

# MANAGEMENT OF SUPER CYCLONE AND FLOOD IN ORISSA

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***Abstract :** Orissa on the East Coast along with West Bengal and Andhrapradesh has the locational disadvantage of being in the path of depression of severe cyclonic storms that occur before the onset of south-west monsoon or after it recedes .The super Cyclone and severe Cyclone of October 1999 devastated 14 prosperous coastal districts throwing the lives of one crore of people out of gear .The unprecedented Cyclonic gale ,torrential precipitation , high flood ,tidal ingress and stagnation are the main factors for trauma and trajedy there . Though relief was pouring in from all parts of the world but it was not reaching the victims due to improper disaster Management . Proposal of Cyclone shelters, Coastal High way , Iridium-phones ,Conservation of declining mangrove and other forests , Afforestation and drainage improvements are the main need in the area. Improvements of saline and other embankments , de-silting(dredging ) of the mouths of channels and rivers and Additional ventage to the roads and cross drainage structures have been advocated . Proper Forecasting and other curative measures with proper disaster Management programme can mitigate the flood and Cyclone to a great extent .*

## **INTRODUCTION :**

The state of Orissa is having irrigation potential of 24 lakh ha. during kharif and 11 lakh hact during rabi out of total 156 lakh hectares of geographic area .Rice is the principal crop(53% of gross cropped area ) followed by pulses (19%) and oil seed (10%).The state has tropical climate characterised by medium to high temperature, high humidity ,short and mild winter .The mean annual rainfall is 1503 mm .The coastal part of the state is frequented by natural disaster like flood and cyclone every year . The super cyclone of Oct. 29th and severe cyclone on Oct. 17th devastated fourteen prosperous coastal districts throwing the lives of more than one crore of people out of gear . More than 10,000 peoples were declared officially deceased and three lakhs of cattle perished , nineteen lakhs houses were razed to the ground .Coastal Orissa which was full of greenery virtually turned barren with over 9 crores of trees getting uprooted .The Cyclone not only flattened out paddy crops but totally destroyed cash crops . The tidal surge of 6 to 7 m arising out of wind speed of 300 km/hr, on the morning of 29th October rapidly swept across a 100 Km of coastal stretch in Jagatsinghpur and Kendrapara districts, submerging the entire area and destroying all the houses and infrastructures .Saline inundation of 2,00,000 ha. of extremely fertile agricultural land struck a death blow to standing crops of the entire coastal area .As the rivers were overful and strong unprecedented Cyclonic gale of 200 to 300 kmph was blowing so large stretch of protective embankments and saline embankments received the massive scouring ,sloughing and overtopping .Therefore breaches in the dams, collapses of spillway structures occured in all medium and minor projects of the state .The loss in Super cyclone is estimated to be around 20,000 crores of rupees.The largest concenentration of urban population of 1.5 million

in Cuttack and Bhubaneswar suffered unprecedented damage from intense rainfall of 500 to 600 mm and cyclonic gale of 200-250 Km/hr. The major cause of such damage was due to

a) Extremely intense rainfall from 400 to 960 mm in two to three days which occurred in the coastal districts accompanied by strong gale upto 300 km at Paradeep .In Ganjam the most intense rainfall of 452 mm at Berhampur in 36 hours, accompanied by cyclonic wind of 180 km/hr .The Isohytes of both cyclonic precipitations are shown in **fig-1 & 2<sup>1</sup>** .

b)The deltaic area from Mahanadi to Subarnarekha got submerged up to 3m depth by stagnation and impeded drainage ,extremely high flood occurred in all the catchments in all the basins that resulted highest ever flood of 5,00,000 cusecs in Baitarani at Akhupada .

c)Grossly obstructed and poorly maintained drainage channels over 30,000 sq.Km. of deltaic area caused high afflux and created submergence of Agricultural land up to 10 days

.d)Cyclonic gale caused a tidal wave of 5 to 6 m height to travel in land , submerging and severely scouring /breaching all the saline embankments .Saline inundation over 2,00,000 ha. is seriously affecting the fertility .

## **SUPER CYCLONE**

A Cyclone is a very large mass of air ranging from 800 km to 1600 km diameter with low pressure surrounded by a high pressure air mass . Due to unequal heating of earth surface pressure difference arises and strong wind blow in a spiral motion towards the low pressure centre from all direction because of rotation of Earth around its own axis , causing cyclonic gale of more than 50 kmph .The large whirling mass of air at the centre where pressure is low is known as Cyclone<sup>2</sup> and acts like a chimney through which air gets lifted , expands ,cools and finally gets condensed causing precipitation . If precipitation is caused by cold front it is very intense but for short period , while by warm front it is more continuous .A Super Cyclone is one whose wind speed encountered in core-area of a tropical Cyclone equals or exceeds 226 kmph .The super cyclone that originated in the Bay of Bengal near Andaman-Nicobar Islands on 25th Oct. concentrated into a severe cyclonic storm and had finally landfall at Paradeep on 29th Oct. morning . It penetrated up to 150 km inland and caused torrential precipitation over 45000 sqkm from the 29th october to 1st november lashing practically the entire coastal stretch of Orissa with a cyclonic gale of 300 kmph .Incessant rain under the influence of depression over the Bay of bengal , heavy down pour added to the miseries of the homeless people .

The tracks of the various Cyclonic storms ( **in fig-3&4**)<sup>3</sup> in the Bay of bengal between 1891-1997 reveals that most of the Cyclonic storms are crossing the east coast through coastal Orissa and East Godavari district of AP . Orissa on the east Coast along with West Bengal and Andhrapradesh has the locational disadvantage of being in the path of depression of severe cyclonic storms that occur during the south west monsoon (June 15 to October 31). Severe Cyclonic storm indeed occurs when the Southwest monsoon recedes or just before the onset of monsoon in late April-May-June spell .

**Table-1**<sup>1</sup> **HISTORICAL SEVERE CYCLONE STORM EVENTS PASSING ORISSA COAST**

Date	Type	Wind Velocity(Kmph)
9th Nov. 1973	VSCS	209
30th Oct. 1971	VSCS	187
31st Oct. 1912	VSCS	185
9th Nov. 1995	VSCS	Nr
22nd Sept. 1972	VSCS	185
10th Sept. 1972	VSCS	176
12th May 1979	VSCS	170
16th Nov 1942	VSCS	168
17th Oct. 1999 (Gopalpur)	VSCS	185
29th Oct. 1999 (Paradeep)	Super Cyclone	329

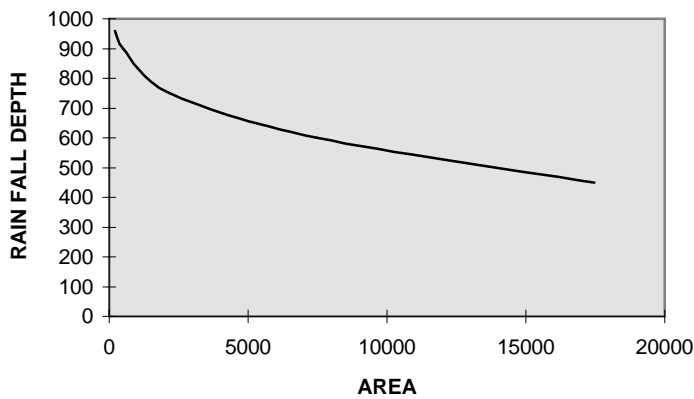
### **RAINFALL AND FLOOD**

The most severe precipitation occurred over Bhadrak-Keonjhar-Mayurbhanj districts. Eleven coastal districts lying in 4 major river basins of Mahanadi, Brahmani, Baitarani and Budhabalanga received massive rainfall of 500 mm to 900 mm. The depth-area-duration curve of these basins have been shown in **fig-5**<sup>1</sup>. The drainage basins of six dams, Ramiala, Remal, Kanjhari, Salandi, Sunei and Kalo have received 500 to 900 mm of rainfall in 36 to 48 hours that has resulted in generation of peak flood much in excess of their design spillway capacity. Damages to head works, canal systems have occurred, rendering the irrigation projects incapable of providing any irrigation although the reservoirs are absolutely full on Nov. 10, 1999. Due to supercyclone and flood the headworks and distribution systems of 422 Minor Irrigation projects have been seriously affected/damaged. It can be seen that the observed floods (**table 4**)<sup>1</sup>, in some cases are as high as 150% of the design flood of the projects. 31 nos. of dams have partially breached/slipped, with significant damage to head regulators and protective stone peaching. Heavy concentration of flood and wave action has caused subsidence and serious surface erosion. On the spillway side embankments have been damaged, the gradewalls have collapsed with deep scours and protective aprons have largely subsided and removed away. Diversion weirs have mostly been out flanked and body wall damaged. The distribution systems over a command area of 86,824 ha. out of total of 1,56,178 ha. has been totally /partially damaged. Almost 1090 Km. of distribution channels have suffered erosion through 1052 breaches and 306 canal structures had received massive damage. Due to super cyclone, 5636 lift Irrigation Projects have been seriously affected. This include disruptions of power supply and damage of head works and distribution system. Due to high flood, most of the pumps and other machineries were submerged which require rewinding.

The deltaic track that received the most intense rainfall particularly in Mahanadi, Brahmani, and Baitarani basin is extremely flat with slope of the order of 1 in

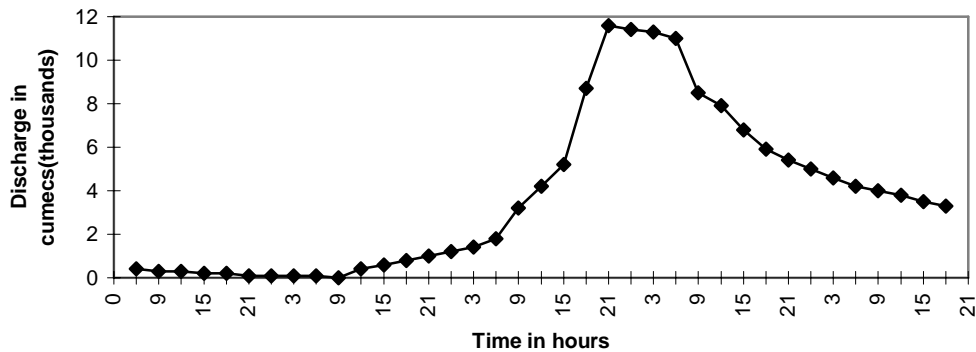
5000 to 10,000 . The two smaller river basins ,Baitarani and Burhabalanga received the most severe rainfall and consequently generated extremely high floods .River Baitarani bifurcates into a branch Budha at Akhupada , which joins Kharsuan , another deltaic branch of river Brahmani . Due to most intense rainfall between 29th Oct. to 1st Nov. the peak flood discharge is assessed as 4,98,000 cusecs at Akhupada against safe carrying capacity of 10,000 cusecs in the main channel and 50, 000 cusecs in Budha . The flood hydrograph of river Baitarani is shown in **fig-6**. The flood in Baitarani and its branches caused serious damages to all embankments and channels of Keonjhar , Jajpur , Bhadrak and Kendrapara districts .Both Anandapur and district town of Jajpur on the bank has been seriously affected by flood spill .

**DEPTH-AREA-DURATION CURVE**



**fig-5**

**FLOOD HYDRO GRAPH OF RIVER BAITARANI( At Akhupada)  
28thoct.-6 AM to 1st nov.99-6 PM**



**Fig-6**

Major contribution to catastrophic flood was from river Kusei (basin area 870 sq. kms) on the right and from several smaller rivers. The river Kusei before its confluence with Baitarani carried almost 200,000 cusecs , resulted in abnormal increase of flow to 498,000 cusecs at the delta head (Akhupada) . The river carried close to 500,000 cusecs crossing the the previous ever highest of 375,000cusecs in 1975 . As the river's carrying capacity at the head of delta is less than 200,000 cusecs, massive breaches occurred in the left and right embankments of the river and all its branches . Baitarani basin had not experienced a flood of this magnitude earlier . A major state highway bridge on this river was outflanked , and due to heavy concentration of flow , has collapsed by scour .The major flow from left to right was contributed by 26 nos of minor irrigation projects by breaches in the dam, collapse of spillway control structure and scour of protective grade walls .All minor projects in this basin irrigating 23,000 ha. have been totally devastated .The river Baitarani through its deltaic branch Budha spilled almost 250,000cusecs into Brahmani basin causing flooding of practically the entire delta of both the rivers and even 30 to 40 km upstream in the sub mountaining region . The NH-5 crosses the river just above the head of the delta where discharge through the bridge was observed as 408,000 cusecs . The two largest rivers basins Mahanadi and Brahmani received intense rainfall only in tail and consequently didnot generate high flood at the head of their delta . It is however more interesting to note that all deltaic branches of these rivers were flowing above danger levels, at locations as far as 20 kms inland from their sea mouth . The high flood occured here because of severe rainfall of 500 to 700 mm on the delta resulting in peak flood in the drainage channels ,which disgorged into the rivers at lower reaches . One million ha. arable land in coastal area were affected primarily by stagnation . The drainage was impeded because of flatness of the terrain being 1 feet/ mile . As the river Mahanadi and its branches Devi, Daya ,Bhargavi were overfull and 200 to 300 km/hr gale was blowing , the protective embankments of 2000 to 2500 kms length including the saline gherries along the coast lines of 350 kms received the massive scour , sloughing , overtopping . Strong cyclonic gale of 300 Kmph at Paradeep which caused a tidal wave 5 to 6 mtrs high traveled inland and spill laterally through all the coastal rivers and creeks upto 20 to 30 km parallel to coast .The length of coastal stretch affected is 250 kms and due to earlier cyclone 100 km length of Ganjam , Khurda , Puri districts has been affected .The saline inundation that occured over 20 to 30 km. wide coastal stretch was also caused by overtopping , breaching , and severe scouring of saline embankments along the coast of almost 1400 km length . The cyclone not only flattened out paddy crops but totally destroy the cash crops .The agricultural land area that has been affected by salinity is 2 lakhs ha. , which was covered with paddy and plantation crops , coconuts in particular . The district of Jagatsinghpur and Kendrapara has suffered massive loss due to wind and submergence in the lower reach .The basin area affected in main 4 rivers are shown in **Table-3<sup>1</sup>** .

**Table-3<sup>1</sup>**

**BASIN AREA AFFECTED**

Name of the basin	Agricultural land in M Ha	Irrigated land in M Ha	Area affected in M Ha
Mahanadi	1.85	0.6	1.20

Brahmani-Baitarani	0.65	0.16	0.45
Burhabalanga	0.3	0.04	0.2

**Table4<sup>1</sup> DANGER LEVEL OF THE RIVERS**

Name of river	Gauging Station	Peak Recorded	Gauge	Danger Level
Baitarani	Anandapur	40.05m		38.36m
Baitarani	Akhupada	20.77m		17.83m
Brahmani	Alva	5.36m		4.87m
Brahmani	Indupur	2.64m		2.50m
Salandi	Rajghat	16.72m		15.13m
Kharsuan	Binjharpur	6.40m		5.95m
Kharsuan	Aul Rajbati	4.70m		4.42m
Mahanadi	Bhutamunde	4.3m		2.8m
Devi	Sribantapur	4.5m		3.1m
Daya	Kanas	4.63m		3.99m
Bhargavi	Khujuria	3.07m		2.74m

### **PRAGMATICAL APPROACHES**

The super cyclone can be managed by adopting preventive ,cautionary and curative measures.Andhra Pradesh & Tamilnadu have thousands of cyclone shelters along the coastal belt stocked with basic amenities of life , beyond inundation points exclusively for those evacuated, each able to accomodate thousands of people . Orissa has not any such provisions . It is high time to construct a chain of of Precast concrete/ RCC cyclone shelters on safe, high ground, equipped with basic amenities of life along the Countries Cyclone-prone coastal areas .The shelters can be used as Schools or community centers in normal times .The housing scheme in the area should also be encouraged for cyclone-resistant construction .Subsidy by Government will help the people in this regard .

Iridium India Telicom limited has provided Govt. relief organisations four free Iridium hand-sets and free air time for use in earthquake devastated regions of UP in march 1999 ,and during ONGC frine earlier this year . Similar gesture of these instruments for Orissa should be provided .Iridium is a global wireless communication system that combines world wide coverage of a network of 66 low-earth orbiting satellites .It provides reliable 2-way communication during disaster relief . The role of these instruments(Iridium hand sets i.e. phones and pagers) in disaster Management are reputed to be extremely durable, handy in bad weather and on rough terrains .It will caution the people in face of ensuing danger to shift to safer place.The track and intensity of killer cyclone can be predicted well in advance ,based on satellite and radar data and by using data interpretation & Mathematical models.

The dense Mangrove forests which grew naturally in the Orissa coast was providing a permanent barrier against cyclones and tidal surges .These were the largest

deep forest of country .The unscrupulous clearence have made the coast bare and exposed to the vagaries of cyclones . According to official report the decay of the forest is 2 sq. kms per year .In 1960 the forest was 500 sq. kms , now it has reached to 190 sq. kms .Due to its rapid destruction the 1971 cyclone's has created a great disaster to Kendrapara district of Orissa .The restoration of mangrove forests requires a urgent attention .A good coordination is required between Finance, Forest and Environment departments. Stringent laws to preserve forests and to increase it by afforestation,plantation of wind breakers like Casuarina and similar trees in the coast will go a long way to reduce the speed of wind . In delta areas wind resistant commercial plantation should be proposed in place of Banana and Coconut tree which are very weak against wind force .

The proposal of construction of Highway between Gopalpur-Digha along the coast of 450 kms length and 7m high should be encouraged .The national Highway will join West bengal ,Orissa ,and Andhrapradesh along the coast which will not only protect saline ingress due to tidal surges to delta but also will boost tourism .Intermediate escapes with slucies are to be provided along the raised high way to facilitate drainage of the river channels to sea .

General flood control measures like catchment management<sup>2</sup> (Afforastation,soil conservation, adoption of contour farming ,construction of check dams) should be adopted to tackle flood and drainage problem in delta .Drainage channel improvement like dredging the river mouth and channel with Special treatment to weak points in various embankments should be provided .The restoration scheme(shown in **table-5**) need to be formulated by short term and long term proposals<sup>1</sup> .Short term(Immediate restoration) like closing the breaches in irrigation channels ,flood and saline embankments,construction of temporary structures , rehabilitating severely damaged structures and de-siltings of canals to bring the irrigation systems to operational condition for providing massive Rabi irrigation to 3 million ha.of agricultural land .In medium and minor irrigation projects both restoration of breaches to dam,canals and also strengthening of dams are required to restore to pre-cyclone condition..In addition to this the increase of spillway ventage with ancillary protection of certain extremely unsafe dams will have to be made . Raising of crest of saline embankments along the coast to RL 4 to 5 m to prevent over topping due to tidal surge is emergently required .

**Table-5**<sup>1</sup> **BASINWISE DAMAGE AND RESTORATION DUE TO SUPERCYCLONE(29.1099--1.10.99)**

Name of the basin	Irrigated area affected in lakh Ha.	Flood protected area affected in lakh Ha.	Canal damage in lakh rupees	Embankment damage in lakh rupees	Saline Embankment damage in lakh rupees	Buildin g damage in lakh rupees	Total restor ation in lakh rupees
Mahanadi	3.37	13.40	3584.73	4063.46	3552.00	1927.25	13127.44

Brahmani	1.03	4.40	4220.95	1757.60	540.00	583.20	7101.75
Baitarani	3.30	3.80	8124.43	3097.00	1000.00	155.50	12376.93
Burhabalanga	0.40	3.40	938.80	1208.00	111.00	59.40	2317.20
Total	8.10	25.00	16868.91	10126.06	5203.00	2725.35	34923.31

Daily rainfall of an intense storm events is now established as 400 to 500 mm anywhere along the coast with hourly intensity of 50 to 60 mm. wind velocity in the range of 100 to 200 kmph can also be considered as a likely annual event .Under these extreme combinations, a tidal surge of atleast 3 m height in the sea and stagnation at 1 to 2 m in the deltaic tract up to 60 to 70 km parallel to the coast is an extremely probable event .Therefore long and medium term action plan has to be drawn up and implemented in a 3 to 5 year time by critical hydrologic and hydraulics analysis as to why canals and embankments breach more frequently at certain locations. Proposals like formulation of well designed drainage plan for unirrigated river basins of Subarnarekha, Budhabalanga,Baitarani and Brahmani which includes

- a) Raising the saline embankments close to the coast to a TBL of 5 m up to 15 km from the coast and 4 m further upstream .
- (b)Protective pitching of rubble of 1.5 foot thickness over filters exposed to wave and scouring .
- (c)The embankment in severely scouring reaches will have launching apron protection .
- (d) Additional ventage in cross drainage structures in particularly for smaller steep catchments will have to be provided .
- (e)Adequate ventage in all roads/Highways will have to be provided that are the main obstacles for flood flow and cause unavoidable afflux .
- (f)It is also necessary to dredge river mouths, particularly for Subarnarekha,Mahanadi and its branches to facilitate quick flood out flow .

All the deltaic rivers below the head of the delta have reduced conveyance capacity by spilling in to breaches .The five major rivers Mahanadi, Brahmani,Baitarani,Subarnarekha,Rushikulya and their branches will have to spill progressively higher flood as they flow downstream .The escape channels (drainage channels) to sea must be provided with adequate waterway at the bridge crossings .All medium dams and minor dams spillway capacity is to be augmented by additional ventage or provision of wave breaker type parapet so that a flood higher than spillway capacity will encroach reasonably into the free board .A number of dams which involves



safety of a large population downstream have been found to have inadequate spillway capacity .Additional storage for flood moderation and provision of robust parapet ,increased ventage in spillway with improved adequate energy dissipating device must be incorporated . Assessing the spills down each deltaic river for floods of at least 1 in 50 year return period and providing robust escape structures at correct locations in the embankments , and leading the spill over the low land quickly to the sea . Because the severe cyclones that cause extremely intense precipitation over very large area along the coastal belt occur frequently in Oct.-Nov. when the crop is maturing therefore the need for drainage is paramount .In case of dams where very large and dense urban/rural habitation exist along the flood plain (Such as Bhadrak town and a number of villages below Salandi Dam) a correct assessment of width of flood zone and shifting of habitants from high flood prone zone is emergently needed . Almost 2,00,000 ha. of this super cyclone affected area experience moderate to severe crop loss in kharif and can not have flow irrigation facility which will need complete double embankment of all deltaic channels as a prerequisite .Most of the dam need special rehabilitation from long term stability consideration .Salandi earth dam in particular would need substantial rehabilitation including possible raising of the dam ,flattening of downstream slope, surface/subsurface drainage improvement as the peak inflow was two and half times the design spillway capacity .The track and intensity of the killer cyclone can be predicted and forecast well in advance ,based on satellite ,radar data and by using data interpretation & mathematical models. Forewarning of the disaster is required and where prevention is not always possible , it is duty of the government to organise and manage short term and long term relief that will reduce human miseries to the maximum extent possible .

## **CONCLUSION :**

The super Cyclone ripped through the entire densely populated coastal Orissa in the absence of predisaster Management plans .The face of Orissa had been scarred beyond recognition . Government should have well formulated plans because Cyclones are an annual scourage and they may return next October -November too and none can predict the next scale of destruction .Therefore with adequate will ,with support of community , NGO and every departments of Government , Calamities can be faced and human miseries can be reduced to the minimum .Since the cyclone seasons is April-May and Oct.-Nov. Committee has to be set up for a fresh look at disaster management and meeting are to be held in March and September to take stock of preparedness, supplies, rations. Disaster Management should be of permanent nature . It is high time that both central and state govt. lend to the subject of disaster management .It would be worthwhile that both the centre and state should have separate department of Disaster management .Immediate restoration,Long and medium term action plan has to be drawn up and implemented by critical hydrologic and hydraulics analysis .The housing scheme like Pucca building should be encouraged for cyclone-resistant construction . Drinking water supply pipe line should be connected to all Cyclone prone villages from outside

area .In delta areas wind resistant<sup>4</sup> commercial plantation should be proposed in place of Banana ,Coconut and other similar trees .Provision of chain of cyclone shelters, Afforestation programme,Drainage improvement programme and provision of Iridium phone sets in Cyclone-prone coastal areas like Orissa ,West Bengal ,and Gujurat are needed . Resources may be constraint on states so centre should take up the matters .Besides structural measures non-structural measures like Forecast of cyclone by remote sensing and advance warning is a need to the area which can often provide adequate warning sufficiently far in advance to permit orderly and complete evacuation . Scrupulous cyclone and flood damage reduction can be done by emergency evacuation . Management with more scientific and technical acumen has now been observed to be the only viable alternative .

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In the last super cyclone out of 4997 kms of flood wall (river embankments) there were 2243 nos of breaches of 205 kms long .Out of saline embankments 1518kms there were 1289 nos of 123kms long breaches .Out of 11947 kms of channel embankments there were 14881 nos of 230kms long breches and 70 nos of slucies of saline embankments has been affected ..In the delta due to poor drainage of 420000ha. a master plan is required .

Eleven coastal districts lying in four major river basins of Mahanadi , Brahmani, Baitarani and Budhabalanga received massive rainfall of 500 mm to 600 mm and caused high floods in the drainage channels , which disgorged into the rivers in lower reaches and deep stagnation over three millions hactre of protected and un protected agriculture land .0.8 millon ha. of irrigated command and 2.5 million ha. of protective agricultural land has suffered inconceivable damage .

Country's 2nd worst Cyclone.IMD could predict the intensity and track of killer Cyclone well in advance, based on satelite and Radar data.

Using data interpretation mathematical models, They could fore cast accurately that Cyclone of 220 KMPH wind speed would hit the Orissa Coast 48 hours in advance.Cyclone would hit the coast between puri in Orissa and Sagar island in WB.About 12hours ibefore it hit paradeep on Oct29.The IMD alerted the Orissa state administration of the impending danger to the port town .

The cyclone died down on southern coast of Orissa bringing to an end the 3 day fury of nature.

The prediction of gale wind speed ranging from 80-300 KMPH also came true .

\*\* A Super Cyclone is one whose intensity -wind speed encountered in core-area a tropical Cyclone equals or more than 226 KMPH.

## **SUPER CYCLONE IN STATE ORISSA AND ITS MANAGEMENT**

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The prediction of gale wind speed ranging from 80-300 KMPH also came true .

The supercyclone of Oct. 29-Nov. 1, 1999 and severe cyclone of Oct. 17-19, that preceded this , inflicted unprecedented damage in fourteen prosperous districts of the state that devastated 3 million ha. of cropped area, infrastructure in addition to sizeable loss of human lives . The super cyclone that originated in the Bay of Bengal near Andaman-Nicobar Islands on 25th Oct. concentrated into a severe cyclonic storm and had finally landfall at Paradeep on 29th Oct. morning. Lashing practically the entire coastal stretch of Orissa with wind velocity of around 300 kmph at Paradeep. The super cyclone penetrated up to 150 km inland and caused torrential precipitation over 45000 sq km from the 29th October to 1st November . The basin wise break of area that received intense rainfall is given in **table no 1**

#### **RAINFALL**

The most severe precipitation occurred over Bhadrak-Keonjhar-Mayurbhanj districts . Eleven coastal districts lying in 4 major river basins of Mahanadi, Brahmani, Baitarani and Budhabalanga received massive rainfall and caused high floods and deep stagnation over 2.5 million Ha. of protected and unprotected agricultural land

#### **DEPTH-AREA DISTRIBUTION.**

\*\*Orissa on the east Coast along with West Bengal and Andhrapradesh has the locational disadvantage of being in the path of depression of severe cyclonic storms that occur during the south west monsoon (June 15 to October 31). Severe cyclone indeed occurs when the Southwest monsoon recedes. Cyclonic storm also occur just before the onset of monsoon in late April-May-June spell.

#### **HISTORICAL SEVERE CYCLONE STORM EVENTS PASSING ORISSA COAST**

#### **SEVERE STORM EVENTS(HISTORICAL)**

**Flood :** the deltaic track that received the most intense rainfall particularly in Mahanadi , Brahmani, and Baitarani basin is extremely flat with slope of the order of 1 in 5000 to 10,000 .

The two largest rivers basins Mahanadi and Brahmani received intense rainfall only in tail and consequently did not generate high flood at the head of their delta . It is however more interesting to note that all deltaic branches of these rivers were flowing above danger level , at locations as far as 20 kms inland from their sea mouth . The high flood occurred here because severe rainfall of 500 to 600 mm on the delta resulted in peak flood in the drainage channels , which disgorged into the rivers in lower reaches . **table 4**

The two smaller basins Baitarani and Burhabalanga received the most severe rainfall over most of the basin and consequently generated extremely high floods .

**BAITARANI :** River baitarani bifurcates into a branch BUDHA at akhupada , which joins Kharsuan , another deltaic branch of river Brahmani . Due to most intense rainfall between 29th Oct. to 1st nov. the peak flood discharge is assessed as 4,98,000 cusecs at Akhupada against safe carrying capacity of 10,000 cusecs in the main channel and 50,000 cusecs in Budha . The flood in Baitarani and its branches caused serious damages to all embankments and channels of Keonjhar , Jajpur , Bhadrak and Kendrapara districts .

Both A **table 2**

**DEPTH-AREA DISTRIBUTION.**

<b>AREA IN SQ.KM.</b>	<b>TOTAL RAINFALL IN MM.</b>
17463	Above 400mm.
7498	Above 500mm.
2112	Above 700mm.
514	800-960 mm.

nanda pur and district town of Jajpur on the bank has seriously affected by flood spill. The river carried 2,00,000 cusecs.

Major contribution to catastrophic flood was from river Musal (basin area 531sq.kms ) and river Kusei (basin area 870 sq. kms) on the right and from several smaller rivers on the left of overall basin area 700sq. kms.

The major flow from left to right of the order of 108000 cusecs was contributed by 26 nos of minor irrigation projects by breaches in the dam, collapse of spillway control , structure and scour of protective grade walls . All minor projects in this basin irrigating 23000 Ha. have been totally devastated .

The river Kusei before its confluence with Baitarani carried almost 200000 cusecs from a basin area of 870 sq. km. A major state highway bridge on this river was outflanked , and due to heavy concentration of flow , has collapsed by scour .Kusei's contribution 200000 cusecs resulted in abnormal increase of flow to 498000 cusecs at the delta head .

Baitarani basin had not experienced a flood of this magnitude earlier although the rainfall (1999) was only intense (average 450 mm ) over the down stream 7000sq.kms. out of the overall basin area of 10200 sq.km. at the head of its delta (Akhupada) The upper basin of 3000sqkm. did receive rainfall of only 100mm.

The NH-5 crosses the river just above the head of the delta where discharge through the bridge was observed as 408000 cusecs. The river carried close to 500000 cusecs during super Cyclone crossing the the previous ever highest of 375000 cusecs in 1975 .

As the river's carrying capacity at the head of delta is less than 200000 cusecs, massive breaches occurred in the left and right embankments of the river and all its branches .

The river Baitarani through its deltaic branch Budha spilled almost 250000 cusecs into Brahmani basin causing flooding of practically the entire delta of both the rivers and even 30 to 40 km upstream in the submountaining region .

**Mahanadi and Brhamani**

One million Ha. arable land in coastal districts of Orissa were affected in these basins primarily by stagnation due to 600 to 700 mm of precipitation received . The drainage was impeded because of flatness of the terrain being 1ft. per mile . As the river

Mahanadi and its branches Devi, Daya, Bhargavi were overfull and 200 to 300 km/hr gale was blowing, the protective embankments of 2000 to 2500 kms length including the saline gherries along the coast lines of 350 kms received the massive scour, sloughing, overtopping.

Strong cyclonic gale of 300KMPH at Paradeep which caused a tidal wave 5 to 6 mtrs high travel inland and spill laterally through all the coastal rivers and creeks upto 20 to 30km parallel to coast. The length of coastal stretch affected is 250 kms and due to earlier cyclone 100 km length of Ganjam, Khurda, Puri districts has been affected. The saline inundation that occurred over 20 to 30 km. wide coastal stretch was also caused by overtopping, breaching, and severe scouring of saline embankments along the coast of almost 1400 km length.

The agricultural land area that has been affected by salinity is 2 lakhs Ha, which was covered with paddy and plantation crops, coconuts in particular. The cyclone not only flattened out paddy crops but totally destroy the cash crops.

The district of Jagatsingh pur and Kendrapara has suffered massive loss due to wind and submergence in the lower reach.)))))))))

In AP after 1977 cyclone, left 10,000 dead, Cyclone shelters were constructed which protected one million in shelters in 1997 Cyclone. AP has 1041 cyclone shelters stocked with basic amenities along coastal belt, beyond inundation points exclusively for those evacuated, each able to accommodate thousands of people. There are cyclone shelters in TN. Orissa has no any or at least such provisions. The super Cyclone ripped through Orissa's densely populated Coastal districts in the absence of pre disaster Management plans.

Committee has to be setup for a fresh look at disaster management. It is the time to construct chain of cyclone shelters, equipped with basic amenities along the Countries Cyclone-prone coastal areas like Orissa, WB, and Gujarat Resources may be constraint on states so centre should take up the responsibility.

Devastation can not be stopped but lives can be saved.

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The housing scheme should be encouraged for cyclone-resistant construction. Pucca building is the safe places.

Since the cyclone seasons is April-May and Oct.-Nov. Meeting are held in March and Sept. to take stock of preparedness suppliers, rations.

Precast concrete, RCC Reinforcements storm shelters on safe, perhaps high ground..

A first aid-kit non-perishable food and water, battery powered Radio. Flash light and extra batteries. shelters able to accommodate 500 to 600 people at a time should have such basics. Communication among other things need a look. The entire efforts would have to be supplemented with better tracking and monitoring of Cyclones and storm surges, The associated abnormal rise of sea level and assessment of areas likely to be inundated.

Iridium India, sole provider of satellite phones in the country has already been flooded with in quires from Government agencies and Industries for purchase of fresh phones, under scoring the role of these instruments in disaster Management.

Although Iridium India Telecom limited has provided Govt. relief organisations 4 free Iridium hand-sets and free air time for use in earthquake devastated regions of UP in march 1999. and during ONGC fire earlier this year, No decision had been taken on to come up with a similar gesture for Orissa.

Iridium is a global wireless communication system that combines world wide coverage of a network of 66 low-earth orbiting satellites. It provides reliable 2-way communication during disaster relief.

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Atleast 10 millions of people had been affected in 10 coastal districts of the state whose entire coastal region had been severely hit in cyclone that struck at 300KMPH

Tidal waves as high as 10 to 15 m have inundated vast tracks of the regions and swept away entire villages.

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The super cyclone hit Paradeep coast at a speed of 260KMPH on friday.

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5. The most of the houses in rural and towns are constructed either with thatched roofs or with tile roofs, which are more prone to damages due to severe winds. Hence Cyclone resistance houses constructed with R.C.C slabs will reduce house damages. The place having greater than 10m have to be identified and the housing colonies shall be developed in these identified areas.

1. The drainage systems in delta area should be improved by forming embankments on either side and removing silts deposited and clearing the vegetation in the bed of drains, to minimise the crop damage.

2. In delta areas wind resistance commercial plantation should be proposed in place of Banana and Coconut tree which are very weak against wind force.

3. The towns and villages below 10m contour need attention to prevent damages caused by Cyclone and Flood.

4. Drinking water supply pipe line should be connected to all villages in Cyclone prone area supplying water from outside area.\*\*\*\*\*

*The study of Cyclone tracks indicated that Cyclones are crossing the east coast either between WB and Bangladesh or at the coast of AP and Madras. The damages due to super Cyclone are studied and need for change in plantation pattern, housing system and improvements to the drainage systems is discussed*

There were Mangrove forests in the coastal area nearer to sea and now it is declining rapidly. Due to rapid destruction of these forest the intensity of cyclones are becoming

high and destroying the lives and properties in high amounts . According to official report the decay of the forest is 2 sq. kms per year but actual decay will be more than 5 sq. kms .In 1960 the area of the forest was 500 sq. kms , due to that the tidal effect was also less. Now it has reached to 190 sq. kms. but it is doubtful to have 100sq. kms . Due to its rapid destruction the 1971 cyclone has created a great disaster to Kendrapara district area .Centre is interested to invest 5 crore rupees every year but state govt is unable to expense 50 lakh rupees . A good coordination is required between finance department Forest and Environment departments . These mangrove forests were the largest deep forest of country .In the next 10 years these forest may totally disappear .Now it is time to check deforestation and afforestation programme should be started immediately with good coordinations of forest ,environmental and finance department ..

Gopal pur-Digha sea beach national highway (BELA BHUMI ): AP Orissa , WB are to be connected by sea beach national highway (BELA BHUMI ). this was proposed by late Biju pattnaik former CM of Orissa in 1990 and the estimate was 500 crores .In Orissa there are 450 kms of sea beach (BELA BHUMI ). From Gopal pur to Digha along the shore sea beach national highway (BELA BHUMI ) of 7m high are proposed by Geographers. It is necessary as along the shore many Defence institutes (8 nos)exists so Ministry of defence may take the responsibility to build it . This NH may also encourage the tourism in beach shore . Two things are essentials to prevent from Cyclone  
 1. To construct NH of 450 kms along the shore of sea coast , now it costs about 1000 crores of rupees .  
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**table no1**

Name of Basin	Area(sqkm.)
Mahanadi	17,500
Brahmani	10,500
Baitarani	13,000
Budhabalanga	4,000
	total 45,000 sqkm.

Name of the basin	Agricultural land in M Ha	Irrigated land in M Ha	Area affected in M Ha
Mahanadi	1.85	0.6	1.20
Brahmani-Baitarani	0.65	0.16	0.45
Burhabalanga	0.3	0.04	0.2



**DEPTH-AREA DISTRIBUTION.**

AREA IN SQ.KM.	TOTAL RAINFALL IN MM.
17463	Above 400mm.
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**HISTORICAL SEVERE CYCLONE STORM EVENTS PASSING ORISSA COAST**

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10th Sept. 1972	VSCS	95	176
12th May 1979	VSCS	92	170
16th Nov 1942	VSCS	91	168
17th Oct. 1999(Gopal pur)	VSCS	100	185
29th Oct.1999(Paradeep)	Super Cyclone	178	329

**SEVERE STORM EVENTS(HISTORICAL)**

Duration of storm	Maximum 3 day precipitation	Area in sqkm. >400mm rainfall	Area in sqkm. >500mm rainfall	Area in sqkm. >600m m rainfall	Area in sqkm. >700mm rainfall	Area in sqkm. >800mm rainfall
1925 (28th-30th June)	600(cuttack)	12960	4160	960	0	0
1927 (28th-30th July)	700(Karanjia)	12000	5440	3220	1760	0
1936 (13th-15th.June )	800(Phulbani)	9440	5980	2720	1535	320
1982 28th-30th August	800(Phulbani)	10400	7900	5920	1920	640

<b>1999 29th-30th October</b>	<b>955(Oupada)</b>	<b>17463</b>	<b>7498</b>	<b>4260</b>	<b>2112</b>	<b>514</b>
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**table4**

<b>Name of river</b>	<b>Gauging Station</b>	<b>Peak Gauge Recorded</b>	<b>Danger Level</b>
<b>Baitarani</b>	<b>Anandapur</b>	<b>40.05m</b>	<b>38.36</b>
<b>Baitarani</b>	<b>Akhupada</b>	<b>20.77m</b>	<b>17.83</b>
<b>Brahmani</b>	<b>Alva</b>	<b>17.6ft</b>	<b>16ft</b>
<b>Brahmani</b>	<b>Indupur</b>	<b>8.65ft</b>	<b>8.23ft</b>
<b>Salandi</b>	<b>Rajghat</b>	<b>16.72m</b>	<b>15.13</b>
<b>Kharsuan</b>	<b>Binjharpur</b>	<b>21ft</b>	<b>19.5ft</b>
<b>Kharsuan</b>	<b>Aul Rajbati</b>	<b>15.4ft</b>	<b>14.5ft</b>
<b>Mahanadi</b>	<b>Bhutamundei</b>	<b>4.3</b>	<b>2.8</b>
<b>Devi</b>	<b>Sribantapur</b>	<b>4.5</b>	<b>3.1</b>
<b>Daya</b>	<b>Kanas</b>	<b>4.63</b>	<b>3.99</b>
<b>Bhargavi</b>	<b>Khujuria</b>	<b>3.07</b>	<b>2.74</b>

**BASINWISE DAMAGE AND RESTORATION DUE TO SUPERCYCLONE(29.1099--1.10.99)**

<b>Name of the basin</b>	<b>Irrigated area affected in lakh Ha.</b>	<b>Flood protected area affected in lakh Ha.</b>	<b>Canal damage in lakh rupees</b>	<b>Embankment damage in lakh rupees</b>	<b>Saline Embankment damage in lakh rupees</b>	<b>Building damage in lakh rupees</b>	<b>Total restoration in lakh rupees</b>
<b>Mahanadi</b>	8.37	13.40	3584.73	4063.46	3552.00	1927.25	13128.22
<b>Brahmani</b>	1.03	4.40	4220.95	1757.60	540.00	583.20	7101.75
<b>Baitarani</b>	3.30	3.80	8124.43	3097.00	1000.00	155.50	12377.83
<b>Burhabalinga</b>	0.40	3.40	938.80	1208.00	111.00	59.40	2317.20
<b>Total</b>	8.10	25.00	16868.91	10126.06	5203.00	2725.35	34925.00

**All are in Dept.of Applied mechanics and Hydraulics  
Regional Engineering College , Rourkela-8(Orissa)**

Drainage systems in delta area should be improved by forming embankments on either side and removing silts deposited and clearing the vegetation in the bed of drains ,to minimise the crop damage .

2 .3 . The towns and villages below 10m contour need attention to prevent damages caused by Cyclone and Flood .

4 . Drinking water supply pipe line should be connected to all villages in Cyclone prone area supplying water from outside area.\*\*\*\*\*

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Let India plan and preparebefore the next calamity like cyclone and flood takes her unguarded way.

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\*\*\*\*\*5 . The most of the houses in rural and towns are constructed either with thatched roofs or with tile roofs ,which are more prone to damages due to severe winds. Hence Cyclone resistance houses constructed with R.C.C slabs will reduce house damages. The place having greater than 10m have to be identified and the housing colonies shall be developed in these identified areas.

1. The deltaic track that received the most intense rainfall particularly in Mahanadi , Brahmani, and Baitarani basin is extremely flat with slope of the order of 1 in 5000 to 10,000 .

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## **SUPER CYCLONE IN STATE ORISSA AND ITS MANAGEMENT**

The supercyclone of Oct.29-Nov.1, 1999 and severe cyclone of oct.17-19, that preceded this , inflicted unprecedented damage in fourteen prosperous districts of the state that devastated 3 million ha. of cropped area, infrastructure in addition to sizeable loss of human lives .The super cyclone that originated in the Bay of Bengal near Andaman-Nicobar Islands on 25th Oct. concentrated into a severe cyclonic storm and had finally landfall at Paradeep on 29th Oct. morning. Lashing practically the entire coastal stretch of Orissa with wind velocity of around 300kmph at Paradeep. The super cyclone penetrated up to 150km inland and caused torrential precipitation over 45000 sqkm from the 29th october to 1st november .The basin wise break of area that received intense rainfall is given in **table no1**

Name of Basin	Area(sqkm.)
Mahanadi	17,500
Brahmani	10,500
Baitarani	13,000
Budhabalanga	4,000
	total 45,000 sqkm.

The largest concentration of urban population of 1.5 million in Cuttack and Bhubaneswar suffered unprecedented damage from intense rainfall of 500 to 600 mm and cyclonic gale of 200-250 Km/hr. The densely populated coastal districts were also totally devastated in the cyclonic gale and severe rain.

The tidal surge of 6to 7m arising out of 300Km/hr, on the morning of 29th October rapidly swept across a 20Km strip of 100 Km coastal stretch in Jagatsinghpur and Kendrapara districts, submerging the entire area and destroying all the houses and infrastructures. Saline inundation of 2,00,000 Ha of extremely fertile agricultural land struck a deathblow to standing crop. More than 10,0000 inhabitants were officially deceased .

**RAINFALL**

The most severe precipitation occurred over Bhadrak-Keonjhar-Mayurbhanj districts . Eleven coastal districts lying in 4 major river basins of Mahanadi, Brahmani, Baitarani and Budhabalanga received massive rainfall and caused high floods and deep stagnation over 2.5 million Ha. of protected and unprotected agricultural land

slno 1. 2. 3.  
4.

**DEPTH-AREA DISTRIBUTION.**

AREA IN SQ.KM.	TOTAL RAINFALL IN MM.
17463	Above 400mm.
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\*\*Orissa on the east Coast along with West Bengal and Andhrapradesh has the locational disadvantage of being in the path of depression of severe cyclonic storms that occur during the south west monsoon (June 15 to October 31). Severe cyclone indeed occurs when the Southwest monsoon recedes. Cyclonic storm also occur just before the onset of monsoon in late April-May-June spell.

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**SEVERE STORM EVENTS(HISTORICAL)**

<b>Duration of storm</b>	<b>Maximum 3 day precipitation</b>	<b>Area in sqkm. &gt;400mm rainfall</b>	<b>Area in sqkm. &gt;500mm rainfall</b>	<b>Area in sqkm. &gt;600m m rainfall</b>	<b>Area in sqkm. &gt;700mm rainfall</b>	<b>Area in sqkm. &gt;800mm rainfall</b>
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Country's 2nd worst Cyclone. IMD could predict the intensity and track of killer Cyclone well in advance, based on satellite and Radar data.

Using data interpretation mathematical models, They could fore cast accurately that Cyclone of 220 KMPH wind speed would hit the Orissa Coast 48 hours in advance. Cyclone would hit the coast between Puri in Orissa and Sagar Island in WB. About 12 hours before it hit Paradeep on Oct 29. The IMD alerted the Orissa state administration of the impending danger to the port town .

The cyclone died down on southern coast of Orissa bringing to an end the 3 day fury of nature.

The prediction of gale wind speed ranging from 80-300 KMPH also came true .

\*\* A Super Cyclone is one whose intensity -wind speed encountered in core-area a tropical Cyclone equals or more than 226 KMPH.

Incessant rain under the influence of depression over the Bay of Bengal , heavy down pour has added to the misery of the homeless people .

At least 10 millions of people had been affected in 10 coastal districts of the state whose entire coastal region had been severely hit in cyclone that struck at 300 KMPH. Tidal waves as high as 10 to 15 m have inundated vast tracks of the regions and swept away entire villages .

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Cyclonic storms: The tracks of the various Cyclonic storms in the Bay of Bengal between 1891-1997 reveals that most of the Cyclonic storms are crossing the east coast through coastal Orissa and East Godavari district of AP .

There were Mangrove forests in the coastal area nearer to sea and now it is declining rapidly . Due to rapid destruction of these forests the intensity of cyclones are becoming high and destroying the lives and properties in high amounts . According to official reports the decay of the forest is 2 sq. kms per year but actual decay will be more than 5 sq. kms . In 1960 the area of the forest was 500 sq. kms , due to that the tidal effect was also less. Now it has reached to 190 sq. kms. but it is doubtful to have 100sq. kms . Due to its rapid destruction the 1971 cyclone has created a great disaster to Kendrapara district area . Centre is interested to invest 5 crore rupees every year but state govt is unable to spend 50 lakh rupees . A good coordination is required between finance department Forest and Environment departments . These mangrove forests were the largest deep forest of country . In the next 10 years these forests may totally disappear . Now it is time to check deforestation and afforestation programs should be started immediately with good coordinations of forest , environmental and finance department ..

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2. To create the artificial forests like mangrove forests .

#### REFERENCES:

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In the last super cyclone out of 4997 kms of flood wall (river embankments) there were 2243 nos of breaches of 205 kms long . Out of saline embankments 1518 kms there were 1289 nos of 123 kms long breaches . Out of 11947 kms of channel embankments there



were 14881 nos of 230kms long breches and 70 nos of sluices of saline embankments has been affected ..In the delta due to poor drainage of 420000ha. a master plan is required .

**Extended Abstract**\*\*

**MANAGEMENT OF SUPERCYCLONE AND FLOOD IN ORISSA**

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The state of Orissa is frequented by natural disasters like cyclone and flood year after year .The severe cyclone of october 17th and the super cyclone of october 29th ,1999 devastated fourteen coastal districts throwing the lives of one crore of people out of gear . More than 10,000 people were declared officially dead , three lakhs of cattle perished , nineteen lakh houses were razed to the ground . Coastal Orissa which was full of greenery virtually turned barren with over nine crores of trees uprooted .The supercyclone not only flattened out paddy crops but totally destroyed other cash crops . Eleven coastal districts lying in five major river basins of Mahanadi , Brahmani , Baitarani , Budhabalanga and Subarnarekha received heavy rainfall of 500mm to 600mm and caused high flood in the drainage channels which disrgorged in to the delta at the lower reaches and deep stagnation of water over three million hectares of agricultural land occured . As the rivers were overflowing and strong unprecedented cyclonic gale of 200 to 300 kmph was blowing large stretch of protective and saline embankments gave way by massive scouring , sloughing and overtopping . Breaches in the dams , collapse of

spillway structures occurred in many minor irrigation projects of the state .The loss due to cyclone , super cyclone and flood is estimated to be around 20,000 crores of rupee .

The super cyclone can be managed by adopting preventive , cautionary and curative measures . The dense mangrove forests which grew naturally in the Orissa coast was providing a permanent barrier against cyclone and tidal surges . The unscrupulous clearance have made the coast bare and exposed it to the vagaries of cyclones . According to the official report the loss of the forest is at the rate of eight sq.kms per year . As a result it has depleted to 190 sq. kms from 500 sq.km which existed in the year 1960 .The restoration of mangrove forests requires urgent attention of forest and environment department . Stringent laws for preservation and extension by way of afforestation specially by wind breakers like Casuarina and similar trees in the coast will go a long way to reduce the speed of cyclone .The proposal of construction of High way between Gopalpur and Digha along the 450 km coastline should be implemented which will not only prevent saline ingress due to tidal surges but also will boost tourism . Intermediate escapes and sluices are to be provided along the raised highway for upstream drainage . Protective sea walls near the human settlements is a preventive measures against tidal surges .

***\*\* Actual abstract with in 500 words will be submitted along with final paper .***

Cautionary measures like installation of radars , providing with Iridium hand sets and pagers (which are reputed to be extremely durable , handy in bad weather and rough terrains and provides reliable two-way communications during disaster ) will caution the people in face of ensuing danger to shift to safer places . The track and intensity of killer cyclone can be predicted well in advance , based on satellite and radar data and by using data interpretation & Mathematical models . Forewarning of the disaster is desired and where prevention is not possible , it is the duty of the government to organise and manage short term and long term relief measures that reduce human miseries to the maximum extent . Andhrapradesh and Tamilnadu have thousands of cyclone shelters along the coastal belt , stocked with basic amenities of life . Orissa is not having any such cyclone shelters . It is high time to go for construction of a chain of Precast / R.C.C cyclone shelters on safe and high ground .The shelters can be used as schools or community centers in normal times . The affected peoples should be encouraged to go for cyclone resistant R.C.C.construction . Subsidy by government will help the people in the regard . Evacuating people of Jambu area of Kendrapara district and Ersama area of Jagatsinghpur district should be taken up by government to save the people .

It is a pity that coastal orissa is frequently exposed to high flood damage . Only two major rivers Mahanadi and Brahmani have been dammed at Hirakud and Rengali respectively . Though Hirakud dam is controlling the flood situation in the delta area but for complete flood and drainage control Sir M.Visweswaray's phase wise Mahanadi river valley project should be implemented . General flood control measures like afforestation and adopting soil conservation measures , construction of check dams , adoption of contour farming , small dams in the tributaries , flood forecasting and warning , should be adopted . Raising the existing embankments , dredging of river

channels , constructions of escapes in the delta should be provided to control flood and avoid drainage problems in the delta . Short term measures like closing critical breaches , strengthening of embankments by pitching and revetments by spurs and groynes and long term measures as envisaged above will save the people from fury of flood and cyclone . Be it Supercyclone or Severe flood, the suffering of people of Orissa is due to absence of proper disaster management plans . A task force should be set up disaster management .Cyclones and floods are annual scourages and they may return next year . But with adequate will , with support of people , NGO's , different departments of governments , these calamities can be faced and scale of human suffering reduced to minimum .