The average rainfall of the both State is 940 mm with a least rainfall of 521 mm in Anantapur. The both State receives substantial rainfall during the south west and the north-east monsoon period. The both States are endowed with plenty of water resources in terms of rainfall and surface flows. The states are blessed with three major perennial river systems of Godavari, Krishna and Pennar and Vamsadhara and 37 other medium and minor river systems (19 to the north of Godavari River and 18 to the south of Krishna River), and further into 81 sub-basins ranging in size from 90 sq. km and above Godavari and Krishna are interstate rivers contributing almost 90 per cent of the surface water resources of the both states. These include Vamsadhara, Nagavali, Champavathi, Gosthani, Sarada, Varaha, Thandava, Yeleru, Errakalava, Thammileru, Budameru, Romperu, Gundlakamma, Musi, Paleru, Manneru, Upputeru, Swarnamukhi, and Palair, etc. Which have smaller catchment and drain into the sea. The state's share of dependable flows at 75 per cent dependability from the river system is estimated at 77.75 bcm (2746 TMC) of which 49.63 BCM (1753 TMC) are currently utilized. According to the existing information (CAD, 2006), the Godavari river basin has about 21.52 BCM (760 TMC) surplus water, while the other river basins together have about 6.51 bcm (230 TMC).

Godavari River Basin:

The Godavari River, the largest of the peninsular rivers and third largest in India, covers drains about 10% geographical area of the country. The river rises in the Sahayadris at +1067 m elevation above mean sea level (MSL) near Triambakeshwar in Nasik district of Maharashtra state about 80 km from the Arabian Sea and flowing over a distance of the length1465 Km in a general south-easterly direction through Maharashtra, Telangana and Andhra Pradesh, Godavari falls into the Bay of Bengal north of Rajahmundry in Andhra Pradesh. (CWC1999). The basin is bounded by Satmala hills, the Ajanta range and the Mahadeo hills on the north, by the Eastern Ghats on the south and the east and by the Western Ghats on the west. It has a catchment area of 312,812 sq km of which 48.60% lies in Maharashtra 20.70% in Chattisgarh, 1.40 % in Karnataka, 5.50% in Orissa and 23.80% in Telangana and Andhra Pradesh. The basin receives the major part of its rainfall during the Southwest Monsoon period. More than 85 percent of the rain falls from July to September. Annual rainfall of the basin varies from 880 to 1395 mm and the average annual rainfall is 1110 mm. Floods are a regular phenomenon in the basin. Badrachalam, Kunavaram, and the deltaic portion of the river are prone to floods frequently.

Perur and Koida gauge stations are the main base stations of the Central Water Commission for flood forecasting in the basin... The River Godavari has tributaries like Pranahita, Manjeera, Maner, Indravati, Kinnerasani, Pamuleru and Sileru. The river flows through Adilabad, Karimnagar, Nizamabad, Medak, Ranga Reddy, and Warangal, khammam, in Telangana and East & West Godavari and Visakhapatnam districts in AndhraPradesh. The major part of basin is covered with agricultural land and accounting to 59.57% of the total area and 3.6% of the basin is covered by water bodies. The annual river flow at 75% dependability is assessed to be 9.11 Mham (3,216 TMC) at Dowlaiswaram...In this, the share of Telangana and Andhra Pradesh is 4.17 Mham (1473 TMC) . Major irrigation projects constructed in the basin in Telangana andAndhra Pradesh are Sriramsagar , Nizamsagar , Kadam , Godavari Barrage (Dowlaiswaram) for irrigation . Singur dam and Manjeera barrage are constructed for drinking water supply to Hyderabad and Secunderabad. Inchampalli, Polavaram, Dowleswaram Barrage (Cotton Barrage), Karanja ,Sriram Sagar Project (SRSP), Nizamsagar , Lower Manair Reservoir, Kaddam reservoir, Upper Indravati Project, Balimela Dam, Mula Irrigation Project, Pench Projects, Upper Kolab, Projects Upper Wainganga are the Major Irrigation Projects .

River Basins of the states

The Krishna River Basin: The Krishna River Basin is south India's fifth largest and second largest Eastward draining interstate river basin covering an area of 2, 58,948.2 km^2 in Peninsular India, which is nearly 8 % of total geographical area of the country. The basin is conjoined by the Godavari River Basin in North and the Pennar and Cauvery River Basins in South. Towards the West it is bordered by a number of small West flowing basins of the Konkan strip originating from the Western Ghats .The Krishna River originates in the rugged topography in the Mahadev range of the Western Ghats or Sahyadhri at an elevation of about 1337 m above msl, North of Mahabaleshwar about 64 km from the Arabian sea and flows from west to east through the States of Maharashtra, Karnataka , Telangana and Andhra Pradesh to join the Bay of Bengal. The total length of the flow of river from the sources to its outfall in the sea is about 1,400 km of which 612 km are in Telangana and Andhra Pradesh, 306 km in Maharashtra and 483 km in Karnataka.

The basin lies in the states of Telangana and Andhra Pradesh 29.5% (113,271km^2) Karnataka 43.7% (76,252km2) and Maharashtra 26.8% (69,425 km^2) Krishna River is the Second largest River After Godavari that flows through Andhra Pradesh... The Krishna Basin's predominant land use is agriculture. The principal tributaries for Krishna river are the Ghataprabha, the Malaprabha, the Bhima, the Tungabhadra, the Musi, the Paleru , the Munneru. Vedhavati, Handri, and Munneru flows through the most parts of both the States. It drains Anantapur, Kurnool, Mahabubnagar, Ranga Reddy, Nalgonda, Guntur and Krishna districts. Major irrigation projects are Rajolibanda, Jurala Project, K.C.Canal scheme, Srisailam reservoir (which facilitates irrigation water supplies to command areas under Telugu Ganga Project, Srisailam Right Bank Canal and Srisailam Left Bank canal, apart from

drinking water supply to Chennai city), Nagarjunasagar Project and Prakasam Barrage (Vijayawada). Musi Project, and P.D.Jurala ,Tungabhadra Right Bank Lower Level Canal, Tungabhadra High Level Stage-I major projects and fifteen other minor irrigation project of Telangana and Andhra Pradesh are in the catchment areas of the river basin.

Penna River Basin: The river Pennar rises in Chennakesava Hills of the Nandi ranges of Karnataka state and flows for 597 Km through Karnataka and Andhra Pradesh before it falls into Bay of Bengal. Its catchment area is 55,213 sq km, which are nearly 1.7% of the total geographical area of the country of which 12 %(6937Km2) lies in Karnataka and 88% (48276Sqkm) in Andhra Pradesh. The cultivable area of the basin is about 3.54 M. Ha, which is about 1.8% of the total cultural area of the country. The Principal tributaries of the river are the Jayamangal, the Kunder, the Sagileru, the Chitravati, the Papagni , the Cheyyeru and Pincha drains parts of Rayalaseema region. The major part of basin is covered with agriculture accounting to 58.64% of the total area and only 4.97% of the basin is covered by water bodies. Though this basin is influenced by both south west and north east monsoons. The annual flow at 75% dependability is estimated to be 0.32 Mham (114 TMC), of which the share of Andhra Pradesh is 0.28 Mham (98 TMC).

Vamsadhara River Basin: Vamsadhara River is an important east flowing river between Mahanadi and Godavari, rivers. The river originates in near Lanjigarh village in the border of Thuamul Rampur in the Kalahandi district and Kalyansinghpur in Rayagada district of Odisha and runs for a distance of about 254 kilometers, where it joins the Bay of Bengal at Kalingapatnam, in Andhra Pradesh. The total catchement area about 10,830 square kilometers. Vamsadhara river basin occupies 8015 square kilometers in Orissa and the remaining 2815 km flows in Andhra Pradesh. The river basin receives high annual average rainfall of magnitude 1400 mm. Andhra Pradesh and Orissa roughly estimated that 115 thousand million cubic feet (TMC) water is available for use in the river. It has five principal tributaries viz. Chauldua, Phalphalia, Ganguda (Harbhangi), Sanna Nadhi and Mathendrathanaya; all are on the left side of the river. Recently, The Vamsadhara project has two canals viz., the left main canal (LMC), irrigating about 148,000 acres (600 km), and the right main canal (RMC) covering an ayacut of 62,280 acres (252 km)... Gotta Reservoir feed the right main canal?

Nagavali River Basin: Nagavali River rises in the eastern slopes of the Eastern Ghats near Lakhbahal in the Kalahandi district of Odisha at an elevation of about 1,300 metres. Another name of the river Nagavali is *Langulya*. The Nagavali river is a medium sized east flowing river in peninsular India. It is surrounded by Vamsadhara in the north, Champavathi and Peddagedda in the south, Godavari in the west and the Bay of Bengal in the east The total length of the river is about 256 km, of which 161 km are in Odisha and the rest in Andhra Pradesh. The catchment area of the basin is 9,510 square km. Nagavali is an interstate river with 4462 km^2 and 5048 km^2 river basin area located in Odisha and Andhra Pradesh respectively. The river basin receives 1000 mm average rain fall annually. It drains parts of the Kalahandi, Rayagada and Koraput districts of Odisha and Srikakulam, Vizianagaram districts of Andhra

Pradesh. The main important tributaries of the River Nagavali are Jhanjavati, Barha, Baldiya, Satnala, Sitagurha, Srikona, Gumudugedda, Vottigedda, Suvarnamukhi, Vonigedda, Relligedda and Vegavati. Major Irrigation Projects are the Thotapally, Narayanpuram , Maddu Valasa and Jaiyavathi projects.

Sarada River Basin: The Sarada River covering an area of 2634.22 Km2. The river originates from the Ananthagiri hill ranges at a height of 1500 m and runs towards the south to join the Bay of Bengal. The river is 131.37 Km long, with no major tributaries joining in the right and some important tributaries joining the river from its left. The notable tributaries are Bodderu Nadi, Edla Gedda, Isaka Gedda, Mala Gedda, Mamidivaka Gedda, Medra Gedda, Ninni Gedda, Pala Gedda, Pedda Eru, Pedda Gadda, RallaGedda, Seshu Gedda, Tacheru Vagu, ToyiGadda, UrakaGedda, and Vedurla Gedda. Irrigation project is Pedderu medium Irrigation Project.

Swarnamukhi River Basin : River Swarnamukhi, an ephemeral river, spreading over a catchment area of 3092 Km, is Covered in Chittoor and Nellore Dist. of A.P, , and flows in a north-easterly direction and passing through the famous Tirupati hills, before finally joining the Sea - Bay of Bengal near Tupilipalem. The river finally merges into the sea Bay of Bengal at Siddavaram. The Swarnamukhi is an East flowing river, having a small catchment area of 3,225 Sq.Km. It rises at an elevation of 300 m in the Eastern Ghats ranges near Pakala village in Chittoor district of A.P.It runs generally in the North-Eastern direction Its total length is 130 Km.

Gundlakamma RiverBasin: The Gundlakamma is a seasonal river that flows through the east central part of the state of Andhra Pradesh, and is the largest of all the rivers that originate from the Nallamalla Hills. It arises Iskagundam village starting point from the Nalamalai mounts close Gundla Brahmeswaram in Kurnool district in the Nallamalla Hills, Its main headwaters lie some 6 kilometres from the village of Ardhaveedu, Prakasam District at an altitude of 425 m. above MSL.[1] It follows a north-easterly direction and enters the plains near Cumbum, after flowing through a town named after it. It has a drainage area of 430 square miles (1,100 km^2) and a capacity of about 37 TMC or 105, million.[2] The river then flows past the town of Markapur and towards the Coromandel Coast. It finally falls enters into the ocean close Ulchi in Ongole the Bay of Bengal, some 19 km east of Ongole after having total covered a distance of 225 km.

Kalangi River Basin: The Kalangi River Rises near Narayanavanam in Chittoor District of Andhra Pradesh and drains 355.75 Km2 in chittoor district and 119 .25 km2 in Nellore district before joining Bay of Bengal. The Kalangi river is an ephemeral river and the river course near Sullurpet is highly meandered . After draining a length 86 km it enters Pulicot (saltwater) lake at Gradhagunta which is 11.6 km from sullurpet town . Kalangi river continuous flow of surface water exists only for three months (90 days) during North East rainy season . The Kalangi River is the main source of water supply for irrigation

and drinking in and around Sullurpet area. The details of all River basins in both the states are given below:

Table 1 Details of Important River system, Catchment Rainfall water potential of Andhra Pradesh and Telangana States of India

Rainfall: The rainfall in Andhra Pradesh is influenced by both South-West and North-East Monsoons. The normal annual rainfall of the State is 940 mm. With a least rainfall of 21mm in Anantapur District. The annual normal rainfall of AP is 940 mm.,624 mm (66%) is contributed by South West Monsoon (June to September), and 224 mm (24%) during the North-East Monsoon (October to December) . An average of 14 mm of rainfall during winter and 78 mm during summer constitute balance 10% of the total annual rainfall. The rainfall distribution in three regions of the both State differs with the season and Monsoon. The influence of South-West Monsoon is predominant in Telangana state (714 mm) followed by Andhra Pradesh regions Coastal Andhra (620 mm) and Rayalaseema (407 mm), whereas the North-East Monsoon provides high amount of rainfall in Coastal Andhra area (324 mm) followed by Rayalaseema (238 mm) and Telangana state (129 mm). There are no significant differences in distribution of rainfall during winter and hot weather periods among two states.

Rainfall pattern in the Basins

Godavari River Basin: The Godavari basin receives its maximum rainfall during the Southwest monsoon. The monsoon currents strike the West Coast of the peninsula from West and South-West; meet the Western Ghats or Sahyadri Range which present almost an uninterrupted barrier ranging from 600 m. to 2100 m. in height. Before surmounting this barrier the currents deposit most of their moisture on its windward side, and then sweep across the interior of the peninsula on the Easterly course. The north-east part of the Godavari basin also receives considerable amount of rain in association with monsoon depressions, which move west-north-west across the Orissa coast.

The Godavari receives the water from a length of about 129 km. of the high rainfall zone in the Western Ghats. The annual rainfall varies from 1,000 to 3,000 mm in this reach. East of the Western Ghats, the rainfall decreases rapidly to less than 600 mm. There is a belt some distance East of the Western Ghats and in width varying from about 80 km. in the South to about 97 km. in the North with less than 600 mm, of normal annual rainfall. The belt which is about 10,360 sq.km of area includes portions of Aurangabad and Ahmednagar districts of Maharashtra. During the next three months, up to end of May, it varies from 20 mm to about 50 mm, in most parts of the basin. All parts of the basin receive the maximum rainfall in the period from June to September. The Godavari basin as a whole receives 84% of the annual rainfall on an average, during the Southwest monsoon, which sets in mid-June and ends by mid-October. The Indravati and Pranhita sub-basins receive upto 86% and 88% of the annual rainfall during the same period due to influence of the cyclonic storms which predominantly pass through these sub-basins.

S No	Name of the River	Lat -Longitudes	Elevation of Source (MSL in Meters)	Length in Km	Catchment Area In Sqkm	Catchment in A,P and Telangana	Length in A.P& Telangana	Temp Min& max (Centigrade)	Average Rainfall (in mm)	Average Water resource potential(mcm)	Utilise Surface water(mcm)	No.of Hydra. Observation Stations	No .of Flood Forcoasting stations
1	Godavari	16^{0}19'to 22^{0}34'	1067	1465	312813	73201	770	15 to 40	600 - 3000	110540	76300	77	18
2	Krishna	13^{0}07' to 19^{0}25'and 73°21' to 81°09'	1337	1400	2,58,948.2	76,252	612	15 -39	784	78120	58000	52	09
3	Pennar	13°18'to 15°49' and 77°01 to80°10'		597	55,213	48,276	95	15.2-41	508 - 980	6320	6900	8	01
4	Vamsadhara	18^{0}15' to19°55'and 83°20' to 84°20'		254	10,830	2815	130	12 -43	1300 - 1500	--	--	--	--
5	Nagavali	18°10' to 19^{0}44'and 82^{0}53' to 84°05'	1300	256	9510	5048	95	16 to 40	1000	---	--	--	--
6	Sarada	17°25'N to !8°16'N and 82°31'E83°13'	1500	131.37	2,665	2665	122	18 to 42.5	1000	--	---	---	---
7	Gundla Kamma	15º 38' and East longitude 78º 47' and streams in a North-East	600	225	1,100 km^2	---	225	---	---	---	----	-----	-----
8	Suvarnamukhi	13^{0}25'30 N and 14^{0}08'30N and 79^0 07'39^{0}Eand 80^{0}11 E	300 m	130	3225	3225	56	22 – 25 to 30-32	920	---	---	---	---
9	Kalingi	---	---	76	5927	5927	76	---	---	---	---	---	---

Krishna River basin:

The Krishna basin is largely semi-arid, visible humid and dry-sub humid areas are found along Western Ghats of Krishna delta. The eastern parts of Western Ghats are arid in the rain shadow. Even though the average Annual rainfall is about 800 mm in the Krishna basin, the extremities ranges from below 300 mm in the northwest to a maximum of 1000mm in the delta area. But the high rainfall of 2000mm occurs in Western Ghats. About 90% of the rainfall is during the monsoon months of May to October.

The Krishna basin is subject to both the southwest and the northeast monsoon: rainfall decrease with distance inland from both coasts. This is particularly striking east of the Western Ghats where rainfall decreases from over 3,000 mm to 500 mm over less than hundred kilometres. Precipitation decreases more gradually from 850-1,000 mm in the Krishna delta in the east to 500-600 mm in the north-western part of the basin. The average rainfall in the basin is 840 mm, approximately 90% of which occurs during south west the monsoon from May to October. The climate of the Krishna basin is predominantly semi-arid to arid with potential evaporation (1,457 mm a year on average) exceeding rainfall in all but three months 3 of the year during the peak of the monsoon. .The average annual rainfall in the Swarnamukhi basin decreases from 1270 mm at the Eastern extremity of the basin to 762 mm at the Western extremity. The North-East monsoon sets in the month of October and withdraws by the end of November.

Floods:

All coastal districts and Cuddapah district are susceptible to floods in Andhra Pradesh state while, in Telangana, Adilabad, Khammam Mahabubnagar and Nalgonda are also prone to floods. The most flood affected area in Andhra Pradesh lies in the Krishna Godavari, Vamsadhara, Nagasaki, pennar river basins.

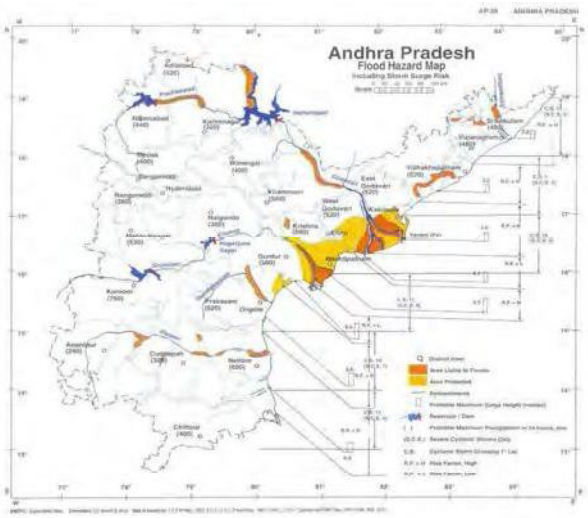

Fig-1 Source: BMTPC Mo HUDA Vulnerability Atlas of India

Causes of Floods:

1. Flooding is caused by the inadequate capacity within the banks of the streams and rivers over spelling of banks to contain the high flood discharge flows brought down from the upper catchments due to heavy rainfall. inadequate drainage to carry away the rainwater quickly to Streams/ Rivers, storm surges,
2. Flooding is accentuated by erosion and silting of the river beds, resulting in a reduction of the carrying capacity of river channels; earthquakes and landslides leading to changes in river courses and obstructions to flow; synchronization of floods in the main and tributary rivers; retardation due to tidal effects;
3. Encroachment of floodplains; and haphazard and unplanned growth of urban areas.
4. Other causes include backing up excessive rainfall which occurs in the monsoon months of July to September of waters in tributaries at their outfalls into the main river often with synchronization of floods in them.
5. Manmade factors such as failure of dams and other control works like reservoirs are the main causes of floods.
6. Some parts of the country, mainly coastal areas of Andhra Pradesh, Orissa, Tamil Nadu and West Bengal, experience cyclones, which are often accompanied by heavy rainfall leading to flooding.
7. Ice jams or landslides blocking stream courses debris flow resulting in the backwater and cyclones overflowing river banks. Flash flood occurs in areas near foot hills are also cause floods..

Flood vulnerability:

Inadequate capacity of the rivers to contain within their banks the high flows brought down from the upper catchment areas, following heavy rainfall, leads to flooding. Central and coastal Andhra Pradesh spans mainly major river basins of Godavari, Krishna and minor river basins of Nagavali and Vamsadhara on the north and Pennar in the south. The Passage of storms/ cyclones in quick succession over a river basin invariably leads to severe floods. The flood problems are confined to deltaic regions are attributed to various causes like flatter slope of drains and back flow due to tides. Confined to spilling by the smaller rivers and the submergence of marginal areas along the Kolleru Lake. The most important coastal problem is presented by the Kolleru lake and the numerous rivers that rise in the ghats and flow into the lake. Rivers like Budameru and the Thammileru not only overflow their banks along their courses to Kolleru Lake but also cause a rise in the level resulting in inundation of adjoining lands. Water from these rivers intermingles in the delta and results in a very high water level, which cause severe flooding in the region. The coastal districts are densely populated and receive heavy precipitation in the Eastern Ghat region. The silt deposited constantly by these rivers in the delta area raises the flood water level and, the rivers often overflow their banks or break through new channels causing heavy damage. In addition, there is also

the problem of mud-flow from the hills, which results in severe losses.

Both of Andhra Pradesh And Telangana are Vulnerable to tropical stroms and related hazards , while its coastal belt is most vunerable region , Khammam, district in Telangana state is most phrone to monsoon floods along with five districs in coastal region . Along the coast line the section between Nizampatnam and Machilipatnam is most prone to storm surges .

Used of Efficient Flood Forecasting System: and warning network:

Flood forecasting and flood warning in India commenced in a small way in the year 1958 with the establishment of a unit in the Central Water Commission, New Delhi, for flood forecasting for the river Yamuna at Delhi. This has now grown to cover most of the flood-prone interstate river basins. The flood forecosting organization set up in Central water commission is presently responsible for issuing forecasts at 166stations of which 134 are for water level fore cost and 32 for inflow forecast used for optimum operation of certain major reservoirs . These 166 stations are located in 14 flood –prone states and 1union territory in addition to NCT of Delhi.. The forecasts issued by the Central Water Commission have been consistent with about 96 per cent accuracy as per the present norms of the Central Water Commission.

Warning of the approaching floods provides sufficient time for the authorities: i) To evacuate the affected people to the safer places, ii) To make an intense patrolling of the flood protection works such as embankments so as to save them from breaches, failures, etc. iii) To regulate the floods through the barrages and reservoirs, so that the safety of these structures can be taken care of against the higher return period floods. iv) To operate the multi-purpose reservoirs in such a way that an encroachment into the power and water conservation storage can be made to control the incoming flood. v) To operate the city drains (out falling into the river) to prevent bank flow and flooding of the areas drained by them.

Modernization of flood forecasting services:

The Central Water Commission is making a constant endeavour to update and modernize forecasting services on a continuous basis to make flood forecasts more accurate, effective and timely. Initiatives being taken for modernizing flood forecasting services could be

- The establishment and modernization of the flood forecasting network, including inflow forecast through automated data collection and transmission;
- use of satellite-based communication systems through very small aperture terminals; and
- improvement of forecast formulation techniques using computer-based catchment models;

Flood Events in the Godavari and Krishna, Pennar Basin :

The Flood Forecasting and Warning Network of Central Water Commission, covers of the main river Godavari and four of its main tributaries, namely, the Wardha, Wainganga, the Manjira and the Indravati rivers. There were 18 flood forecasting sites which

were operational during the flood seasons 2008. Out of these, 12 sites were on the main Godavari River including two inflow forecasting sites, Jaikwadi dam and Sriram Sagar (Pocharnpad), one in Wardha river, two each on the Manjira and Waingaga rivers, and one in the Indravati river. Two sites on Manjira, namely, Singur dam & Nizamsagar Dam were also inflow forecasting sites.

During the flood season 2008 out of 9 level forecasting sites and 7 inflow forecasting sites, no forecast was required on 4 level forecasting site viz., Kaleswaram, Kunavaram, Rajahmundry on Godavari.

The Krishna River, two of its main tributaries, namely, the Tungabhadra, and the Bhima. There were eight flood forecasting sites on these rivers, which were operational during the flood season, 2008. Out of these sites, five sites (all inflow forecasting sites) are on the main river Krishna, two on the Tungabhadra (one level & other inflow forecasting site) and one on the Bhīma, and Nellore Anicut on Pennar.

Impacts on Floods;

Floods are the natural calamity which results in huge losses in the human lives and the property. In India occurrence of floods are very frequent, many existing example proves its severity. A flood is relatively high stream flow that overtops the natural or artificial banks in any reach of a stream. The overtopping of the banks results in spreading of water flow, the flood plains and generally comes into conflicts with men and his activities. In Both the states usually no overflow of the banks during high discharges and the problem is confined to bank erosion, rise of bed level due to sedimentation. Occurrence of floods due to excessive precipitation, combined with inadequate channel capacity. Over spilling can also occur due to obstruction in or aggradations' of the river bed. Erosion leads for carrying of silt along with river water, part of which gets accumulated at the bed also along the banks, thereby rise in the bed level and congestion in the water flow occur. The erosion of soil due to cultivation practices in the encroached river course results to flooding situation in both states.

Losses due to floods:

Particularly In Andhra Pradesh, floods inundate the banks, destroy crops, damage properties, perish livestock, disturb communication and power supply and endanger human life. Floods are followed by epidemics. Supply of drinking water and restore sanitation are post flood challenge. Details are analyzed for both states In both the States the area affected by floods was 0.07 million hectars in 1953 and 9.04 mha in 2005 with a peak of 9.04 mha during 2005 at current prices , the damages to crops was in the wide range of R.S 1.44 crore in 1955 and 12616.1 crore in 2010 . The flood also caused damage to crops worth's Rs 3758.870 cm in 2010 . During the last 6.3 decades of the 20th century 1953 to 2013 , 8 times floods occurred in 1953-60 period Floods whole _2 times floods in 2011 -13 lowest floods registered1981 -1990 , medium number 7 times in 1991-2000 , 13 times floods disasters face in 2001-10 while losses due to natural floods human losses lowest 106 persons in 2011-13 and highest 11010 persons 1971 -80 , population affected lowest 2.86 millon persons in 1953 -60 and highest 36.937 milloin persons in 1981 -90, Cattle population lost lowest , 49,987 cattle population in 1953- 1960 and highest 8,49,202 in 1971-80 , damages of cropped area lowest 0.4 million hectores in 1953

– 1960 and highest 9.22 million hectares in 2011-13 Damages of houses , lowest in 1596 in 2011 -13 and highest in 2115216 houses are damaged Area affected lowest 0.66 million hectares in 1961-70 and highest 9.339 million hectors in 2001-10 Economically property losses are Estimated lowest 11.71 crores in 1953 -1960 and highest 45635.3 cror(table -2).es in 2001-10 during the last century . In addition there was a great loss of human lives and livestock often affecting the poor strata of the population.. Taking into consideration the other factors such as serious disruption and massive health rehabilitation measures needed, the loss could indeed be tremendous. (Table-2).

The both states has 1.39 million hectares area prone to floods which are 5.05 Percent of the total geographical Area, 4.09 percent of the total area damaged due to floods in country. During the period 1953 -2013 due to flood disaster event losses are 26825 human losses , 11229.092 million population are affected , 20,92,072 lost of cattle heads , 7671270 houses are damaged 31.004 million hectares of damage of crops and estimated economic loss 95982.93 crores. During the period 1953-2011, average annual area affected due to floods was 0. 434 million hectares The average flood affected area in the state is 5.07 percent of the total flood affected area of the Country. Between 1953-2013 average damages due to floods 344 human lives lost, 34589 lots of cattle head, 0.527 million hectares of area was affected ,288.161 millions of population are affected 132147.840 millions of houses are damaged , 0.334 million hectares of cropped area , estimated economic loss Rs 1620.53 crore. Maximum area affected was 9.040 million hectares during the year 2005.(Table -2).

Floods occurred due to:

1. Excessive rainfall in catchments areas ,
2. Intensive rainfall
3. Poor natural drainage and interference of drainage system
4. Cyclones and very severe rainfall.
5. River bank erosion and silt of river beds
6. In adequate capacity which in bank of the river to contain high flow.
7. Flash floods and mismanagement of the Traditional Tank System.
8. Lack of proper maintenance of the flood protection and irrigation systems, drains, embankments etc.,
9. Lack of comprehensive coastal zone and delta management.

Risk reduction strategies:

The main risk reduction strategies for floods and water hazards include

1. Proper Land-use control and planning to avoid locating vulnerable facilities in flood plains.
2. Better Retaining walls and levees along rivers and sea walls along coasts may keep high water levels out of flood plains (although levees may create other problems over time or elsewhere downstream).
3. Appropriate Structures which are located in flood plains should be engineered to withstand flood forces and designed with elevated floors to reduce damage from flood waters.

Table 2: Flood Damages and Losses in Andhra Pradesh and Telangana states (1953 to 2013)

S.No	year	No.of Flood Events	Area Affected In M.hec	Population Affected in million	Damage to Crops Area in M.hec	Damahe to houses No.s	Cattle Lost No	Human lives Lost no	Public Utilitie s	total damages (in Crores)
1	1953 - 1960	8	1.66	2.86	0.4	28608	49987	230	9.54	11.718
2	1961-1970	10	0.66	14.1	0.64	787676	256695	1501	47915.641	239.485
3	1971-1980	10	1.828	17.47	1.68	2115216	849202	11010	248983.406	1108.882
4	1981 -1990	5	6.46	36.937	3.68	1590167	172525	1785	1920999	28967.095
5	1991- 2000	7	1.736	11.596	3.259	249797	55742	1022	80170.84	4949.272
6	2001 -2010	13	9.339	28.386	5.373	1834648	108145	1196	32789.58	45635.31
7	2011-2013	2	0	20.605	9.22	1596	98757	106	0	115.1
	Total	55	31.004	11229.092	33.402	7671271	2092072	26825	3268178.07	95982.939
	Average		0.434	288.161	0.516	132147.840	34589.000		49592.938	1620.539
	Maximum		9.040	11110.000	9.150	1063879.000	500978.000	9974.000	937310.000	14956.000

Table -3: River wise flood events and PeakDischarges affected Districts of Andhra Pradesh and Telangana

S.No	Year Of the Event	Peak Discharge M^3s-1	Affected Districs
1	August-1986	67,746	Khammam, East and West Godavari
2	August-1990	66,918	Khammam, East and West Godavari
3	August -1992	35,046	Khammam, East and West Godavari
4.	July -1994	41,064	Khammam, East and West Godavari
5.	August -1994	39,559	Khammam, East and West Godavari
6.	August--2004	N.A	Khammam, East and West Godavari
7.	July-2005	N.A	Khammam, East and West Godavari
8.	Sep-2005	N.A	Khammam, East and West Godavari
9.	May-2006	N.A	Khammam, East and West Godavari
10.	Aug-2006	N.A	Khammam, East and West Godavari
Krishna River			
1	July 1989	18800	Guntur , Krishna, Nalgonda
2	Sept-1989	12,200	Guntur , Krishna, Nalgonda
3	August-1990	12,200	Guntur, Krishna, Nalgonda
4	Sept-1991	12200	
5	Sept-1998	12200	
6	Oct-2009	34000	Kurnool , Mahabubnagar, Krishna, and Guntur
Pennar River			
1	August -1988	2,956	Nellore
2	November-1991	6549	Nellore
3	October-2001	10368	Nellore
Vamshadhara River			
1	August -1990	2749	Srikakulam
2	Oct-1990	1588	Srikakulam
3	November-1990	2347	
4	July-1992	3,695	
5	September-2008	2886	
Nagavali			
1.	Sept-1990	1009	Srikakulam , Vijayanagaram
2.	July-1991	1691	Srikakulam , Vijayanagaram
3.	Sept-1991	845	Srikakulam , Vijayanagaram
4.	July-1992	1835	Srikakulam , Vijayanagaram
5.	Sept-1994	1616	Srikakulam , Vijayanagaram
6.	July -1996	992	Srikakulam , Vijayanagaram

Source: Revenue (Disaster management) Department Govt. of Andhra Pradesh

4. All Dams are capable of storing water so that it can be released at a manageable rate.
5. Water regulation (slowing the rate at which water is discharged from catchment areas) can be achieved by constructing reservoirs, increasing vegetation cover to slow down run-off, and building sluice systems.
6. Removing silt build ups or dredging deeper channels and constructing alternative drainage routes (new river channels, spillways and pipe systems) may prevent river overload.
7. Storm drains in towns assist drainage rates; and beaches, dune belts, and breakwaters can sometimes reduce the power of tidal surges.
8. Flood reduction aims to decrease the amount of runoff, usually by altering the watershed, and is most effective when employed over most of the drainage basin. Typical treatments include reforestation or reseeding; contour plowing or terracing; and protection of vegetation from fire, overgrazing and clear-cutting. Other approaches involve clearing sediment and debris from streams, deepening and widening the riverbed and constructing or preserving farm ponds and other water holding areas. In urban areas, water holding areas can be created in parks and ponds.
9. Flood-proofing helps reduce the risk of damage. Temporary measures include blocking or sealing entrances or windows and the use of sandbags to keep flood waters away. Permanent measures include the use of hazard resistant designs such as raising living or working spaces high above the possible flood level. Houses may be elevated by structural means (stilts) or by raising the land using landfill. Buildings should be set back from water bodies. Land surrounding buildings and infrastructure should be protected against erosion.
10. Streambeds should be stabilised with stone masonry or vegetation, especially near bridges.

Community-based risk reduction measures:

The majority of deaths and much of the destruction created by floods can be prevented by mitigation and preparedness measures in both the states communities can be actively involved in reducing the risk of flood damage. Where construction in flood-prone sites is necessary or cannot be avoided, houses can be constructed to be flood resistant using materials resistant to water damage and strong foundations. Awareness of water hazards can be reflected in living practices such as constructing elevated storage and sleeping areas. Crop cycles can be modified to avoid the flooding season, and flood-resistant crops can be introduced.

Community members should also be aware that deforestation can exacerbate flooding. Communities can reduce the risk of personal harm by preparing flood evacuation plans which include the identification of evacuation routes and availability of boats or other appropriate transport and rescue equipment. Monitoring and warning systems at the local (and regional) level are also important components of a risk reduction strategy. Inhabitants of flood prone areas usually have a number of traditional methods for coping with floods. Some aspects of flood planning and response can be managed at the

village level and upgraded with outside assistance. These are:

- issuing warnings at the local level
- Participating in flood fighting by organising work parties to repair embankments or clear debris from drainage areas, pile sandbags and stockpile needed materials.
- facilitating agricultural recovery
- planning emergency supplies of food and clean drinking water
- identifying traditional mitigation and preparedness measures and determining their effectiveness
- Programmes to promote public awareness of flood hazards may contain the following components:
- Explanations of the function of flood plains, location of local flood plains and drainage patterns
- Identification of flood hazard and warning signs
- Advice on how to flood-proof possessions and develop personal escape plans
- Explanation of local evacuation plans and warning systems, and appropriate postdisaster activities
- Emphasis on personal responsibility for flood prevention/mitigation in day-to-day living practices. This includes the use of proper farming practices, prevention of deforestation and maintenance of drainage systems
- Provision of escape routes—neighbourhoods should have clear escape routes and designated areas of refuge on higher ground
- Evacuation procedures should be practised on a regular basis and ways to disseminate warnings via radio, television, warning sirens or bells should be devised

Floods could be managed by:

1. Improvement of hydro meteorological studies, flood forestry and communication system
2. Maintenance & strengthening of embankments and flood walls.
3. Capacity building & training for personal of state and districts multihazard preparedness of response plan.
4. Identification of hazard prone region on the basis of historical & technical knowledge
5. Design of Engineering Technologies / specifications for various kinds of structures.
6. Conserving catchments areas is one of the most crucial aspects of water management.
7. Construction of More dams or Reservoirs and the inter- linkage of rivers
8. Improving of water management and management of river areas.
9. Natural detention basin and Channel drainage improvement measures, and Diversion of flood waters. from the reservoir by interlinking of all tanks and enhancing the capacity of tanks.
10. Among non-structural measures, initiatives such as flood forecasting and warning , flood fighting and Insurance, flood plain zoning and flood proofing are undertaken. Flood plain zoning aims at disseminating information on a wider basis so as to regulate indiscriminate and unplanned development in flood plains and is relevant both for unprotected as well as protected area
11. Restoration of existing old tanks and filling through canals.
12. Construction of parallel canal at both left and right banks for utilizing surplus flow.
13. Sound watershed management through extensive soil conservation,

catchment area treatment, preservation of forests and increasing the forest area and construction of check dams.

14. Desilting at the selected zones along the river course.
15. Protecting the original river course without any habitation and cultivation.
16. Study of silt concentration and its accumulation phenomenon.
17. Monitoring the bed levels, width of river, alignment of course and acting for restoration to possible extent.

Adequate flood cushion to be provided in the storage structures.

Conclusion:

Both Andhra Pradesh and Telangana states are prone to floods disasters and climatic conditions, river basins, vulnerability, Peak Discharges, Flood events of various rivers. The flood losses and impacts is complex. These risks , can be minimized strategic measures of flood management which can form an important segment of planning for future action with timely preventive measures .

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