NATURAL HAZARDS MANAGEMENT IN SOUTH ASIA: A CASE STUDY OF BAY OF BENGAL CYCLONES

Dissertation submitted to the Jawaharlal Nehru University
in partial fulfilment of the requirements
for the award of the degree of

MASTER OF PHILOSOPHY

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1994

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Date : 21-7-1994

Centre for International Politics,
Organization and Disarmament,
School of International Studies.

Certificate

Certified that the dissertation entitled **NATURAL HAZARDS MANAGEMENT IN SOUTH ASIA : A CASE STUDY OF BAY OF BENGAL CYCLONES** submitted by **Sanjay Kumar Singh** is in Partial fulfilment of the requirement for the award of the degree of **Master of Philosophy**, is his bonafide work and has not been previously submitted for any other degree of this or any other University.

We recommend that this dissertation may be placed before the examiners for evaluation.

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To,

The Victims
of Natural Hazards

ACKNOWLEDGEMENTS

Words are inadequate to express my deep sense of gratitude to my supervisor Prof. R.C. Sharma. But for his inspiring guidance, unfailing encouragement, generous help and co-operation, this dissertation would not have been completed. My sincere thanks to him.

I am also grateful to the staff of various libraries, especially Central Water Commission (CWC) and Indian National Scientific Documentation Centre (INSDOC) for their whole-hearted co-operation.

Mr. Govind, Mr. Chandan, and Mr. Bhagwan were responsible for almost all the typing work, which was both extensive and demanding.

I shall be failing in my duty if I do not express my gratitude to my parents who were a constant source of encouragement and moral support during the course of this study.

Thanks are due to many of my friends who have helped at various stages of this study and in particular my seniors - Rajeev, S.B., Neeraj, Kakali and Shashi, and friends Reena, Nalin, Himanshu, Sarvottam, Giri, Ajay, Manish, Upendra, Anurag and Janardan.

Errors of substance or judgment if any, are my sole responsibility.

Sanjay Kumar Singh

SANJAY KUMAR SINGH

CONTENTS

Introduction

INTRODUCTION

Disasters have always been with mankind and will probably continue as long as there is life on this planet. Disastrous events induced by natural physical processes and human activities and habitation are respectively described as natural and man made. Both of these are characterised by uncertainity, lack of information and limited time for response. But in the natural disaster man's capacity to control them is extremely limited unlike in man made disasters.

The word 'Disaster' evokes different types of images and is often used loosely to refer to any sudden unexpected or extraordinary misfortunes, regardless of whether it occurs to an individual, a family, a small group, a community or a region.

Natural disasters are a global phenomenon and no country is an exception to them. Inspite of sophisticated technology, the modern world remains very vulnerable to disruption by disasters. But the natural disaters have a greater adverse impact on developing than on developed areas since the former have a poorer and less flexible administrative system, a lower potential to benefit from previous learning situations and more primitive and

inadequate technological infrastructures. It may be argued that greater the economic dependence of developing countries upon primary production, the greater is their vulnerability to natural disasters. That is why South Asian Countries are more vulnerable to natural disasters.

Disasters have occured in India in the past with varying degree of intensities. Though there had never been a major country wide disaster, but different regions do fell victims to calamities of various types. In India floods are an annual recurring phenomenon in the plains during the later part of the monsoon period. The disaster next in terms of national impoartance is the cyclones which frequently occur year after year on the sea coasts of both the Bay of Bengal and the Arabian Sea. Drought and earthquake are of greater concern in India.

In Pakistan floods, droughts and earthquakes are the main natural disasters along with landslides, but tidal waves and cyclones are less frequent.

Bounded between 20^{o} and 27^{o}N latitudes and 88^{o} and 92.5^{o} East Longitudes, Bangladesh is one of the biggest deltaic countries of the world and is formed by flood plains of the three major rivers namely the Ganges, the Brahmaputra and the Meghna and their numerous tributaries. Due to unique

geographical situation, Flood is the most-serious calamity which adversely affects the national economy and causes untold suffering to the people almost every year. Bangladesh is also prone to frequent destructive Tropical cyclones associated with tidal surge particularly in the monsoon months.

Nepal is a land locked country situated between China and India. In Nepal people suffer every year from floods, land slides, soil erosion, partial drought and famine, and avalanches.

The Maldives, is situated in a place, which is sometimes called a 'disaster free' Zone. Maldives have never had flooding and earthquake (because of coral and not the volcanic origin of the island).

Thus we see that cyclones and floods are main disasters in the South Asian Countries. It is not possible to prevent the occurrence of disasters but their effects can certainly be minimised by proper planning and management.

In the dissertation, chapter I deals with concepts, definitions, various aspects of natural disasters and their typology.

Chapter II is concerned mainly with the natural hazards

and their frequencies in the South Asian Countries. South Asian Countries have underdeveloped economies that is why they are more vulnerable to natural disasters.

In Chapter III, various phenomenon related with cyclone, and its time space pattern in the Bay of bengal has been dealt with. The origin of cyclone, the source of energy, its occurance and tracks has also been dealt in this chapter.

Chapter IV is mainly concerned with the impact of cyclones on the people and economy of Orissa and Andhra Pradesh.

Chapter V is related with the management aspects of cyclones. As the occurance of cyclone can not be prevented its proper management is necessary to minimise the adverse effects. There is necessity of co-operation at International, Regional and National levels. Planning at local level, the the role of Voluntary organisations and early warning systems are also necessary.

Chapter I

Natural Hazard And Its Typology

CHAPTER I

NATURAL HAZARDS AND ITS TYPOLOLGY

From time immemorial natural and man made calamities and disasters are not uncommon occurrences affecting normal life of flora and fauna all over the world. It is more so in the modern world. Disasters are all pervading phenomena in human affairs; they loom large in the history of human events and profoundly influence all they touch. The threats of death, disease, injury and destruction that flow from these tragic confrontations with nature, technology or human error serve to remind us continually that we are mortal and despite the apparent security of late twentieth century, life is till vulnerable to the vagaries of the biological, physical and man made environment. Disasters have the ability to strip away much of the comforts and veneer of human life; and to show that it is nature that is the master and not the man'.[1]

Natural disasters are, of course, as old as mankind: Floods, famines, fires, diseases and all other calamities triggered by nature's forces fill the chronicles of

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1. Arun Bapat, 'Natural Disaster-Man : Slave or Master', Nagpur: Maharastra State Council of Educational Research and Training, 1992, p.32.

recorded history. Along with wars, they were for centuries the principal events by which people marked transitions from one epoch to another, leaving behind their indelible marks on demographic and social structures. Despite successive technological revolutions, their effects are still with us in the 'boom and bust' model for explaining fluctuations in populations growth in the past. The great economist Malthus has clearly pointed the role of disasters in maintaining a balance between population and resources.

The concept as well as definition of disaster have tended to change over time. Prior to the first few decades of the twentieth century, epidemics, floods and famines were considered to be natural disasters and largely unavoidable 'acts of God'. In the past fifty years, however the idea concerning cause and effect have changed and such events have come to be seen as amenable to human intervention. The emphasis has shifted away from the view of disasters as simply physical phenomena to one which sees them more as social issues based on demographic and socio economic vulnerability.[2]

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2. Fredrick Krimgold, 'Overview of the priority area', Natural Disaster, New York; United Nations, 1976, p.16.

Disaster involves the interaction of a disaster agent and a vulnerable population (UNDRO, 1980) and occur at the interface of extreme geophysical, meteorological, biological and social phenomena and human vulnerability.[3] The 'act of God', the independent operation of incomprehensible and uncontrollable forces, is no longer seen as the dominating element of a disaster situation. Disasters are always more prevalent where human population occupy vulnerable positions. That is why people remain the essential reference point for all disasters. It is their vulnerability misfortune and behaviour that are of central concern. Thus, all disasters are population oriented, for arguably without people, there can be no disasters. Disasters are about human population, how their lives and activities are imperilled or changed, how they react to crisis, the attitude they hold, the adjustment they make and how they confront the everyday problems of risk and vulnerability.

Year after year, we witness disasters that 'inflict untold misery on vast number of people, especially poor people. Disasters are a recurring phenomenon of nature.

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3. Ibid., p. 17.

They have occurred in the past, have been occurring in the present and will continue to occur in future as well. Most of the viewers of the world disaster situation indicate that there has been an increase in the frequency of large scale disasters and that the most striking increase have occurred in developing countries.[4] This has occurred largely because of an increase in the vulnerability of the population at risk. Vulnerability to disaster is related not only to poverty and economic resources but also to population growth, urbanisation and changes in human behaviour. Some of these disasters have been been described as natural and beyond the control of man. The natural disasters are of different types, namely cyclones, floods, earthquakes, droughts, tidal waves, etc. Man made disasters, on the other hand, include civil strife, fire, environmental pollution, accidents, explosi-tion, radiation, epidemic and technological lapses. In developing countries, while conditions are often marginal in rural areas, it is the cities which have

4. H.D. Foster, "Assessing disaster magnitude: a social science approach". Professional Geographer,. No.28, 1976, pp241-7.

attracted much recent attention. Today possibly as many as 270 million people live in urban areas under conditions of absolute deprivation and poverty. In many cities, the fastest growing sector is the slum and squatter settlement population. Every day more people are being exposed to hazardous and life threatening circumstances, be they from infectious diseases, industrial accidents, earthquakes, cyclones or flooding.[5] In the past 2-3 decades, throughout the developing world, there has been a rapid increase in the numbers exposed to the risk of disaster. The factors responsible for this increasing vulnerability are four fold. In the first place, there has been rapid population growth in recent decades. In the second, there has been the inability of governments to meet the most basic housing and public health requirements for the bulk of urban dwellers, in many cases forcing people to occupy high risk sites or to be at high risk from infectious disease. Thirdly, the rapid expansion in motor vehicle and manufacturing industry and the indiscriminate use of pharmaceuticals, pesticides and insecticides has created

5. The World Bank, 'Operational Directive OD 8.50', Washington D.C.: Emergency Recovery Assistance, 1989, p.104.

an environment marked by high levels of pollution and a high prevalence of industrial and occupational diseases. Finally, export of polluting industries and dumping of nuclear wastes in developing countries by the developed ones has further aggravated the situation.

Following table shows the relative position of different disasters in terms of total loss of life and the number of disasterous events.

Table 1.1

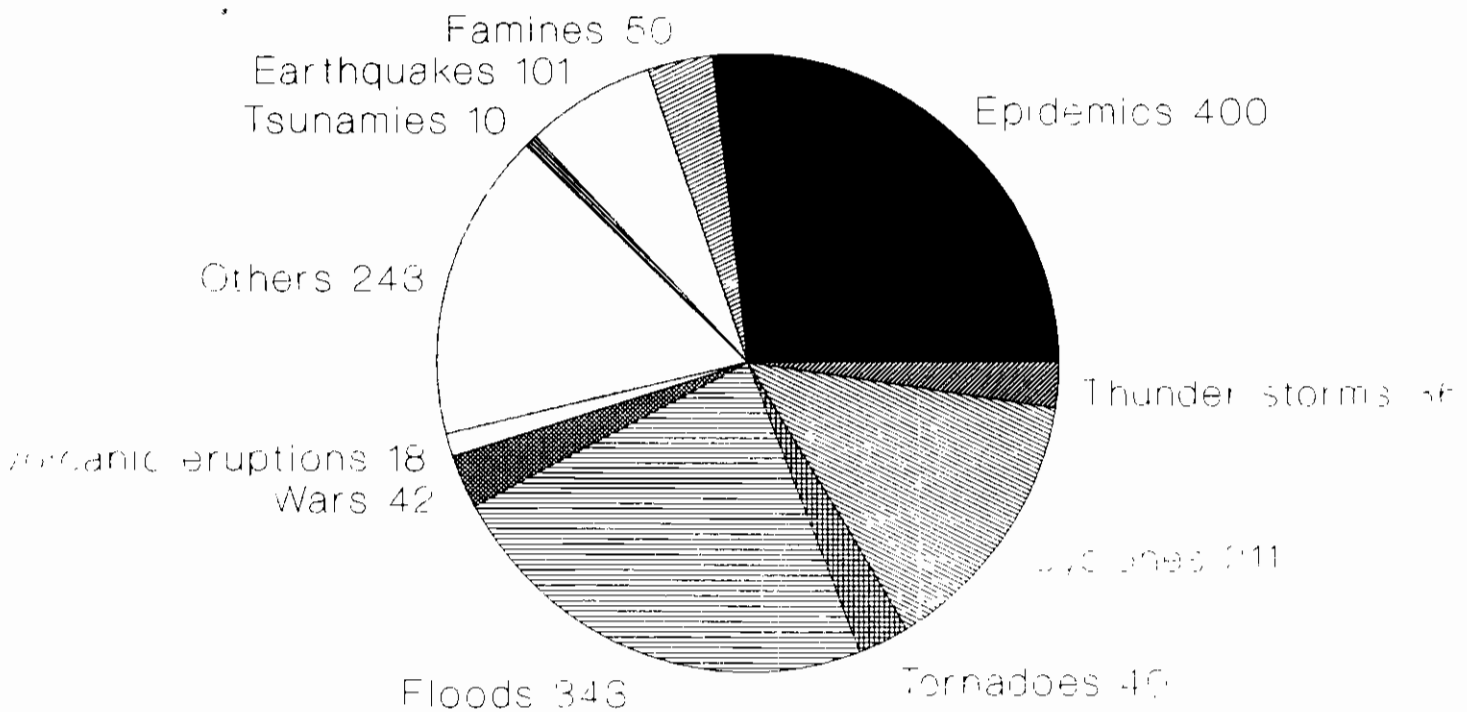
HUMAN LOSSES IN DISASTER EVENTS, 1947-1981

Events	Total loss of life	Number of disaster events
Epidemics	45,000,000[a]	>400[a]
Famines	40,000000[a]	50[a]
Wars	9,677,500	42
Cyclones/Hurricanes/Typhoons	500,808	211
Earthquakes	426,998	101
Floods	96,168	343
Thuder storms	21,140	36
Volcanic eruptions	9,457	18
Tsunamies	8,568	10
Tornadoes	8,215	40
Others	36,653	243
	95,885,502	

[a] = Rounded estimate

Major Source : Thompson (1982); Bouthout and Carrere (1976); WHO (1970-81), Nash (1976); U.S. Department of Health (1970-81).

NUMBER OF DISASTER EVENTS
1947-1981



Definition of Disaster

It is difficult to define disaster with any precision. Some authors include biological events such as epidemics of infectious diseases, while others concentrate on geophysical and meteorological events. Few would seen to include wars, industrial and nuclear accidents or social and political decisions in their definitions. Consequently,, the term 'disaster' continues to be used in a wide variety of ways, reflecting in part the particular requirements of the movement and in part the lack of agreement on what criteria should be used to differentiate disasters.

The term 'Disaster" owes its origin to the French word 'desastre' but this word itself has latin roots (dis = bad or evil) and astrum meaning 'star'. So the word conveys the sense of 'Bad or Evil Star' obviously, all happenings on earth were attributed to different celestial bodies. But now a days the concept has changed a bit and the term 'Disaster' is universally used to denote any odd event, be it man made or natural which brings about sudden and immense miseries to humanity. Though there are various types of disasters , we are concerned mainly with natural disasters.

Hazards Risk, Vulnerability and Disaster are some frequently used terms in Disaster Management studies. So at first we should understand the characteristics associated with them.

Natural Disaster

This means damage to the physical, social and economic components and qualities of the natural and man-made environment caused by an extreme natural phenomenon. It is a situation resulting from natural or man made catastrophe other than war, demanding total integration of the rescue or life support systems available to officials responsible for the stricken areas together with the communications and transportation resources required to support the relief operations.[6]

Hazard

Means the frequency of occurance of any extreme natural phenomenon and its strength in a given area and within a given period of time.[7]

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6. 'Natural Disaster' - New Dehi : a Publication of Joint Assistance Centre, 1989, p.88.
7. Ibid., p.17.

Vulnerability

is the degree of susceptibility of the environment to a hazard. Vulnerability takes into account social, natural and economic aspects of human environment. In other words, a given location becomes vulnerable by human activities. The extent, therefore of a vulnerability of a given location depends on the concentration, density, resistance and access/egress of the location.

Risk

is defined as the product of vulnerability and hazard. $R = vxh$.[8]

Thus, disaster may be taken as a sudden and unexpected occurrence on account of man's manoeuvres/ natural phenomena resulting in huge losses to properties and lives of flora and fauna including human beings.

Demographers have tended to accept a fairly simple definition of what constitutes a demographic crisis or disaster. An excess of deaths (or illness) over normal expectations in a restricted time-space framework is usually enough to denote a population crisis . For

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8. Ibid., p.18.

demographers the crucial variables in this equation are (a) the size of the population affected (b) the actual excess mortality rate and (c) the duration of crisis (Hollings worth, 1979). Implicit in their reasoning is that mortality must exceed some normal level by a certain factor of magnitude. In contrast to demographers, geographers and other social scientists working within the natural Hazards framework have tended to define disasters more in environmental and behavioural terms, placing emphasis on such things as the nature of disaster events itself, the levels of physical damage caused, the degree of disruption to the structural arrangements of the society and the amount of collective stress engaged. To Sjoberg (1962 : 357) for example, a disaster is a '..... severe relatively sudden and frequently unexpected disruption of normal structural arrangement with a social systems or subsystem, resulting from a force, 'natural' or 'social', internal to system or external to it, over which the system has no firm control'.[9] Where as Heath-cote (1973) describes disaster as 'extreme geophysical events

9. G. Sjoberg, 'Disasters and Social Change', in C.W. Baker, and W. Chapman, Ed.. 'Man and Society in Disaster' New York : Basic Books, 1962, pp.356-84.

greatly exceeding normal human expectations in terms of magnitude or frequency and causing significant material damage to man and his works.[10] WHO. defines natural disasters as 'catastropic consequences of natural phenomenon or a combination of phenomena resulting in injury, loss of life or input in a relatively large scale and some disruption to human activities.[11]

Most definitions of disaster, whether demographic or geographic, stress temporal and spatial characteristics, that is they describe a relatively sudden event concentrated in time and space. This would not necessarily preclude consideration of slow onset disaster such as AIDs or widespread events such as famine or droughts, providing a flexible definition of time and space were allowed. It would also be seen that disasters have an unexpected/unforeseen nature which exceeds the community's normal expectation. Above all, disasters are high-magnitude events in physical and demographic terms compared to some natural period of human experience.

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10. R.L. Hearthcote and B.G. Thom (Eds.) 'National Hazards in Australia' Canbera: Australian Academy of Sciences, 1973, pp.3-10.
11. D.K. Smith, 'National Disaster Reduction: How Meteorotegical and Hydrological Services can Help', Switzerland: WHO, 1989, p.14.

Finally disasters have considerable environmental, social and psychological effect and place unforeseen pressure on existing facilities and societal structures.[12]

Unfortunately, much research concerning natural hazards/disasters leaves unanswered a series of crucial questions. At what point, for example does a geophysical, biological or societal event become a disaster? There must be extensive physical and demographic damage occur and it so physical and demographic damage occur and if so how much? should the psycho-social factors such as fear, hysteria and panic be taken as yardsticks of disaster? The question of exactly how to define a disaster is one on which there seems little general agreement; consequently the term 'disaster' lacks quantitative precision. On this point demographers are perhaps more explicit than those studying natural hazards. Wrigely and Schofield (1981) in identifying local demographic crisis in English villages rely on close analysis of the monthly frequency of deaths.[13] Many other analysts have adopted other

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12. D.J. Parker and D.M. Harding, 'National hazard evoluation perception and adjustment' Geography, No.64, 1979, pp.307-16.
13. E.A. Wringley and R.S. Schofield 'The population history of England 1541-1871' London : Edward Arnold, 1981, p.79.

criterion. Hewitt and Burton (1975) for example produces a series of criteria based on degree of property damaged or economic loss (to more than 20 families or loss exceeding U.S $ 50,000) the degree of strain on essential public services and/or the manpower involved required to handle the event and a mortality of ten or more, or a mortality of 50 or more.[14] Baird et.al.(1975) increases these levels to at least U.S. $ 1 million damage and/or at least 100 deaths and 100 injuries.[15] In the previous decade many efforts have been done in the field of Disaster prevention and management. On the process Anthony R Michaelis[16] has classified events according to casualty of life or follows:-

Accidents	1-1000 people dead or in immediate danger of death.
Disasters	1000 - 1 million people dead or in immediate danger of death.
Catastrophes	More than 1 million dead or in immediate danger of death.

14. K.W. Hewitt and Burton, I, 'The Hazards of a place : A Regional Ecology of Damaging Events', University of Toronto Pub.,1975, p.123.
15. A. Baird et.al. (1975), 'Towards an Explanation and Reduction of Disaster Proneness', University of Bradford occasional paper, 1975, p.36.
16. Anthony R. Michaelis, 'Interdisciplinary Disaster Research' Interdisciplinary Science Reviews,Vol.9, No.3, 1984, pp.193-95.

These definitions are by no means adequate. Because in some disasters more properties are destroyed than the number of deaths. Harold D. Foster of the University of victoria, BC has so far given the most comprehensive definition of disaster and their magnitude.[17] His scale is built around a social stress rating, derived from an individual loss or change subsequent to being involve in a disaster. He derived a number of formulae allowing for a difference between developed and underdeveloped countries. The terms in his formulae included the number of fatalities of seriously injured persons, the stress values and the number of total population affected. He derived a logarithmic magnitude scale for a number of famous disaster events. For example, Black Hole of Calcutta of 1756, magnitude 5.0; Titan-ic sunk (1912) magnitude 6.1; World-War I-10.5; World War-II, 11.1;Atomic Bomb at Hiroshima (1945), 8.2 etc.

There are however, many difficulties in applying such schemes cross - culturally or to small-scale societies or sub-group. It follow a demographic approach and relate the number of deaths, illness and injuries and the degree of physical and a degree of social damage to some normal period or

17. Professional Geogapher, Vol.28, No.3, 1976, p.241.

expectation, as well as to the social, demographic and geographic population at risk.

Many definitions of disasters place emphasis on the nature of the actual onset - a relatively sudden and unexpected event. Yet given the fact that many disasters are neither sudden in outset nor totally unexpected,this would seem a less than ideal criterion. Many disasters are in effect slow onset events be they slow viral disease like Kuru or AIDS, or famines or droughts an equally important question is disaster for whom ? Undoubtedly one person's misfortune may be anothers gain. What is catastrophic for one particular group may be viewed trivial, unimportant even beneficial by another. Perhaps it is the differential nature of disasters that make them so tragic. The poor, the disadvantaged and the marginal generally suffer most, whether the disaster is an epidemic, famine, earthquake, flood, cyclone or war. Moreover, same disasters are more visible than others and some are largely invisible to the wider community because of the particular status and / or location of the group affected.

Clearly we must be carefully cognisant of the various components of a disaster - physical, demographic epidemiological, social, economic and political. To obtain

a satisfactory definition some measure of magnitude must be employed. This must be related to the population at risk and to some index of the normal demographic experience of that population. The definition must also do justice to the various elements that stem from disasters such as the physical effects of immediate impact, demographic effects (both short and long term), psychological effects, social disruption, economic effects, political effect etc. It must also do justice to some of the less easily measurable elements of disaster such as stress, fear, hysteria and panic.[18]

Typology

Natural disasters have been described as natural and beyond the control of man where as artificial or man made disasters are caused by and within the control of man. Natural disasters are of different types namely cyclones, floods, earthquakes, droughts, tidal waves etc. on the other hand, man made disasters include civil strife, fire, environmental pollution, accident explosion, radiation,

18. R.W. Kates, 'Natural Hazards in human ecological perspective : hypothesis and model' Economic Geography No.47, 1971, pp.438-51.

epidemic and technological lapses. But we are concerned here mainly with natural disasters. Natural disasters can be classified on different basis - either on source of origin, or on the onset period, or on the nature of devastations caused by them.

A. Classification of Natural Disaster on the basis of source of origin -

Natural Disasters

1. Geothermal origin
   a) volcanic eruptions
   b) Tsuanamies
   c) Ground deformations

2. Wind based
   a) storms
   b) cyclones
   c) Tornadoes
   d) Hurricanes
   e) Typhoons
   f) Tidel waves

3. Water based
   a) floods
   b) droughts
   c) Cloud bursts
   d) Dam burst
   e) Excessive rains

4. Seismic origin
   a) Earthquakes
   b) Tsunamies
   c) Avalanches
   d) Land slides
   f) volcanoes

5) Ecological
   a) Flash floods and related land slides
   b) Mud slides
   c) Cavings etc.

B. Another Criterion of classification of natural disaster may be on the basis of onset period -

Natural Disasters

1. Sudden onset period below two hours such as	2. Intermediate onset period between one and seven days	3. Long onset Period between several weeks to a month
a) Earthquakes	a) Tropical cyclones and storm surges	a) Droughts
b) Tsunamies	b) River and coastal floods	b) famines
c) Volcanic eruptions	c) Wind storms	c) Climatic changes (several decades)
d) Nuclear accidents		
e) Chemical spills		
f) forest fires		

C. Natural Disasters are also classified on the basis of nature of origin[19] as -

Natural Disasters

Exogenic	Endogenie	Anthropogenic
a) Floods	a) Volcanoes	a) Subsidence
b) Droughts	b) Earthquakes	b) Reservoirquakes
c) Landslides		c) Collapses of structures
d) Avalanches		

D. Predictability can be another basis of classification-

Natural Disasters

Unpredictable	Predictable
a) Earthquakes	a) Floods
b) Volcanic eruptions	b) Cyclones
c) Land slides	c) Hurricanes
d) Avalanches	d) Typhoons
	e) Storms
	f) Tornadoes

There is a saying "man lives by geological consent subject to change without notice." This single sentence encompasses much of the story of life on earth.[20] Our planet is unique in its ability to give rise to life, sun provides us energy, through earth and atmosphere which

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19. Prof. D.K. Sinha, 'Disaster Reduction for Nineties': Perspectives, Aspects and Strategies'. Calcutta: International Journal Services, 1991, p.27.
20. Arun Bapat, op.cit., p.30.

helps circulations of air, water, dust, sea water, deposition and melting of snow etc. During the course of these dynamic processes, certain natural happenings obstruct the natural or routine functioning of human beings and man tends to call it as disaster or catastrophe.

Amongst all the natural disasters, earthquake, is 'the most gentle disaster'. This may sound paradoxical but it is true. Earth quakes last for few seconds and it does not kill any person. It is the collapse of man made structures which kills men. Earthquakes could not be predicted and wherever it occurs, it takes a heavy death toll, whether it is in San Salvador , Maxico, Aremenia, Bihar, Nepal, China, Iran or Philippines.

Floods

Floods are the most universally experienced hazards. Although flood plain of the world occupies only 3.5% of the land surfaces,[21] yet it supports 16.5% of the World Population. Food occurrences and flood losses are increasing both at regional and global level, despite

21. S.L., Kayastha, 'Floods in India: A Study of their occurance, causes, forecasting and control', NGJI, 29, [illegible], pp.121-141.

flood control measures. Floods are an annual ordeal in India. About 25 m hec. area is flood prove. In 1980, flood loss was estimated at Rs. 4837 million affecting 53 million people and 11.23 m hac. of area of which 50% was cropped area.[22]

Landslides

At times, landslides occur during the post seismic or post flood period. The area of landslides are well-known but systematic record of its occurrence is not available. On an average, about 650 people die due to this catastrophe, every year.

Cyclones

Cyclones are one of the deadliest disasters. Many South Asian and South East Asian Countries are affected by this disaster every year; whenever there is a pressure drop over an area, wind blows from all directions towards the low pressure area. The rotation of earth also exerts a deflecting force (coriolis force) on monsoon winds. The east and west coasts of India are vulnerable to cyclonic damages. Here cyclones occur usually between April-May

22. Ibid., p.137.

called as pre-monsoon cyclonic storm and during October-December, called post-monsoon cyclonic storms. The losses and damages due to cyclonic storms are very heavy. For examples, the November 1977 Cyclone in Andhra Pradesh took toll of about 8,000 lives, 30,000 cattles and property loss of about Rs. 250 crores.[23]

Drought

Drought is one amongst mankind's natural adversary. The term 'Drought' has different connotations in various parts of the world. In Bali, Indonesia, a period of six days without rain is drought; in parts of Libya droughts are recognised only after two years without rain; in Egypt, any year without flood in the river Nile is a drought, regardless of the amount of rainfall. There are various parameters which have been utilized for different types such as Meteorological drought, Hydrological drought and Agricultural drought. In India, agricultural drought is a period of four consecutive weeks with half or less of normal rainfall. Drought prone areas are Gujarat, East Rajasthan, parts of Haryana, West Uttar Pradesh, M.P.,

23. Deccan Chronicle (Hyderabad), 23 Nov., 1977.

interior Karnataka, Rayalseema, South Telegana, and Tamil Nadu. Chronically drought affected areas are western part of Rajasthan and Kutch. Drought conditions leads to famines and starvation conditions. Palamau in Bihar, Koraput and Kalahandi in Orissa are regularly hit by starvation deaths almost every year.[24,25,26]

Lightening, dust storms, hailstorms, heat and cold waves, flash floods, and epidemics are other forms of disasters which inflict misery on human beings but are more or loss localised in extent.

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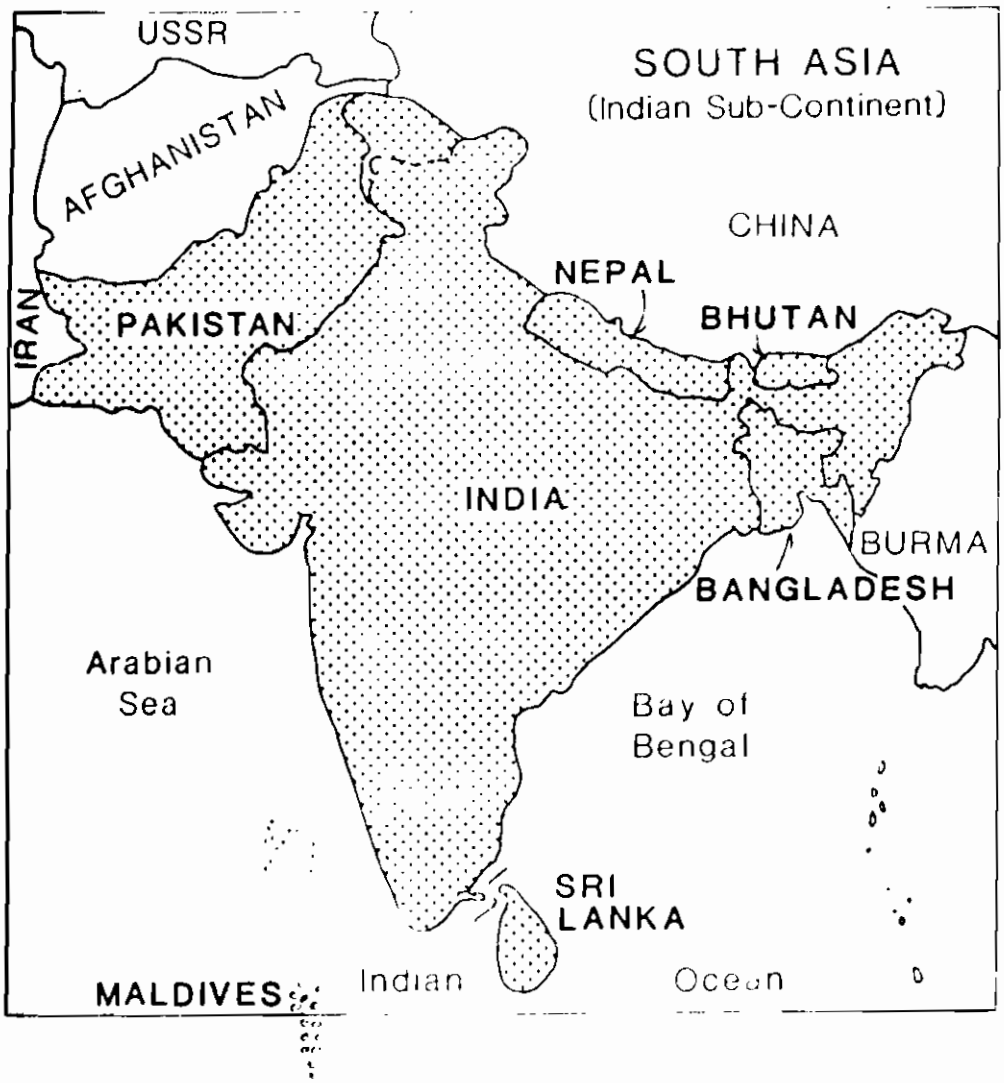
24. Hindu (Madras),16 May 1993, 'The Truth behind the Starvation deaths'.
25. Indian Express (New Delhi), 17th Sept., 1992.
26. Hindustan Times (New Delhi), 19 Sept. 1987, 'Only deaths can end starvation'.

Chapter II

Natural Hazards In South Asia-Their Magnitude And Related Issues


USSR
SOUTH ASIA
(Indian Sub-Continent)
AFGHANISTAN
CHINA
NEPAL
IRAN
PAKISTAN
BHUTAN
INDIA
BURMA
BANGLADESH
Arabian
Sea
Bay of
Bengal
SRI
LANKA
MALDIVES
Indian
Ocean

CHAPTER-II

Natural Hazards in South Asia - Their Magnitude and Related Issues

Natural hazards are a global phenomenon and no country is an exception to them, Inspite of sophisticated technology, the modern world remains very vulnerable to disruption by disasters particular those of meteorological, hydrological and geophysical origin. Natural disasters such as cyclones, floods, fire and droughts are commmon phenomena in South Asia. The densely populated areas of the coastal flood plains bordering the Bay of Bengal and Arabian sea, as shown by the past occurances are dangerously exposed to these calamities, particularly the cyclones and floods. These natural calamities take the administration and the people totally unaware because of the magnitude and disruptness with which they hit, causing widespread devastation and leaving a trail of suffering. Before the local administration is able to plan alleviation measures to deal with one occurance, another recurs throwing all relief measures out of gear through a cumulative impact on the affected population.

Since its origin, humanity has continued to co-exist with natural diasters. Nature has been responsible for destruction of many of the advanced civilizations of the

world. Even though natural disasters donot differentiate between rich and poor countries but it certainly affects over whelmingly the poor people in poor countries. It is the poorer section of society who occupy in majority the disaster prone areas like pockets susceptable to floods, rain storms and earthquakes. For example, in Bangladesh 15 million people live in areas which are less than three meters above the sea level. It is quite natural that due to floods in river Ganges or rise in the sea level after a hurricane these people will be the victims as it happened in 1970 when 1,50,000 to 2,00,000 people were drowned.[1]

Following tables will make the pictures more clear-

Table 2.1

HUMAN AND MATERIAL LOSSES IN DIFFERENT REGIONS 1900 - 1987

Region	Damage millions of dollors	Total no. of deaths
Africa	6,945	21,651
Latin America and the caribbeans	22,422	284,369
Europe including (USSR)	38,747	246,487
Asia and SW pacific	22,663	3,489,320

Source : Compiled from 'Natural Disaster Reduction for Nineties: Perspective, Aspects & Strategies', Based on a report by the Secretary General at the forty-third session of the United Nations on october 18, 1988.

1. A.K. Chatterjee, 'Monsoons, Floods and Cyclones in India', New Delhi: Radiant Publication, 1992,p.79.

Table 2.2

Number of disasters and human loss during 1960-1981 in different economies of the world.

Sl. no.	Category	Number of Disasters	Number of people killed
1.	Low Income Economy	467 (39.24)	10,98,490 (76.06)
2.	Middle Income Economy	644 (54.12)	3,34,990 (23.20)
3.	High Income Economy	79 (6.64)	10,700 (0.74)
		1190	14,44,180

Source : Compiled from 'Economic consequences of 1977 cyclone in Andhra Pradesh', Based on 'Prevention is Better Than cure', Swedish Red cross, 1984.

Note: Figures in brackets are percentage to total.

From the table 2.1 it is very much clear that in developed countries, though the damage to property is higher, the casualities due to disasters are remarkably lower than that of the developing regions like Asia and sw. Pacific. The picture is more clear when we put a glance on the table no. 2.2. Out of 14,44, 180 people killed during 1960-1981 the share of High Income Economy category countries was less than one percent while 76.06 per cent people were killed only in the countries of low Income Economy. However, the number of disaster events in these

economies constituting 39.24 percent of the total disasters. It was found that in middle income economies the number of diasaters accounted for 54.12 percent of the total disaster events where as the number of people killed constituted only 23.20 percent. The country wise data on the number of disaster and people killed in the world during 1960-1981 have been shown in table 2.3.

Table 2.3

Number of Disaster and people kiled in the world during 1960-1981

Name of the country	Number of disaster events 1960-1981	Number of people killed
1	2	3
A. LOW INCOME ECONOMY		
1.Afghanistan	12	540
2.Bangladesh	63	6,33,000
3.Burma	26	1,500
4.Chad	14	2,300
5.China	20	2,47,000
6.Ethiopia	16	1,03,000
7.Gambia	11	200
8.Haiti	17	6,400
9.India	96	60,000
10.Laos	11	400
11.Madagascar	13	420
12.Mali	13	540
13.Mozambique	13	1,100
14.Nepal	19	2,900
15.Niger	12	300
16.Pakistan	21	7,400
17.Somalia	11	19,000
18.Srilanka	18	1,900
19.Sudan	11	310
20.Tanzania	12	590
21.Upper Volta	16	870
22.Vietnam	22	8,800

B. MIDDLE INCOME ECONOMY

1.Algeria	20	3,800
2.Argentina	17	650
3.Bolvia	21	530
4.Brazil	39	4,100
5.Chile	17	8,000
6.Colombia	26	1,800
7.Costa Rica	16	70
8.Dominican Republic	10	3,300
9.Ecuador	21	640
10.Greece	15	190
11.Honduras	13	8,400
12.Hongkong	10	680
13.Indonesia	59	17,000
14.Iran	38	48,000
15.Malaysia	10	310
16.Mauritius	11	20
17.Mexico	37	2,600
18.Morocco	18	13,000
19.Nicaragua	17	1,06,000
20.Panama	11	100
21.Peru	31	91,000
22.Philippines	76	17,000
23.Senegal	16	70
24.South Africa	11	830
25.South Korea	27	2,900
26.Thailand	10	1,300
27.Turkey	33	1,200
28.Yugoslavia	14	1,500

C. HIGH INCOME ECONOMY

1.Italy	24	6,100
2.Japan	43	2,700
3.Spain	12	1,900

Source : Compiled from 'Economic consquences of 1977 cyclone in Andhra Pradesh; based on "Prevention is Better Than cure", swedish red cross, 1984

UNDRO data indicate that the major impact of natural disasters is concentrated among 50 to 60 disaster-prone developing countries mainly located in Asia where

agriculture is the main form of economic activity. The U.N estimated that damages caused by natural disasters in these countries far exceed in absolute terms the external and multilateral assistance received by these countries.[2] These natural disasters have a greater adverse impact on developing than on developed areas since the former have a poorer and less flexible administrative system, a lower potential to benefit from previous learning situations and more primitive and indequate technologial infrastructure. It may be argued that the greater economic dependence of developing countries upon primary production, the greater is their vulnerability to natural disasters.[3]

Data available from the economic and social commission for Asia and the pacific made up of 32 countries in the developing world, which have primary producing agricultural sector, show that between 1961-1974 total cumulative damages caused by monsoons, tropical cyclones and floods were at least in the order of U.S. $300 billion at 1974 market prices[4]. Nearly 200 million acres of areable

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2. Randolph kent, 'Anatomy of Disaster Relief: The International Network In Action', London: Pinter pub, 1987, p. 17.

3. G.K. Mishra and Mathur, 'Natural Disaster Reduction', ed; New Delhi; Reliance publishing house, 1993, p.43.

4. G.F. White, 'Natural Hazards; Local, National, Global', London: oxford University Press, 1974, p. 63.

ricultural land under cultivation were flooded causing estimeable losses to farmers. The situation has indeed d to a startling revelation by experts that the effects natural disasters in disaster prone developing countries nd to cancel out real growth in these countries.

Table 2.4

oss of life by diasater type and by continents 1947- 1980.
See Appendix I

The table clearly shows that Asian continent is the most vulnerable to natural disasters. Out of 12,22 929 casualities,only Asian countries constituted 10,54, 090 i.e. nearly 86.2% casualities. In Asia, cyclones along with typhoon and hurricanes have the highest killing capacity, followed by earthquakes and floods. Only these three disasters namely floods, cyclones and earthquakes cause nearly 95% loss of lives due to disasters in the continent of Asia, we are concerned here mainly with the south Asian countries of this continent.

Now, let us take the disasters which are very much common in south Asian countries and their consequences on the areas of their occurances.

FLOOD

Bangladesh and India are amongst the most flood prone nations on earth. Other SAARC nations which face floods are

kistan, Nepal and Srilanka. It should be noted that though Maldives does not experience floods as in the rest of the SAARC countries, there is flooding of the islands due to storm surges and high waves.

The principal reasons for floods in these five countries lie in the very nature of their natural ecological systems. The monsoon, the highly sedimented river systems and the steep and highly erodible mountains, particularly those of the Himalayan range.[5]

The monsoon affects all SAARC countries. The average rainfall in India is about 1150 mm with significant variations across the country. The annual rainfall along the western coast and western Ghats, Khasi hills and over most of the Brahmaputra valley amounts to more than 2500 mm. Hills and mountains have a striking influence on rainfall levels as in the case of the southern slopes of khasi and Jaintia hills and the higher reaches of Western Ghats.

The heavy spells of rainfall occur in association with the formation and movement of depression or cyclonic storms which originate in the Bay of Bengal and sometimes in the Arabian Sea. The principal rainy season is from June to

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5. B.D. Dhawan, 'coping with floods in Himalayan rivers' Economic and Political weekly, 28 (18), 1 May 93, p.851.

september for almost the entire country, when it comes under the grip of southwest monsoon. Most of the floods occur during the monsoon period and are usually associated with tropical storms or depressions, active monsoon conditions and break monsoon situations.[6]

In the arid areas of India and Pakistan, rainfall is extremely erratic. Years may pass without any appreciable rainfall and then several times the annual mean rainfall may occur in a single month leading to heavy floods.

The river system also plays a crucial role in the causation of flood. Broadly speaking, the riversystem in the subcontinent can be classifed into two groups-namely rivers of the Himalayan region and the rivers of the Peninsula. The three Himalayan rivers, Indus, Ganges and Brahmaputra together with their tributaries are a bane for Pakistan, India, Nepal, and Bangladesh. In India apart from the basin of the three major Himalyan rivers, there are two more flood-prone areas namely the north-west region, which consists of west-flowing rivers like Narmada and Tapi and the central Indian and Deccan region consisting of east flowing rivers like Mahanadi, Godawari, Krishna and Cavery.

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6. Nootan Das, et. al; 'cyclones and depressions over the Indian Seas during 1988', Mausam, 41(1), 1990, p.4,

Economic losses due to floods in the SAARC region

Bangladesh : About 60% of the country is vulnerable to floods. In a normal year 20 percent of the total area of the country is inundated which can riseto 40-60 percent in case of a severe flood year (as in the case of 1987 and 1988). In a normal year, about 30 percent of the cultivable area of Bangladeshis inundated to depth exceeding one meter.

The 1988 floods covered partly or wholly 53 of the 64 districts of the country and affected 45 million people (total population 110 million). Crops on 2 mha of land were damaged out of a cultivable area of 9.5 mha [7]; roads, railroads water control works and social services were seriously disrupted. Flooding reached unprecedented levels in Dhaka, The more serious losses in 1988 were, not in normally flood affected areas but in areas where deep flooding is not an annual event.

In a similar cyclone in 1991 around Chittagong, about 131,000 people were killed.[8] M.Aminul Islam [9] in his study

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7. M.Maniruzzaman Miah,'Floods in Bangladesh: A case for regional cooperation', South Asian Journal, 3 (1&2) July-Dec. 89, p.133.

8. Telegraph (calcutta), 6 october 1991.

9. M. Animul Islam, 'Agricultural adjustment in three villages of Bangladesh' National Geographical Journal of India, Vol. 28 (1&2), 1980, p.56.

3 villages of Bangladesh has shown how the cropping tern and cultural as well as economic life of the llages have adapted to flood.

dia : On an average about 11.9 mha is affected every ar, out of which 5.4 mha are agricultual land. The llowing table shows damage from floods and cyclones from 53 to 1982.

TABLE 2.5

DAMAGE FROM FLOODS AND CYCLONES FROM 1953 TO 1982

See Appendix II

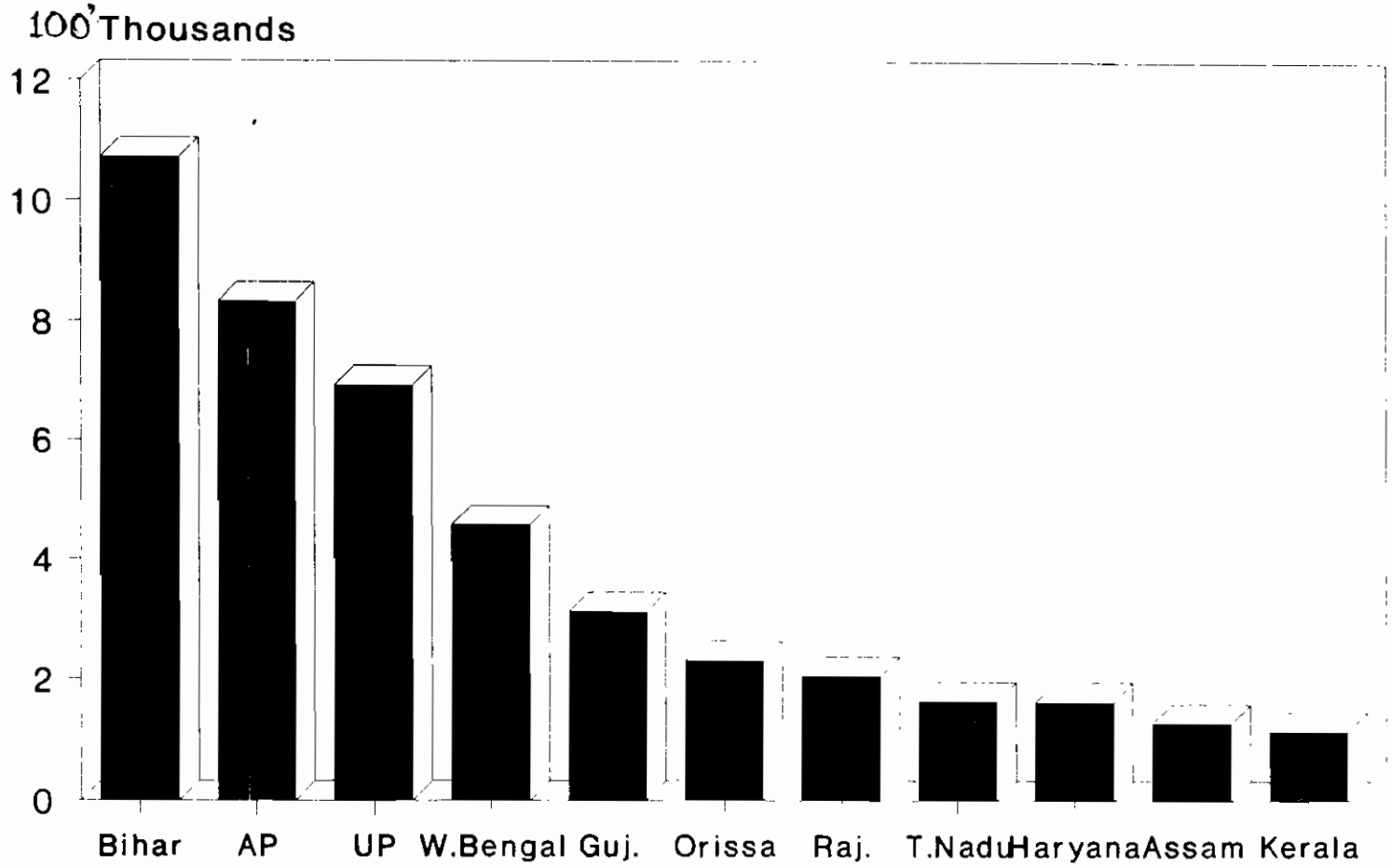
In another study, the average annual flood damages uring the period 1966-78 in various states was done. only hose states are taken where the average loss has exceeded s.1000 lakhs.

TABLE 2.6

Annual Damage during 1966-1978

S.no	Name of state	Annual damage in lakh (Rs)	As percentage of the total in the country
1.	Bihar	10,704	22.8
2.	AP*	8,306	17.7
3.	UP	6,914	14.4
4.	West Bangal	4,569	9.7
5.	Gujrat	3,120	6.6
6.	Orissa	2,303	4.9
7.	Rajasthan	2,049	4.4
8.	Tamil Nandu*	1,631	3.5
9.	Haryana	1,625	3.5
10.	Assam	1,271	2.7
11.	Kerala	1,142	2.4

DURING 1966-1978



12. Total for the country	46,952	--

* Includes figures of damage casued by cyclones source; "National commission on floods " report, volumeI, Govt of India, Ministry of Energy and Irrigation, New Delhi, March 1980, p. 163.

Bihar tops the list of damage and consists 22.8% of the total damage by flood in the country during 1966-78. Flood is an annual feature particularly in north Bihar which is drained by rivers like Koshi, Ganga, Gandak, Burhi Gandak, Bagmati etc. A large portion of area is inundated, of huge loss of crop and property occures and human-beings as well as cattles are killed.

Pakistan : Since 1948 the cumulative losses due to floods have been estimated to be about Rs.. 30,000 million with a loss of about 6,000 lives. In 1955 floods in the Punjab region inundated 2,420 villages levelling 1321 of them. About 400 people and 70,000 cattles died and crops were ruined over 101,911 hec[10]. The Ravi syphon which carried under the Ravi, the link canal taking Chenab water to the Sutlej was destroyed. The damage was Rs 83 million. During the period 1972-1977, three serious floods affected 15 million people in the Indus plain killing about 1600 people

10. 'Report on SAARC seminar on Disaster Management - September 28 - October 1, 1987', Hyderabad: National Institute of Rural Development, 1988, p.24.

[11] The 1976 flood inundated 8 mhec killed 425 and left behind damages totalling Rs 5,800 million.

The July 1 1977 down pour-229 mm rainfall in a single day- led to flash floods in Malir and Lyari rivers in karachi, killing 280 persons and rendering 18,000 homeless.

Two major floods occured in 1988, both of which inflicted heavy loss of life and property in thekasur district of Punjab which lies between the Ravi and the Sutlej.

NEPAL : In Nepal, systamatic monitoring of flood damages has only recently been initiated. Floods and heavy rains and landslides in 1985-86 caused 313 deaths, 122 injuries, a loss of 1853 cattle, 3574 houses and 18 bridges and 16,505 bighas of land were affected in varying degrees. The total loss was about $ 3.96 million. [12]

SRILANKA : The floods following the 1978 cyclone damaged 28 percent of the island affecting nearly a million people inhabiting five districts.

The cost of rehabitilitation and damages due to unprecedented landslides following the 1989 flood was

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11. Ibid, p.26.

12. Ibid., p.32.

estimated at Rs 1.4 billion (equivalent to $ 35.5 Million) The disaster claimed 300 deaths, left 85,000 families homeless, with another 15,000 homes partially destroyed requiring relocation of families to safer sites.[13]

EARTHQUAKES

The Indian subcontinent situated on the boundaries of two continental plates is very prone to earthquakes. All five SAARC nations-India, Pakistan, Nepal, Bhutan and Bangladesh-who have the Himalayan range as their boundary or are in close proximity to it have a long history of seismic tremors. In Maldives and Srilanka, there is no record of any disastrous earthquakes, and these two countries are generally considered as earthquake free.

Massive earthquakes generally occur near the junction of two crustal plates, for example, along the Himalayan range where the Indian plate goes below the Eurasian plate. This is the commonmost form of earthquakes, known as tectonic earthquakes. The other forms being volcanic earthquakes, impact earthquakes (due to impact of meteorities), reservoir induced earthquakes and collapse earthquakes[14]. Some of these have also been found in SAARC region.

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13. Hindu(Madras), 12May, 1989.

14. Martin Degg, ' Earthquake Hazard, Vulnerability and Response', Geography, 78 (2), p.166.

Pakistan occasionally falls victim to earthquakes. Quetta city was completely destroyed by an earthquake in 1935 and 30,000 persons were killed. The epicentre of the earthquake was very near Quetta and its intensity was 7.2 on Richter scale. Though earthquke is a regular feature but no reliable information about their occurance before 1933 is available. The Makran earthquake of 1945 and North west Frontier province (NWFP) earthquake of 1991 were widespread. In the Besham earthquake of 1973, there was loss of 5000 lives in kohistan district.

India has also not escaped major eathequakes. India has been divided into five seismic zones according to the maximum intensity of earthquake expected. Of these zone V is seismically the most active while zone I is the least active. Zone V comprises whole of north east India, the northern portion of Bihar, adjoining Nepal, west Uttarpradesh Hills, Himachal Padesh around Mandi, Rann of Kutch and Andman and Nicobar islands. Zone IV includes Himachal Pradesh, Delhi, parts of Punjab , Uttar Pradesh and Bihar, Sikkim and adjoing West Bengal, a small portion near calcutta, Maharastra near Koyna (south of Bombay and a part of Gujrat). Zone III, II and I comprises remaining parts of the country. It has been shown in fig 2.1.

In India, in present century a severe earthquake hit

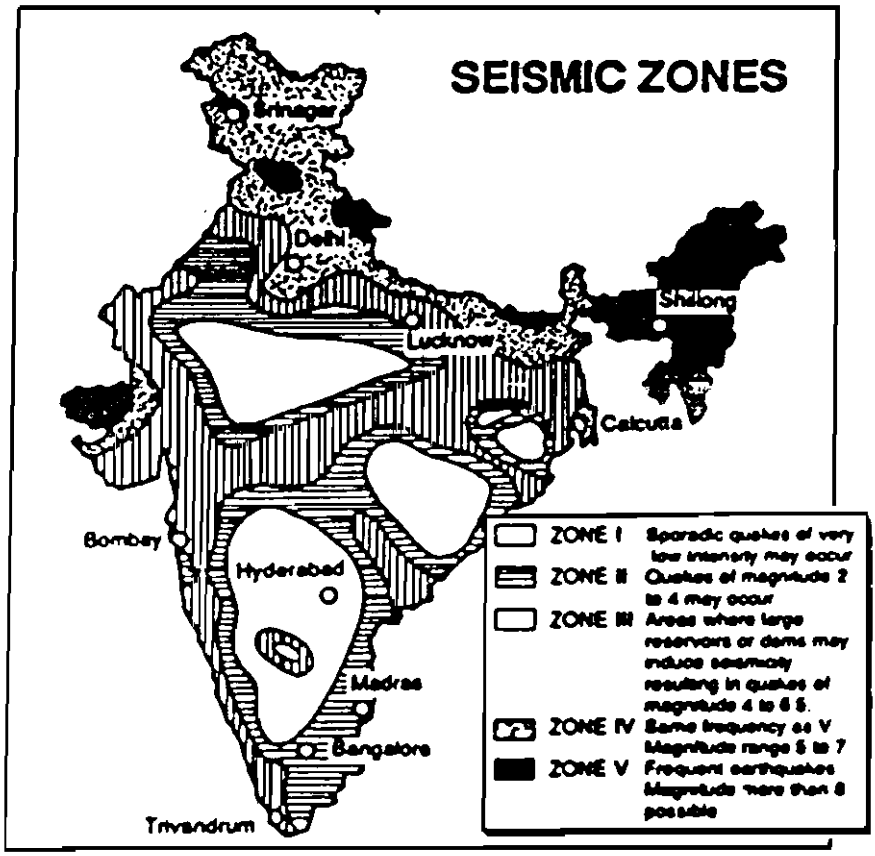
SEISMIC ZONES
Srinagar
Delhi
Lucknow
Shillong
Calcutta
Bombay
Hyderabad
Madras
Bangalore
Trivandrum
ZONE I Sporadic quakes of very low intensity may occur
ZONE II Quakes of magnitude 2 to 4 may occur
ZONE III Areas where large reservoirs or dams may induce seismicity resulting in quakes of magnitude 4 to 6 5.
ZONE IV Same frequency as V Magnitude range 5 to 7
ZONE V Frequent earthquakes Magnitude more than 8 possible

Fig - 2.1

the Indo-Nepal border in 1934. It had an intensity of 8.4 at Richter scale and had taken a toll of 11,000 human lives besides heavy devastations.[15] In the very next year, Quetta region (now in Pakistan) was affected by earthquake killing 30,000 people. In recent times three major earth- quakes occured in Bihar (1988) [16], Uttar pradesh (1991) and Maharastra (1993) with epicentres at Darbhanga, Uttarkashi and Laturrespectively. [17,18] Latur earthquake has erased many villages of latur and osmanabad, leaving none to console anyone[19].

TABLE 2.7

Major Earthquakes of 20th century in India

* See Appendix III

Nepal lying on the southern slopes of the Himalaya is subject to high seismic activity. A chronology of earthquakes of magnitudes six and above on the richter scale

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15. S.N. Saha, 'Earthquakes, prediction and mitigation of Hazards', Science and Culture, Sep. 1989, p.334.

16. Parvathi Menon,' Lost forever- the trails of death,' Frontline, Nov.5, 1993,p.11.

17. Rahul Pathak, 'Lessons from Uttarkashi,' India Today, October 31, 1993, p.69.

18. Raj Chengappa, 'Where Next' , India Today, October 31 1993, p. 54.

19. Parvathi Menon , ' Orphaned overnight,' Frontline, Nov. 5, 1993, p.20.

indicates that between 1800 AD and 1975 AD, 23 major earthquakes have occured in Nepal. Earthquakes of lower intensity occur frequently especially during the rainy season. Observations suggest that large earthquakes occur about once in 50 years. There have been three major earthquakes in the last 55years. The 1934 earthquake, which affected Bihar and Nepal destroyed 3,400 lives in Kathmandu valley along with other two earthquakes which occured in 1980 and in 1988 in the area of Bajhang (western Nepal) and at Udaipur (eastern Nepal) respectively[20].

Bhutan lying in the northern part of the Himalayan belt has a high seismicity rate. Earth quakes of magnitude 7 to 7.5 on the Richter scale have been recorded in the country. The entire country can be taken to be within seismic zone V corresponding to the highest seismic zone of India. Bhutan, how ever has not been hit by any major earthquake in the past. The most recent earthquake which affected the country in August 1988 caused only minor cracks on the Tashgang Dzong. [21]

Bangladesh, particularly the northeastern region, has in the past experienced earthquakes of moderate to high

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20. 'Report on SAARC Seminar on Disaster Management', op.cit., p.76.

21. Ibid., p.78.

intensity. The great earthquake of 1897 which has its epicentre in the shillong plataeu of India, caused wide spread damage. Two other major earthquakes, the Bengal earthquake of 1885 and Srimangal earthquake of 1918, caused several damages in limited area surrounding the epicentre.

Table 2.8

Lives lost in some major earthquakes in South Asia-

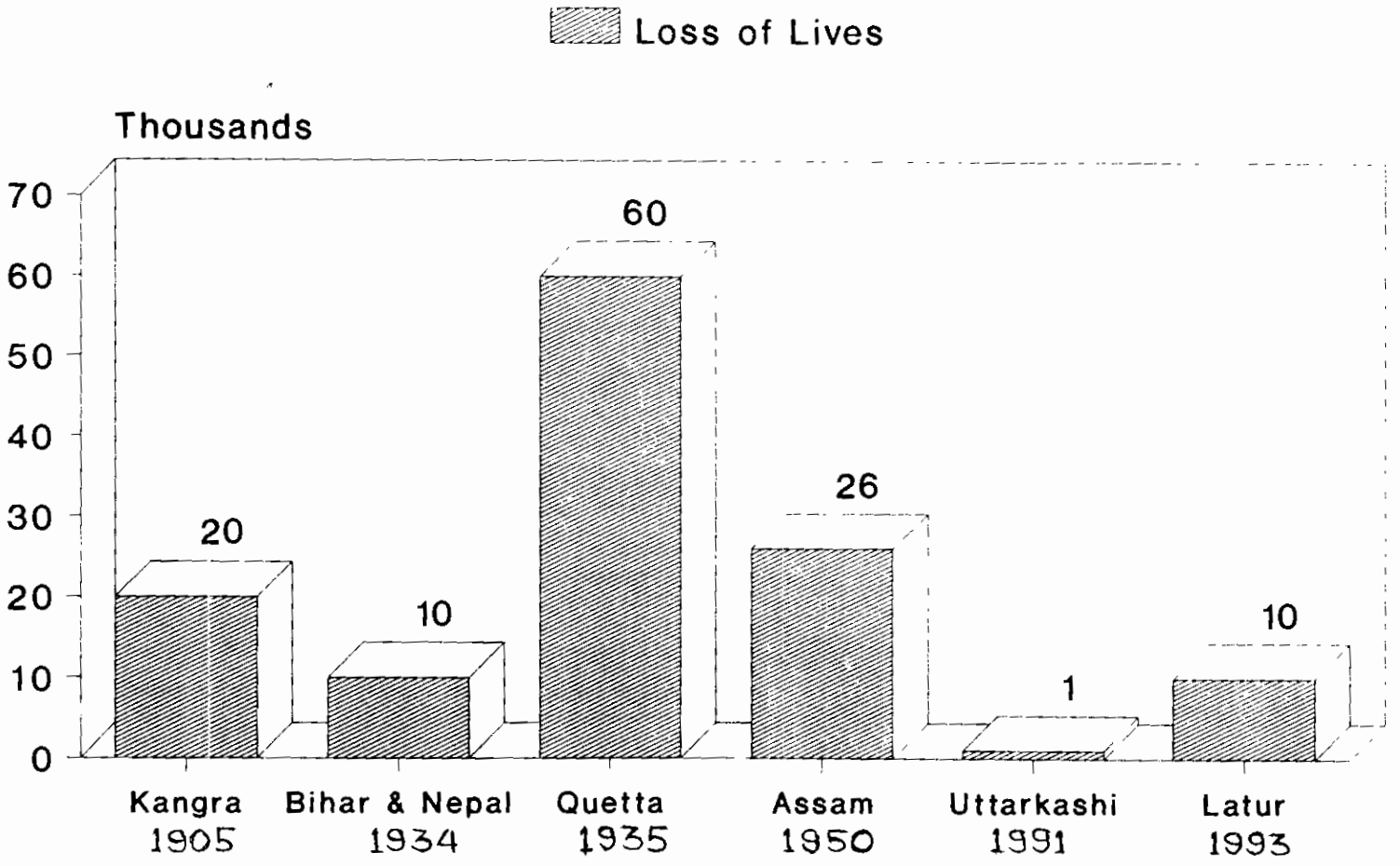
Place		Loss of lives
Kangra	(1905)	20,000
Bihar and Nepal	(1934)	10,000
Quetta	(1935)	60,000
Assam	(1950)	26,000
Uttarkashi	(1991)	1,000
Latur(Maharastra)	(1993)	10,000

Source : 'Report on SAARC seminar on Disaster Management', SAARC Technical committee, National Institute of Rural Development, Rajendranagar, Hydrabad.

DROUGHT

Droughts are the result of acute water shortages, causing severe and sometimes catastrophic economic and social consequences. Out of all the natural disasters common

EARTHQUAKES IN SOUTH ASIA



in the region, droughts effect more people and larger areas than any other. The countries affected by droughts include India, Pakistan, Bangladesh, Nepal and Srilanka. Bhutan and Maldives do not Sufferfrom Drought Problem. The Republic of Maldives, for instance recieves adequate rains both during the southewest and north east monsoons.

The period between the two monsoons is a dry season when Scarcity of drinking water does arise. This is being solved by implementing various schemes to collect rainwater during the monsoon season.

Of all the SAARC countries, India is most affected by drought, especially in terms of the number of people it affects. In India, areas prone to drought are characterised by low annual rainfall (appx. 750mm) with high evaporation, high variation in annual rainfall and lack of assured water availability. The hardcore drought prone areas of the country comprise about 16% of the geographical area and corresponding 11 percent of country's population [22].

The Irrigation commission in 1972 identified two types of areas-drought prone and cronicallydrought prone. Drought prone areas are those with 20% probability of rainfall deficiency of more than 25 percent of the normal rainfall.

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22. P.R. Dudbashi, "Drought and Development,' Economic and Political Weekly, 27 (13), 28 March, 1992, p. 29.

Regions included in this category are Gujarat, east Rajasthan and adjoining parts of Punjab, Haryana, west Uttarpradesh, Western M.P. and interior of Penisular India. A small portion of north west Bihar is also a drought prone area. Chronically drought affected areas are those which have a 40 percent probability of rainfall deficiency of more than 25 percent of the normal rainfall. They cover the western part of Rajasthan and kutch region of Gujarat[23].

In Pakistan, the effect of drought has been controlled through its massive canal network but in some areas drought remains chronic. Baluchistan province is extremely dry almost half with less than 125 mm and extreme variability in annual rainfall. Drought is also frequent in Thar desert.

Though Bangladesh is free from annual aridity, there is an existence of seasonal aridity of four to six months in north eastern and north western regions. Drought is thus a temporary, especially irregular and non- periodic phenomenon affecting small parts of Bangladesh. While only the chittagong region is completely drought free, except for its southan tip, Bogra and Noakhali have the maximum numbers of drought years Drought conditions in Bangladesh vary from

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23. V.S. Ramakrishna, 'Studies on the incidence of droughts over Western Rajasthan' National Geographical Journal of India, 26 (1&2), 1980, pp. 45.

region to region reaching from the lowest in Rajashahi region to the highest in Sylhet region.

Nepal lacks the information on dryland issues. In Terai region there is favourable groundwater conditions because of a vast network of rivers. But the definition of drought is subject to multiple interpretations and drought can occur even under conditions of high rainfall. Drought conditions prevail in the far western development region of Nepal, where rainfall is insufficient because of the monsoon arrives two to three weeks after it touches the eastern border of the country.

In Sri Lanka, the dry zone area generally superimposes the drought-prone area of the country. On the basis of an average annual rainfall, the country has been divided into three zones which are wet, dry and intermediate zone. Dry zone has an average annual rainfall below 1900 mm ; Intermediate zone is between 1900 mm and 2500 mm and wet zone between 2500 mm and 5500 mm. In the extreme north west (in the Manner Kalpitiya area) and in the extreme south east (yale area), the mean annual rainfall is below 1000 mm. After the severe drought of 1935-37, severe droughts have occured during the periods of 1947-49, 1953-56, 65, 1974-77 and 1981-83. The major droughts of 1953-56, 1974-77 and

1981-83 caused major setbacks to the agricultural communities in Srilanka.[24]

In South Asian countries, agriculture production are highly dependent on rainfall. so drought has a number of short term and longterm effects on the affected area. For example 60 percent of the rice area in India is rainfed. So foodggrain production is an important indicator of rainfall pattern. Prolonged drought has a direct impact on poverty. When the drought strikes, thousands of acres are left unsown and consequently wage earning drop, leaving thousands of people unemployed.[25]

TABLE 2.9

Years of severe and calamitious drought in India.

Year	Area affected (million Sq. km)	% Area of the country affected	category
1877	2.03	64.7	calamitous
1899	1.99	63.4	calamitous
1972	1.39	44.4	servere
1987	1.55	49.2	severe

Source : Compiled from 'Disaster Management' (A Report) GOI, New Delhi, 1987.

24. Report on SAARC seminar on Disaster Management' op.cit. p.84.

25. S.S. Acharya, 'Drought and response of rural families.' Economic and Political weekly, 27(36), 5 sep. 1992, P. 1895.

Table 2.10

Drought Prone Areas of Different Countries of South Asia

Country	Drought prone Area(mha)
Bangladesh	5.74
Bhutan	---
India	52.8
Maldives	---
Nepal	N.A.
Pakistan	N.A.
Sri lanka.	3.2 (of Dry zone)

Source : Compiled from 'Regional study on the causes and consequences of Natural Disaster and the protection and preservation of Environment', SAARC secretariat, kathmandu, 1992.

MASS WASTING AND LAND SLIDES

The hazards of landslides is mainly concentrated in the Himalayan region of Pakistan, India, Nepal and Bhutan, though other parts of India, Bangladesh and Srilanka also suffer from it. Maldives is totally immune to this problem.

Around 30 percent of the worlds lands-lides occur in the Himalaya. The Himalayan mountain constitute the youngest and the most dominating mountain system in the world. It comprises a series of seven curvilinear parallel

folds running along a grand arc for a total of 3400 km. The total landmass covered by the mountain range is approximately 50 million hectare. Because of its unique nature, the Himalaya has a history of landslides having no comparison with any other mountain range in the world.[26] The unscientific exploitation of the Himalaya, deforestation and indiscriminate construction, mining and quarrying activities have combined with its immature and complex geology, seismic activity and heavy rainfall including flash floods, to create instability problem.

In Nepal landslides is a major natural disaster. They occur annually particularly in central and western development region of Nepal. The average annual loss of land and cattle was estimated Rs 6.5 million between 1970- 1980. As in the other SAARC countries improper mining and road building in Nepal have served to aggravate mass wasting. Livelihood pressures have forced marginal farmers to extend cultivation to fragile hill slopes. Forest fires have also added to the instability. These fires are often started by villagers in search of more land for cultivation or for pastures. These activities have aggravated soil erosion

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26. 'Regional study on the causes and consequences of Natural Disasters and the Protection and Preservation of the Environment, Kathmandu: SAARC Secretariat, 1992, p.154.

and triggered mass wasting . In 1978, 125mm of rainfall fell within a few hours in the 'Tinau' wasteland. The result was the blockage of river and the subsequent overtopping of the natural dam. The consequence was the wiping away of Dauretole causing colossal damage of life and property.

In Bhutan, the natural susceptibility is high owing to its steep terrain, the continuing tectonic activity in the Himalayan region and the down cutting of the river systems. In June 1990, numerous sporadic landslides occured as a result of heavy rains blocking most of the major highways of Bhutan.

In India, landslides occur both in the Himalayan mountains and in the western Ghats in the south, along the steep slopes overlooking the Konkan coast. Landslides are also very common in the Nilgiri range, characterised by a lateritic cap which is very sensitive to mass movements. In the Nilgiris, in the 1978 alone triggered about one hundred landslides which caused severe damage to communication lines, tea gardens and other cultivated crops. A valley in the Nilgiri hills is called 'Avalanches valley'. This area is covered by loose cover of debris consisting of boulders. In recent times two major landslides occured in this region, one in November 1978 and another in July 1983.[27]

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27. Ibid, p.156.

Cloud bursts and flash flood accompanied by heavy rainfall is the main cause of landslides in India. Accumulation of boulders and massive rocks, transported by the turbulance of fast flowing rivers, throttles the narrow river passage. This builds up a reservior of tapped water which ultimately forces the debris out and in the process causes landslides in the surrounding hill regions.

Mass wasting is a very common phenomenon in Pakistan especially in mountain region of the north and northwest. During rainy season, landslides take place along the highways built in mountain terrain such as the Murree Hills, Pir panjal and the Hindukush. Mass wasting is also common in Baluchistan and the hilly areas of Sind province.

Srilanka has also been experiencing increasing occurance of landslides in its central hill country and southwestern region since the early 1980's . This is evident from the fact that while the first six decades in this country recorded only six major landslides, since 1981, there have already been six major landslides in 1981,1984,1985,1986,1989 and 1990.[28] The Jaunuary 1988 landslides were the most widespread.

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28. Ibid,p158.

CYCLONES

Except for two land locked countries of Nepal and Bhutan, all the other five SAARC nations are affected by cyclones, tidal waves and their compounding effects. Cyclones may have peripheral effects even on Nepal and Bhutan. Because of their extensive coastlines India, Bangladesh, Pakistan,Srilanka and Maldives have suffered from sea based storms in varying degrees. Although only about seven percent of the global tropical cyclones occur in the north Indian ocean, they are the deadliest in the world. The Bakerganj cyclone of 1876 and the cyclones of 1970 and 1991 have caused extensive damage to property and each killing more than 2,000,000 people in Bangladesh.

Bangaldesh has the worst record of cyclones and tidal surges. Cyclones andtidal surges are frequent in the months of October and November. They destroy crops,damage infrastructure, houses and vital installations and cause widespread health hazards for the people. They occur so frequently that they have multiplied problems of poverty.

Cyclonic storms and storm surges are much more common on the east coast of India than on the west coast. India Meteorological Department has been collecting data on cyclonic storms for well over a century. The study of previous hundred year history shows that the incidence of

cyclonic storms (wind speed between 34 knots and 63 knots) and severe cyclonic storms (wind speed between 64knots and 89 knots) reaching Tamil Nadu and Andhra Pradesh is high during the post-monsoon season where as the Orissa-west Bengal coast has higher storms during monsoon and summer season. In Srilanka, devastating cyclones are rare. Major storms usually affect sparsely populated coastal areas of the east and northwest parts. The cyclone season of Srilanka is from November to December as 83 percent of cyclone occurances, which have reached its east coast, have been during this period. Out of 12 cyclonic storms between 1881-1980, only four have been severe.

Maldives has a unique situation. It has a large number of small islands with an average height of 0.8 m to 2m above sea level. The islands are exposed to continuous attack of waves and currents. But as these islands have been formed at the rim of atolls, a natural defence is being provided by coral reefs. These reefs act as a natural breakwater for islands and the protection of coral reefs is very crucial for the survival of these islands. Maldives is not subject to cyclones.

Cyclones and storm surges along Pakistan's 1120 km. long coastline are not so disasterous as the country is not located in the region of cyclonic storms.

It is very much clear that vulnerability to disasters is linked to poverty and therefore the developing countries find it more devastating as compared to that of the developed nations. Among the developing contries also the SAARC countries are in a still worse situation. India alone had 80 percent of the world's victims of drought in the seventies and during 1960-81, 70 percent of the flood vicitims in the world were from India and Bangladesh.[29]

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29. B.D. Burman, 'Coping with floods in Himalayan rivers', Economic and Political Weekly, 28 (8), 1 May 1993, p. 849.

Chapter III

Cyclones In The Bay of Bengal : Pattern And Incidents

CHAPTER III

Cyclones in the Bay of Bengal: Pattern & Incidence

Cylones are the deadliest among all natural disasters. They have been a subject of great interest for many centuries all over the globe particularly in the tropical countries. Tropical Revolving storms are known by different names, according to the part of the world in which they occur. They are known as typhoons in Western North Pacific and China seas, hurricanes in Western North Atlantic, Eastern North Pacific and Western South Pacific, 'Baguios"' in the Phillippine region, 'willy willies' in the Australian waters, and as 'cyclones' in the Arabian sea, Bay of Bengal and Southern Indian Ocean[1]

A 'cylonic storm' or a 'cylone' is an intense vortex or a whirl in the atmosphere with very strong winds circulating around it in anticlockwise direction in the Northern Hemisphere and in clockwise direction in the Southern Hemisphere.

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1. P.A. Menon, 'Our Weather', New Delhi: N.B.T. Publication, 1989, p.140.

The word 'cylone' is derived from the Greek word cyclos' meaning the coils of a snake. To Henri Peddington, the tropical storms in the Bay of Bangal and in the Arabian Sea appeared like the coiled serpents of the sea, so he named these storms as "cyclones" [2]

The criteria followed by the World Meteorological Organization (WMO) and adopted by the Indian Meteorological Department of India to classify low pressure systems are as follows.[3]

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2. Hazards of cyclones, New Delhi: I.M.D. Publication, 1989, p.1.

3. Ibid, p.1.

Table 3.1

Types of Distrubances	Associated wind speed in the circulation
1. Low pressure area	Not exceeding 17 knots
2. Depression	17 to 27 knots
3. Deep Depression	28 to 33 knots
4. Cylonic storm	34 to 47 knots
5. Severe cyclonic storm	48 to 63 knots
6. Severe cyclonic storm with a core of a hurricane winds	64 knots and above

1 knot = 1.85 km per hour

A full blown cyclone is 150 to 1000 km across, with winds of 120 km/hr or more and 10 km high, spiralling round a centre of very low pressure. The central calm region of the storm is called the 'Eye', the diameter of which varies betwen 30 and 50 km and is a region free of clouds and has light winds, clear skies and no rain. Around this calm and clear 'eye' , there is a 'wall cloud region' of the cylone, about 50 km in extent where gale winds, thick clouds with torrential rain, thunder and lightning prevail. Away from

the 'wall cloud region' the wind speed gradually decreases. However, in severe cyclonic storms, wind speeds of 50 to 60 kmph can occur even at a distance of 600 km from the storm centre.

The gales accompanying a cyclone give rise to confused seas, torrential rains, occasional thunder and lightning flashes under an overcast sky. The cyclone usually aproaches at 300 to 500 km per day and crosses or skirts along the coast. A sudden rise in sea level is often associated with this, and is known as 'storm surge", It is a storm surge which is responsible for much of the death and destruction. The cyclone that hit the orissa coast on 3rd

June 1982 generated a surge of 3.5 meters. [4]

Cyclones fall into three general classes—

1. The wave cyclone of middle and high latitudes (also called extratropical cyclone): It ranges in severity from a weak disturbance to a powerful storm.

2. The Tropical cyclone of low latitude over ocean areas: It ranges from a mild disturbance to the terribly destructive hurricane or typhoon.

3. The Tornado: Although a very small storm, it is an intense cyclonic vortex of enormously powerful winds.

Cyclones of middle and high latitudes depend for their development and sturcture upon the coming together of large bodies of air of contrasting physical properties. A body of air with fairly uniform upward gradients of temperature and moisture over a large area is known as an airmass. In extent, a single air mass may be of

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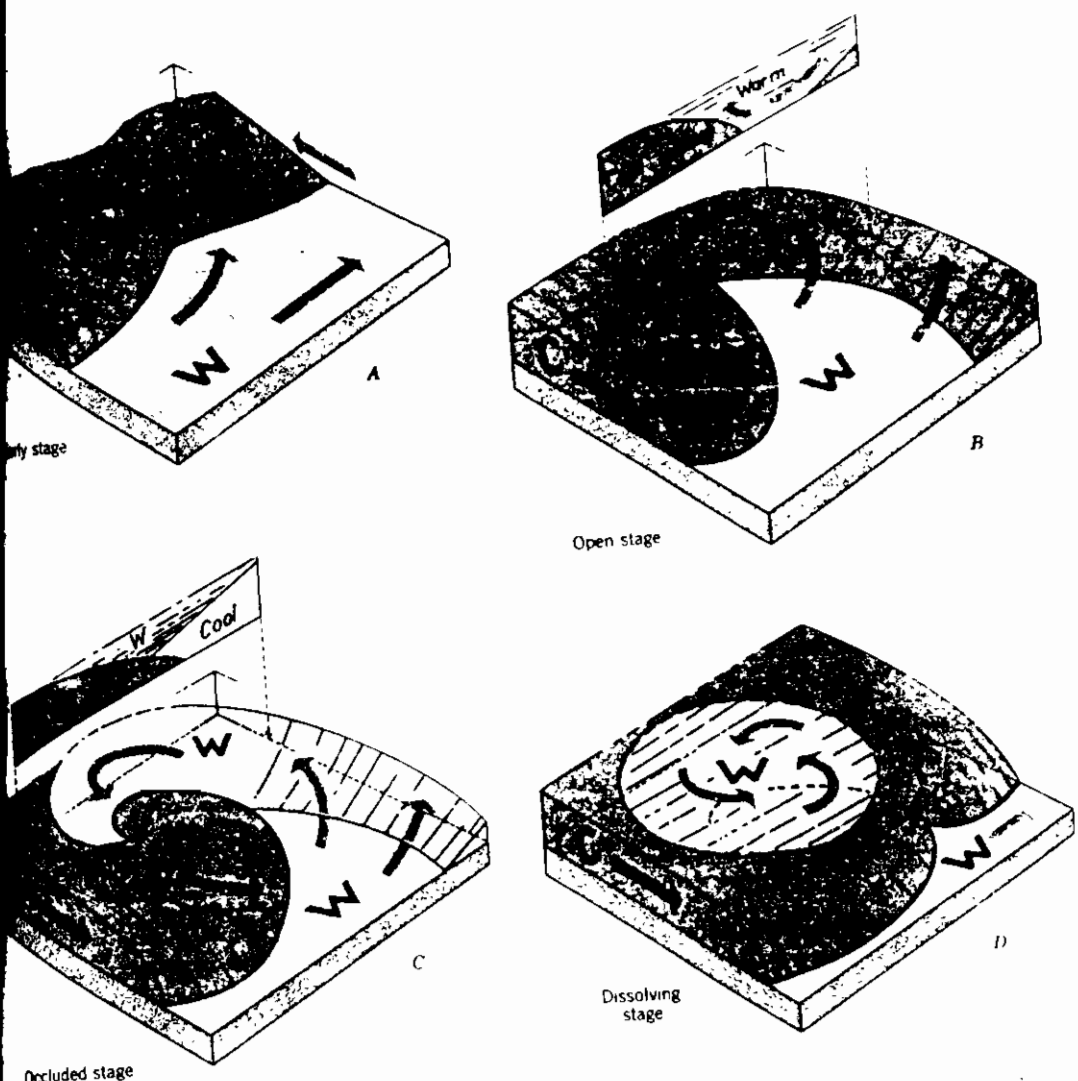
4. B.K. Basu, 'Storm Surge associated with the Paradip cyclone of 1982' Mausam, 37 (3), 1986, pp. 343-346.

subcontinental properties and in vertical dimension it may extend through the troposphere. A given air mass may have a rather sharply defined boundary between itself and a neighbouring air mass. This discontinuity is termed as 'front' [5]

A series of individual blocks, in the figure shows the various stages in the life history of a wave cyclone. At the beginning of the cycle, the polar front is a smooth boundary along which air is moving in opposite directions. In block 'A' of the Figure '3.1 ' block A, the polar front shows a bulge, , beginning to form a wave. Cold air is turned in a southerly direction, warm air in a northerly direction, as if invading the domain of each other. In Block-B, the wave like disturbance along the polar front has deepened and intensified. Cold air now pushes southward along a cold front and warm air now actively pushing north eastward along a warm front. Each front is convex in the

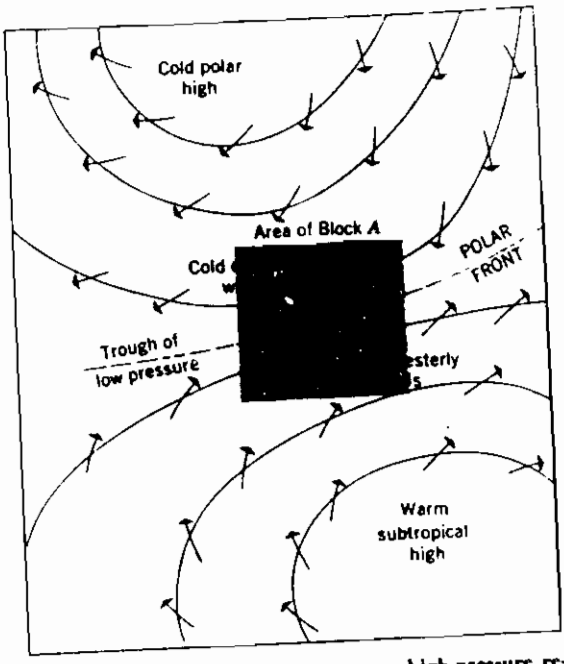
5. H.J. Critchfield, ' General climatology,' New Delhi: Prentice Hall of India, 1987, p. 108.



The development of a wave cyclone.

Fig – 3.1

Source: Strahler, Arthur N, (Physical Geography' Singapore : John Wiley & Sons 1975, p. 189.



6 The trough between two high-pressure regions is a likely zone for development of a wave cyclone.

Fig. 3.2

Source : Strahler, Arthur N (Physical Geography
Singapore : John Wiley & Sons. 1975
P.188.

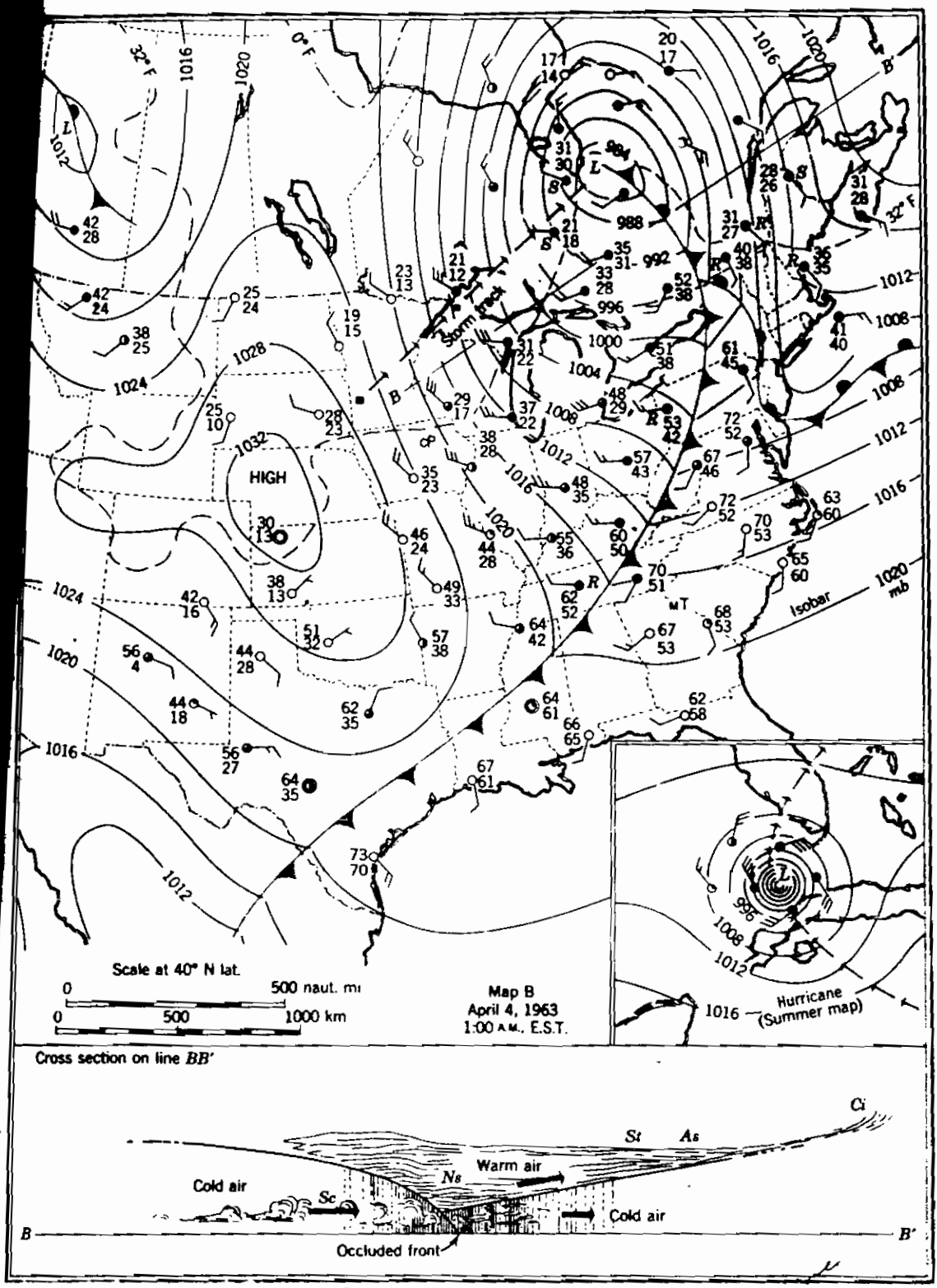

HIGH
Storm track
Isobar
MT
Scale at 40° N lat.
0 500 naut. mi
0 500 1000 km
Map B
April 4, 1963
1:00 A.M., E.S.T.
Hurricane
(Summer map)
Cross section on line BB'
Ci
St
As
Ns
Warm air
Cold air
Sc
Cold air
Occluded front
B
B'

Fig. 3-3.

direction of motion. There is now a considerable zone of precip-itation which is wider along the warm front than along the cold front. The cold front moves rapidly and consequently reduces the warm air to a narrow sector. In Block C, cold front overtakes the warm front, producing an occluded front and forcing the warm air mass off the ground, isolating it from the parent region of warm air to the south. In Block D, it has been shown that how the source of moisture and energy has been cut off. As a result the cyclonic storm gradually dies out and the polar front is reestablished as in its original position.

Tornado - is the smallest but most violent of all known storms. It is a small, intense cyclone in which the air is spiralling at tremendous velocity. It appears as a dark funnel cloud, hanging from a large cumulonimbus cloud. At its lower end the funnel may be from 90 to 460 mt. in diameter. The funnel appears dark because of the density of condensing moisture, dust, and debris swept up by the wind. Tornadoes are more speedy than any other storms. The estimated wind speed is as high as 500 mi (800 km.) per hour. A violent updraft also occurs in the funnel along with

the movement. As the tornadoes move across the country, the funnel writhes and twists. The end of the funnel cloud may alternately sweep the ground, causing complete destruction of anything in its path and rise in the air to lease the ground below unharmed.[6] The destruction is caused by pressure gradient of the vortex. They occur in greatest numbers in the central and south eastern states and are rare over mountains and forested regions. They are almost unknown from Rocky Mountains westward and are relatively fewer on the Eastern sea board. It seems to be a typically American Storm, being most frequent and violent in the United States.

Tropical cyclones- 'From a vantage point in space the tropical cyclones look to be quite innocent, small flat spirals, drifting on the sea, gently eddies in the endless flow of the planet's atmosphere. But when they meet the shipping lanes, inlands and the coasts of continents, they prove to be extremely fatal[7]. One of the most powerful and

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6. Arthur N. Strahler, 'Physical Geography, ' Singapore: John Wiley & Sons, 1975, p.189.

7. G.S. Mandal, 'Tropical cyclone and their warning system' in G.K. Mishra and G.C. Mathur, Natural Disaster Reduction, New Delhi: Reliance Publishing House, 1993. p.123.

destructive types of cyclonic storms, the tropical cyclones are the off spring of ocean and atmosphere. They are powered by the heat from the sea, driven by the easterly trades and temperate westerlies, the high planetary winds and their own fierce energy.

Formation: Tropical revolving storms (TRS) develop only under favourable conditions when certain prerequisites are fulfilled. They originate in large sea or ocean areas where the sea surface temperature (SST) is over 26 degree c. This apparently is the threshold value to maintain a steep vertical lapse rate. This temperature is also required to ensure that the air from the lowest layers which undergoes adiabatic expansion and condensation remains warmer than the surrounding to about 12 km. Tropical cyclons generally form in a pre existing Synopitc system such as - wave in the equatorial trough, easterly wave, mid-tropospheric trough or a low pressure area on the surface. This is the starting mechanism.

All disturbances donot develop into cyclones, only a few grow under a combination of favourable circumstances. A

certain minimum value of the coriolis force is required to provide the initial torque. This means that cyclones donot form near the equator (about 5 ^{o}latitude on either side). A mechanism is required to remove the rising air in the upper troposphere by rapid divergence in order to facilitate the deepening of the surface low. That is why cyclones intensify when the low level distrubance is situated underneath a high level anticylone. The vertical wind shear in the basic current must be weak. This condition limits the formation of cyclones to latitudes far equatorward of the STJ. cyclones develop near the ITCZ, away from the equater where the SST is over 26^{o}c. That is probably why no cyclones form in the South Atlantic Ocean where the ITCZ remains always north of the equator and the SST is lower than 26^{o}c.[8]

The energy for the development of the intense vertical storms is provided by the CISK. The inter tropical convergence zone (ITCZ) where the trade winds of the two hemisphere meet is a region of high radiation energy which suplies latent heat for evaporation of sea water into the

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8. P.A. Menon, op.cit, p.141.

air. The moist unstable air rises, generates convective clouds and leads to an initial disturbance with a fall in surface atmospheric pressure and convergence of surrounding air towards the area of low pressure.[9]

The latent heat released in convective precipitation further fuels the development of the weather system by a process called Convective Instability of the Second kind (CISK). Thus a weak tropical disturbance amplifies into a tropical revolving storm under favourable moisture conditions. The threshold SST is greater than $26^{o}c$, enables intense and sustained convection in an oceanic region of radius of nearly 100 km.

Evolution of Tropical Cyclone : ATRS has a definite life cycle.[10] The evolution has four phases-

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9. Nootan Das, et. al., 'Cyclones and depressions over the Indian ocean during 1988' Mausam, vol.41, No.1, 1990, pp. 1-10.

10. P.A. Menon, op.cit, p. 142.

I. **Formative Stage:** A tropical disturbance is noticed in a large oceanic area where winds become variable with thundersqualls. This state extends from LPA (Low Pressure Area) to SCS (Single Closed System) when an eye and eyewall are formed. Pressure falls slowly and the central pressure defect of the order of 10mb.

II. **Immature Stage:** There is rapid fall in the central pressure, reaching the lowest limit. Clouds and rain get organised into spiral bands. Area of strong winds remain small but winds attain the maximum speed.

III. **Mature Stage :** In this stage there is fall in pressure and consequently wind increase is arrested. The circulation expands outwards and asymmetry sets in as the area of rain and gales extends much more to the right in the direction of motion of the system. This stage lasts for few days.

IV. **Dissipating Stage:** The decay of the TRS starts when the system enters land on an oceanic region where SST is lower than 26^0c. On land sufrace, the moisture supply is drastically curtailed, cutting off the energy

input and also there is dissipation due to increased frictional drag. As a result the winds decrease, the cyclone fills up and weakens, though the rainfall may persist for two more days.

In the past, storms could be spotted only by ships at sea in their initial stage and often they struck coast without prior warning. Ships at sea used to be caught unawared and were the worst sufferers. Now, Weather radars, aircraft, reconnaissance and satellite imagery enable us to spot and track cyclones through their entire life cycle.[11] Drop Sondes and probes by special instrumented aircraft have provided a large volume of data on temperature, pressure, winds etc. within the cyclone fields. From the analysis of data obtained from these various sources e.g. radar, aircraft and satellite, a fairly reliable three-dimensional structure of TRS, has emerged.

Horizontal Structre : A full-fledged cyclone has three well defined components[12]-

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11. H.J.Asthana, 'Radar observation of thunder storms from cyclonic disturbances,' Mausam, 31 (4), 1980, p.43.

12. P.A. Menon, op.cit., p.145.

(i) **Eye** - The innermost or central portion of the mature cyclone is the 'eye'. It is about 10 to 30 km. in diameters, depending upon the size of the storm and is more or less calm region with little or no clouds and some subsidence. The eye or the calm can be described variously as the:-

- pressure eye : where MSL pressure is the lowest.
- wind eye : light or calm wind conditions.
- radar eye : the eye seen in radar echoes.
- satelite eye : dark spot seen in the cloud mass in satellite imagery.

All eyes not necessarily always coincide. In the warm core system the temperature inside the eye region can be as much higher as 10^{0}C than the surroundings.

(ii) **Eye wall or Inner Ring** - Surrounding the 'eye' is a tight 'inner ring' of hurricane winds which have velocity of 63 kt. This core of maximum winds is at the centre of a solid thick wall of towering cb clouds, 30 to 50 km wide round the 'eye' and is referred to as the 'eye wall'. Incessant lightning keeps the entire eye wall-illuminated, making it a fascinating and awesome

spectacle. This is a region of violent thundersqualls and torrential rains. The eye and eyewall together constitute the core of the 'cyclone'.

(iii **Outer Ring** - 'Outer ring'is the region beyond the 'eyewall' of cyclonic circulation where the wind speed decreases steeply and clouds, rains etc diminish rapidly outwards. The winds fall off to about 40 kt at a distance of approximately 200 km. The cyclones vary in size. The smallest ones are only about 150 km in diameter. While big cyclones can have a diameter of 1500 km.

Tracks of Cyclone :-

The lifespan of TRS , averages a week. The larger the sea area, the more intense the storm grows. When fully developed, storm is a violent whirl 200 km to 1500 km across, 6 km. to 8 km high, spiralling around the centre and progressing like a spinning top on the ocean surface, at a speed of 10 to 30 km/hr, covering a distance of 300 km to 500 km a day. It is steered by the high level zonal easterlies and moves from east to west. There is a tendency to move into areas of warm waters. They weaken if they enter

colder water (less than 26^0C). There are preferred regions of cyclogenesis, when the storm strikes coast, it weakens.

Once the cyclones reach higher latitudes, they often change their direction and move north and then northeast in northern hemisphere and south and south-east in the southern hemisphere. This process is known as recurvature[13]. Before it recurves, the speed decreases and the system remains stationary for a day or more. Once the recurvature commences, the storm picks up speed and thereafter moves rapidly. Often, the steering current and the position of the high level anticyclone determine the track. When two cyclones exist near each other, they interact and move anticlockwise with respect to each other. The track of cyclones may be a zig-zag or a loop. Cyclones move along the periphery of the high level anticyclone. Once they cross the

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13. Ibid., p. 146.

latitude of the ridge line of the anticyclone, they come under the steering influence of the zonal westerlies and move in an easterly dirction. In India, when cyclones recurve, they get broken up over the Himalayas and hence there is no further eastward movement. After recurvature, once a TRS reaches temperate latitudes, it may acquire the characteristics of an extratropical cyclone, as it happens sometimes in the Atlantic and the European regions.

Storm Surges - In a cyclonic storm in open sea, there is a rise in the water level due to the low pressure and is known as 'inverted barometer wave'. These waves are as high as 20 meters and travel long distances affecting the water of 20 meters depth. Consequently, compensating sub-surface counter currents are set up and hence the water does not pile up very high in the open ocean. When the storm approaches the coast, the counter current gets retarded, making the water level rise. This is the 'storm surge' which hits the coasts as a solid wall of water with the speed of the hurricane winds. The height of the surge depends on various factors, the shape of the coast line and the area of spread of the piled up water being the most important factor. Other

factors may be funnelling of water into enclosed region (such as Bays) gentleness of the continental slope, angle between the coastline and the storm track or superimposition of storm surge upon astronomical tide etc. Mr. Basu[14] has obtained the correct magnitude of storm surge generated by the Paradeep cyclone of 1982. For this he has based his study on the data available from tide gauges and post storm surveys condcuted by India Meteorological Department and Government of Orissa.

The three-dimensional picture of tropical revolving storms has been constructed out of the composite data accumulated from radar picture, Aircraft Raccee Probes, satellite imagery etc, mainly over the Atlantic and Pacific. Data from the Indian ocean have been meagre. In spite of wide variations and differences in the characteristics of individual storms, a generalised but fairly realistic picture of TRS, has been built up. Many studies have been done on various aspects of cyclone-origin and related phenomenon. AVM. S. Lakshminarayanan[15] has shown that

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14. B.K. Basu, op.cit, pp. 343-346.

15. AVM. S. Lakshminarayanan, 'Role of convection in cyclone,' Mausum, 38(1), 1987, pp. 15-22.

hurricanes, typhoons and cyclones are associated with convective clouds. Moisture convergence due to cyclone in lower layers of atmosphere adjacent to earth's surface makes convective cloud formation possible and the heat energy released by the condensation of water vapour contributes to cyclone growth and intensification of cyclones. This cooperative intensification process is called Convective Instability of Second Kind (CISK). He has shown two factors common in cyclone and convective intensification-cross isobaric flow and vertical motion. Brij Bhusan[16] has given a quantitative approach for determining the movement of depression/cyclone. He has argued that centre of a well marked low pressure system should theoretically move in the direction of vector. The initial point of the vector is at the centre of low pressure system (LPS) from where the system moves to next position. But this new position should show tendency of generation of absolute positive vorticity, i.e. a low pressure system shall move to an area in its vicinity, where positive vorticity field is developing at a faster rate. Through a Quasi-Lagrangian Model (QLM),

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16. Brij. Bhushan, 'A quantitative approach for determing the movement of depression/ cyclone' , Mausam, 41,1, 1990,pp.119-124.

Mathur[17] has presented a numerical prediction model for tropical cyclone motion. QLM has recently been implemented at the National Meteorological Centre for the operational prediction of Hurricanes. In this system idealised initial stages of hurricanes are used. Because of lack of data, the circulation of a storm is not well represented in the operational analysis. An idealised vortex, is therefore superimposed on the analysis to stimulate the observed storm. A numerical result show that the motion of a tropical storm depends on its initial size and intensity. Chakraborty and Bandopadhaya[18] in their studies of influence of solar activities on cyclonic disturbance over Indian seas have shown a negative correlation between number of cyclonic disturbance and the sunspot number. While the study of Kalsi and Jain[19] underline the role of westerly troughs and boundary layer convergence, which lead to intensification of marginal cyclones into intense hurricanes. An attempt has

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17. Mukut B. Mathur, 'Numerical prediction of tropical cyclone motion', Mausam, 41, 4, 1990, pp. 321-324.

18. P.K. Chakraborthy and R. Badopadhaya 'Influence of solar activities on the cyclonic disturbances over Indian Seas' Mausam 40, 3, 1989, pp. 287-292.

19. S.R. Kalsi and R.K. Jain 'Some aspects of marginal cyclones' Mausam 40, 1, 1989, pp. 47-50,

also been made by Mathura Singh[20] to correlate cyclonic storms and microseisms generated by them. It is found that secondary microseisms are more likely when the storm is near the coast while primary microseisms occur only when storm is over deep sea.

CYCLONES IN THE BAY OF BENGAL

Cyclones are most frequently observed in the Bay of Bengal during the pre monsoon months of April-May and post-monsoon months of October-Novermber. They usually occur in the Bay of Bengal between 16^0N and 90^0E. Initially, they are observed as depressions, some of which intensify into deep depressions or cyclones. Firm guidelines for deciding which depressions will intensify into cyclones and which will not, have yet to be established. But satellite observations indicate a greater organisation of clouds in these depressions that are likely to intensify into cyclones.

The majority of Bay of Bengal cyclonic storms develop out of depressions orginating in the Bay of Bengal itself.

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20. Mathura Singh and S.N. Bhattacharya, 'Amplitude spectra of microseisms generated by cyclonic storms." Mausam, 1986, 37, 3, pp. 391- 396.

However, occasionally, remnants of tropical cyclone over the South China Sea move into the Bay of Bengal as a residual low pressure system and activate a Bay of Bengal cyclone. The initial movement of a cyclone in the Bay of Bengal is towards the west or northwest. Some cyclones continue to move in the same direction and eventually strike the Indian coast, while others recurve and move towards the north and north east, before striking the coast.[21]

A study has been done for the cyclonic disturbances for the past hundred years (1891-1990). A table containing yearly and monthly frequencies of cyclonic disturbances for this period has been attached (table 3.2).

In table 3.3, the annual variation of frequency of cyclonic disturbances originating over Bay of Bengal, Arabian Sea and Land has been shown for the period 1891-1990. It shows that in the Bay of Bengal , out of 1209 disturbances, 445 intensified into storms, which is 36.8% of the total number of disturbances over Bay of Bengal. While in the Arabian Sea, total 250 disturbances occured during

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21. G.S. Mandal, op.cit., p. 327.

Table - 3.2 (a)

& MONTHLY FREQUENCIES OF CYCLONIC DISTURBANCES (1891 - 1990)

n	Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Ann		Mar	
A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
0	0	0	0	0	0	0	1	0	0	0	1	0	4	0	5	1	1	0	3	3	0	0	15	4	10	1
0	0	0	0	0	1	1	0	0	2	1	4	1	1	0	2	1	4	2	1	0	0	0	15	6	9	3
0	0	0	0	0	1	1	1	1	3	1	2	0	3	0	3	3	3	2	2	2	0	0	18	10	11	-
0	0	0	0	0	1	1	0	0	3	1	4	3	2	0	3	0	4	1	0	0	0	0	17	6	12	-
0	0	0	0	0	1	1	0	0	3	1	2	0	3	0	4	2	2	0	0	0	1	1	16	5	12	3
0	0	0	0	0	0	0	1	1	3	2	3	2	4	1	1	1	1	0	2	1	1	0	16	8	11	5
0	0	0	0	0	0	0	1	1	3	0	3	1	4	1	3	0	2	2	0	0	2	1	18	6	13	2
0	0	0	0	0	0	0	2	2	1	1	3	0	6	1	2	1	1	1	1	1	0	0	16	7	12	3
0	0	0	0	0	1	1	0	0	6	0	4	0	3	1	2	0	3	1	1	0	0	0	20	3	15	1
0	0	0	0	0	0	0	1	0	2	1	3	1	3	1	2	0	2	0	0	0	0	0	13	3	10	3
0	0	0	0	0	1	1	1	0	3	0	3	0	4	0	1	0	2	0	2	2	1	0	18	3	11	0
0	0	0	0	0	0	0	2	2	2	1	4	1	2	0	3	0	4	2	0	0	1	1	18	7	11	2
0	0	0	0	0	0	0	2	1	2	1	4	2	2	1	2	0	2	2	3	1	1	0	18	8	10	4
0	0	0	0	0	0	0	1	1	4	0	5	0	2	1	3	0	1	1	2	1	0	0	18	4	14	1
0	0	0	0	0	0	0	1	0	1	1	4	1	1	0	5	1	2	2	0	0	1	1	15	6	11	3
1	0	0	0	0	0	0	0	0	2	1	4	2	2	0	2	0	2	2	1	0	2	1	16	7	10	3
0	0	0	0	0	0	0	2	0	4	4	0	0	4	0	2	0	2	1	3	2	1	0	19	8	10	-
0	0	0	0	0	0	0	1	0	3	1	2	0	5	1	4	1	3	1	2	1	1	1	21	6	14	3
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0	0	0	0	0	1	1	0	0	2	0	1	1	1	1	4	0	1	0	2	2	0	0	12	5	8	1
0	0	0	0	0	1	1	1	1	2	1	1	0	5	0	3	1	3	1	1	0	0	0	17	5	11	2
0	0	0	0	0	0	0	0	0	0	0	1	1	3	1	3	0	4	2	2	1	1	1	14	6	7	2
0	0	0	0	0	0	0	0	0	2	0	3	3	3	1	2	0	4	1	2	0	1	1	17	6	10	4
0	0	0	0	0	0	0	2	1	2	2	2	0	2	0	3	0	1	0	1	0	1	1	14	4	9	2
0	0	0	0	0	0	0	0	0	1	1	0	0	2	1	4	1	3	0	3	2	1	1	14	6	7	3
0	0	0	0	0	0	0	2	2	2	1	0	0	3	0	1	1	4	2	3	2	0	0	15	8	6	2
0	0	0	0	0	0	0	2	1	5	1	2	0	3	0	2	0	3	1	1	0	0	0	18	3	12	1
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0	0	0	0	0	0	0	1	1	2	0	2	1	5	0	1	1	1	0	3	2	1	1	16	6	10	2
0	0	0	0	0	1	1	0	0	2	1	2	0	2	0	2	0	2	0	2	1	0	0	14	3	8	1
0	0	0	0	0	1	1	1	0	2	0	2	1	1	0	3	0	3	1	2	1	1	0	17	4	8	1
0	0	0	0	0	2	2	0	0	2	0	3	0	3	0	4	0	1	0	3	3	2	1	20	6	12	-
0	0	0	0	0	1	1	1	1	0	0	3	0	4	0	2	0	1	0	1	1	3	1	13	4	9	2
0	0	0	1	1	1	1	1	0	2	1	2	0	5	1	1	0	3	0	2	2	0	0	18	6	10	2
0	0	0	1	1	1	1	2	1	3	1	3	0	2	0	2	0	2	1	3	2	1	0	21	7	10	1
0	0	0	0	0	0	0	1	1	0	0	2	1	3	1	5	3	2	1	3	2	1	1	17	10	10	5
0	0	0	0	0	0	0	4	2	1	1	5	1	4	0	4	0	2	1	2	2	1	0	23	7	14	2
0	0	0	1	1	0	0	1	0	2	1	2	2	3	0	3	0	3	1	1	1	1	1	17	7	10	3
1	0	0	0	0	0	0	1	0	2	1	5	1	4	1	2	1	2	0	2	1	0	0	19	6	13	-
0	0	0	0	0	0	0	2	2	4	2	3	1	0	0	2	0	2	2	3	3	1	0	17	10	9	2

Contd..

(b)

Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Ann		Mar	
A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
0	0	0	0	0	0	1	1	0	0	1	0	4	1	2	0	5	2	0	0	3	1	16	5	7	1
0	0	0	0	0	0	3	2	1	0	4	0	1	0	2	1	3	2	2	1	0	0	16	6	8	1
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0	0	0	0	1	1	0	0	3	0	2	0	3	0	2	1	3	1	2	2	0	0	17	5	10	1
0	0	0	0	1	0	0	0	2	1	2	1	2	0	2	0	2	2	3	1	1	0	15	5	8	2
0	0	0	0	1	1	1	1	3	2	3	0	2	0	3	1	1	1	2	0	2	0	18	6	11	3
0	0	0	0	2	1	0	0	2	1	3	1	2	0	4	1	3	1	2	0	1	1	19	6	11	3
0	0	1	0	0	0	2	0	0	0	2	0	1	0	1	0	1	1	3	3	0	0	11	4	4	0
0	0	0	0	1	1	0	0	1	1	4	1	3	1	4	0	3	0	3	1	1	1	21	7	12	3
0	0	0	0	0	0	1	1	2	2	1	1	4	1	2	0	2	2	3	2	1	0	16	9	9	3
0	0	0	0	0	0	2	2	4	1	2	1	4	2	2	0	2	0	2	1	1	1	19	8	12	4
0	0	0	0	2	0	0	0	1	1	3	1	2	0	3	0	3	2	1	1	0	0	15	5	9	2
0	0	0	0	0	0	2	1	0	0	5	2	4	0	1	1	3	3	2	0	0	0	17	7	10	3
1	1	0	0	0	0	1	0	2	0	5	2	4	2	1	0	3	1	2	1	1	1	20	8	12	4
0	0	0	0	1	0	0	0	1	0	3	1	1	0	3	0	1	1	3	0	2	1	16	3	8	1
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0	0	0	0	0	0	2	1	2	0	0	0	1	0	3	2	3	1	2	2	0	0	13	6	6	2
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0	0	0	0	0	0	2	2	0	0	3	0	2	0	1	0	2	0	1	1	3	3	14	6	8	1
0	0	0	0	1	1	1	0	3	0	2	0	0	0	3	2	2	0	4	4	2	1	18	8	8	2
0	0	0	0	0	0	1	1	1	0	2	0	1	0	3	0	4	3	1	0	1	1	15	6	7	2
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0	0	0	0	0	0	1	1	3	1	2	0	2	0	2	1	3	2	1	1	1	1	15	7	9	2
0	0	0	0	1	1	0	0	1	0	3	1	3	0	2	2	2	1	3	1	3	1	18	7	9	3
0	0	0	0	0	0	1	0	1	1	4	1	2	0	1	0	2	1	2	2	3	1	16	6	8	2
0	0	0	0	1	1	2	2	1	0	0	0	2	1	2	2	3	0	1	1	0	0	12	7	5	3
0	0	0	0	0	0	3	2	4	1	1	0	2	0	2	0	4	1	3	3	0	0	20	7	9	1

Contd...

(C)

Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Ann		Mon	
A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2	A1	A2
0	0	0	0	1	1	1	1	0	0	1	0	3	1	1	1	2	2	4	3	1	1	14	10	5	2
0	0	0	0	0	0	1	1	1	1	3	0	3	0	2	0	2	1	5	3	1	0	18	6	9	1
0	0	0	0	0	0	1	1	2	0	2	0	2	1	4	0	2	1	4	3	0	0	17	6	10	1
0	0	0	0	0	0	1	1	3	1	1	0	2	1	1	1	1	0	2	1	0	0	11	5	7	3
0	0	0	0	0	0	1	0	2	0	0	0	3	0	2	0	3	1	1	0	2	2	14	3	7	0
0	0	0	0	0	0	0	0	1	0	0	0	3	1	3	1	2	1	2	2	1	1	12	6	7	2
0	0	0	0	0	0	2	2	1	0	2	0	5	0	2	0	3	2	4	1	1	0	20	5	10	0
0	0	0	0	0	0	0	0	2	0	0	0	1	0	1	0	2	2	1	0	1	0	8	3	4	0
0	0	0	0	0	0	0	0	1	0	0	0	2	0	0	0	1	1	2	2	1	0	7	3	3	0
0	0	0	0	0	0	2	2	0	0	0	0	4	0	2	1	4	2	2	1	1	1	15	7	6	1
0	0	0	0	0	0	0	0	0	0	1	0	3	0	1	0	0	0	2	1	0	0	8	1	5	0
0	0	0	0	0	0	0	0	1	1	0	0	1	0	2	0	2	2	1	1	1	0	9	5	4	1
0	0	0	0	0	0	0	0	2	0	1	0	1	0	0	0	2	1	2	2	1	0	9	3	4	0
0	0	0	0	0	0	1	1	3	0	1	1	1	0	0	0	1	0	3	1	0	0	10	3	5	1
0	0	0	0	0	0	2	1	1	0	0	0	2	0	1	0	2	0	2	0	1	1	11	2	4	0
4		5		37		111		182		217		251		234		230		188		88		1567		884	
1		4		27		70		57		45		33		47		100		116		46		552		182	

ber of cyclonic disturbances that occured over the area from
35 ° N and from 50° E to 100° E

ber of cyclonic disturbances that intensified into storms

Source : India Meteorological Department, G.O.I.
'Tracks of storms and depressions in the Bay of Bengal and Arabian Sea, 1891-1970',
New Delhi, 1979

Table - 3·3 (a)

ANNUAL VARIATION OF FREQUENCY OF CYCLONIC DISTURBANCES ORIGINATING OVER BAY OF BENGAL, ARABIAN SEA AND LAND (1891-1990)

	** Bay of Bengal **													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann	Mon
Total No. of disturbances	19	4	5	29	82	122	158	191	190	181	150	78	1209	662
% distribution	1.5	0.3	0.4	2.3	6.7	10.0	13.0	15.7	15.7	14.9	12.4	6.4	---	54.7
Total No. that intensified into storms	6	1	4	21	50	38	41	30	39	78	95	42	445	148
% distribution	1.3	0.2	0.8	4.7	11.2	8.5	9.2	6.7	8.7	17.5	21.3	9.4	---	33.2
% of cyclonic disturbances intensifying into storms	31.5	25.0	80.0	72.4	60.9	31.1	25.7	15.7	20.5	43.0	63.3	53.8	36.8	22.3

** Arabian Sea **

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann	Mon
Total No. of disturbances	6	---	1	8	31	43	16	4	18	52	57	14	250	81
% distribution	2.4	---	0.4	3.2	12.4	17.2	6.4	1.6	7.2	20.8	22.8	5.6	---	32.4
Total No. that intensified into storms	2	---	---	6	20	18	3	2	8	25	29	6	119	31
% distribution	1.6	---	---	5.0	16.8	15.1	2.5	1.6	6.7	21.0	24.3	5.0	---	26.0
% of cyclonic disturbances intensifying into storms	33.3	---	---	75.0	64.5	41.8	18.7	50.0	44.4	48.7	50.8	42.8	47.6	38.2

** Land **

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann	Mon
Total No. of disturbances	---	---	---	---	1	16	45	53	33	3	---	1	152	147
% distribution	---	---	---	---	0.6	10.5	29.6	34.8	21.7	1.9	---	0.6	---	96.7

this period out of which 119 intensified into storms, which constituted 47.6% of total disturbances over the Arabian Sea.

In figure 3.4 monthly distribution of cyclonic disturbances and cyclonic storms has been shown for the period 1891-1989 over Bay of Bengal. It clearly shows that months of June, July, August, September , October and November constitute nearly 82 percent of the annual cyclonic disturbances. The maximum disturbances occured in the months of August and September and minimum was observed in the month of February.

Tracks of cyclonic storms

Severe cyclonic storms occur during months of July, August, September , October and November. In the months of July and August, in the Bay of Bengal storms are formed north of 18^{o} N and west of 90^{o} E and move generally in a west northwesterly direction. Arabian Sea is practically free from storms in these months.

In September Bay storms originate in the area north of 15^{o} N and west of 90^{o} E. They move initially in a west to

northwesterly direction and later recurve towards north-northeast.

Storms in Bay of Bengal originate between 8^{o} N and 14^{o} N in the month of October. They move initially in a northwesterly direction. Most of them later recurve and move northeast. The North Tamil Nadu and Andhra coast and the coastal belt of Bangladesh are particularly vulnerable to the incidence of storms in this month. [22]

In November, most of the storms in Bay of Bengal originate between 8^{o} N and 13^{o} N. Those which move in a west northwesterly direction stirke the North Tamil Nadu coast and adjoining South Andhra coast and emerge into the Arabian Sea where they reintensify. [23]

Tracks of cyclonic storms during May, July and November are shown in the figures 3.5,3.6 and 3.7 respectively.

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22. S.P. Saxena, 'Disaster forecasting and warning services for Tropical cyclones of Indian Seas' in Report on SAARC seminar on Disaster Management, Hyderabad: National Institute of Rural Development, 1987, p.37.

23. Ibid, p.38.

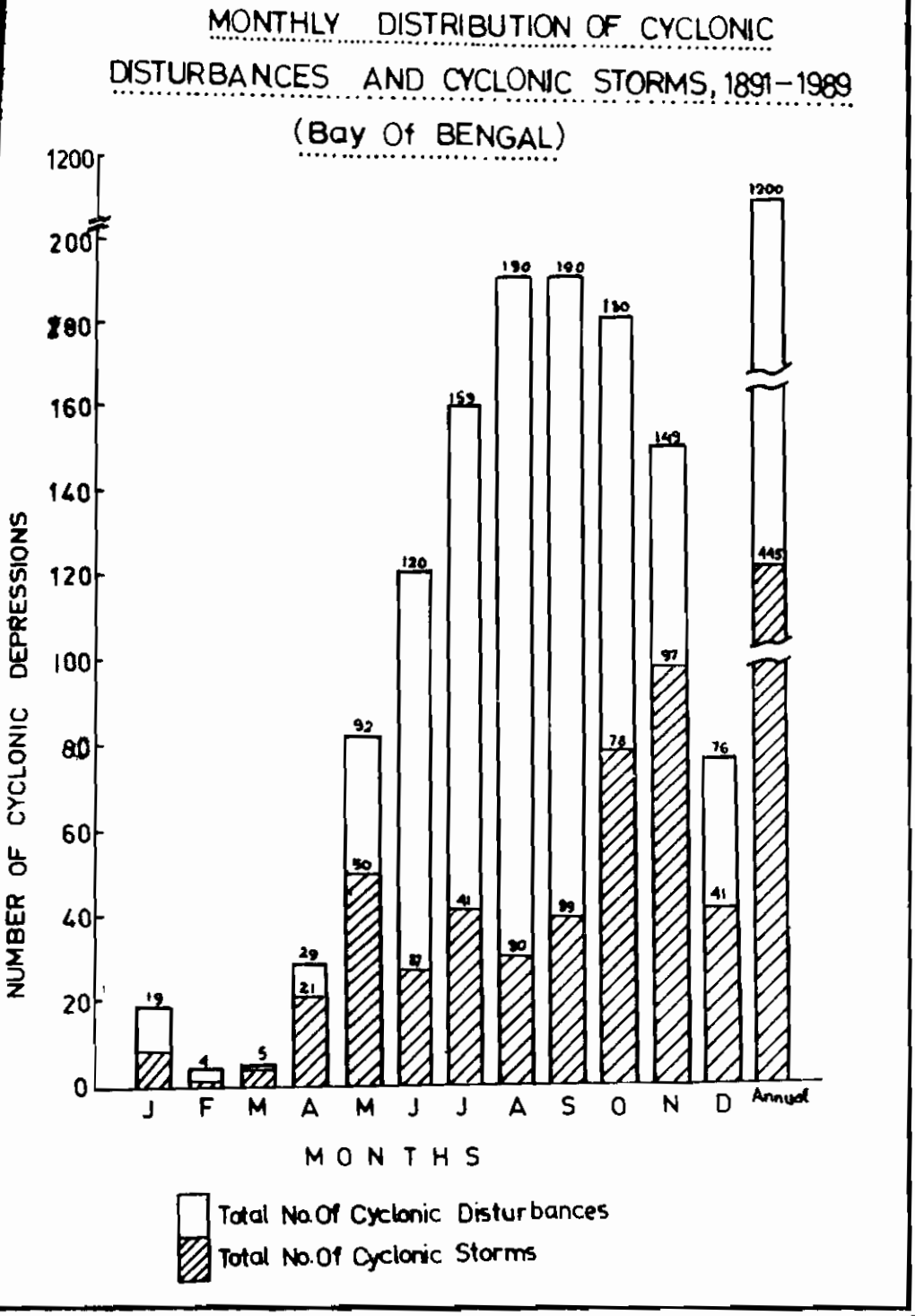
MONTHLY DISTRIBUTION OF CYCLONIC
DISTURBANCES AND CYCLONIC STORMS, 1891-1989
(Bay Of BENGAL)
NUMBER OF CYCLONIC DEPRESSIONS
1200
200
180
160
140
120
100
80
60
40
20
0
19
4
5
29
21
92
50
120
27
152
41
190
30
190
99
180
78
149
97
76
41
1200
445
J F M A M J J A S O N D Annual
MONTHS
Total No. Of Cyclonic Disturbances
Total No. Of Cyclonic Storms

Fig- 3.4

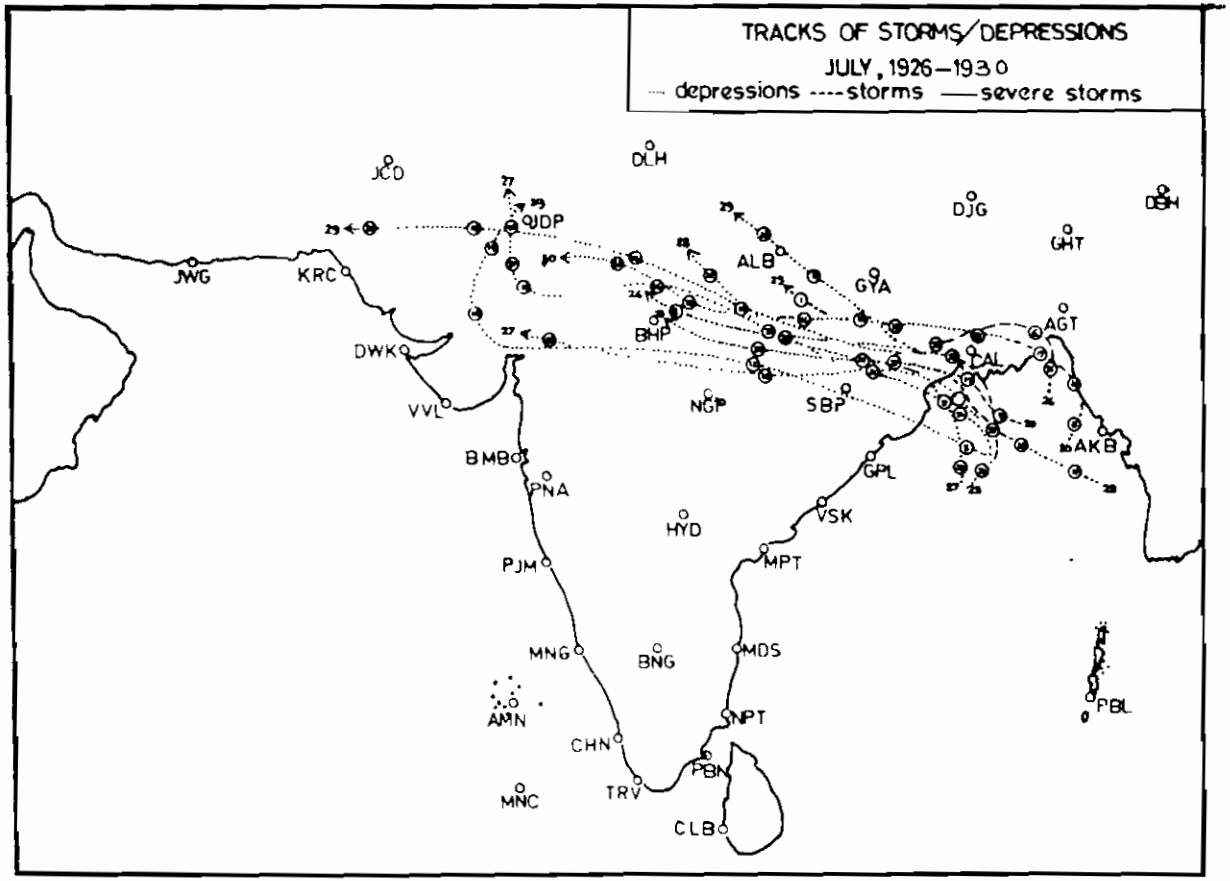
TRACKS OF STORMS/DEPRESSIONS
JULY, 1926–1930
— depressions ----storms ——severe storms
JCD
DLH
DJG
DBH
GHT
JWG
KRC
JDP
ALB
GYA
AGT
BHP
CAL
DWK
VVL
NGP
SBP
AKB
BMBO
PNA
GPL
HYD
VSK
PJM
MPT
MNG
BNG
MDS
AMN
PBL
CHN
NPT
PBN
TRV
MNC
CLB

Fig. 3.5

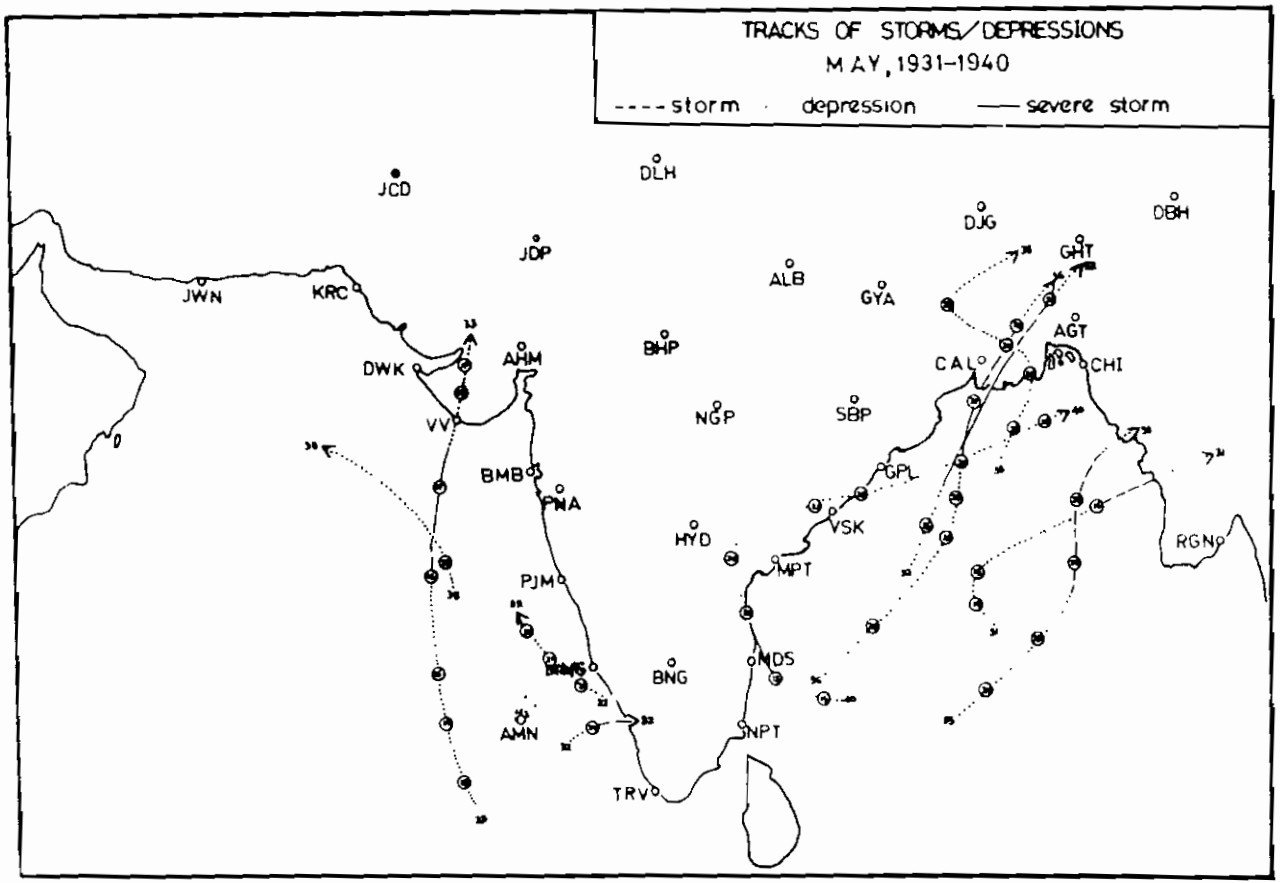
TRACKS OF STORMS/DEPRESSIONS
MAY, 1931-1940
---- storm · depression —— severe storm
JCD
DLH
DJG
DBH
JDP
ALB
GHT
JWN
KRC
GYA
AGT
BHP
DWK
AHM
CAL
CHI
NGP
SBP
VV
BMB
PNA
GPL
VSK
HYD
RGN
MPT
PJM
MDS
BNG
AMN
NPT
TRV

Fig 3.6

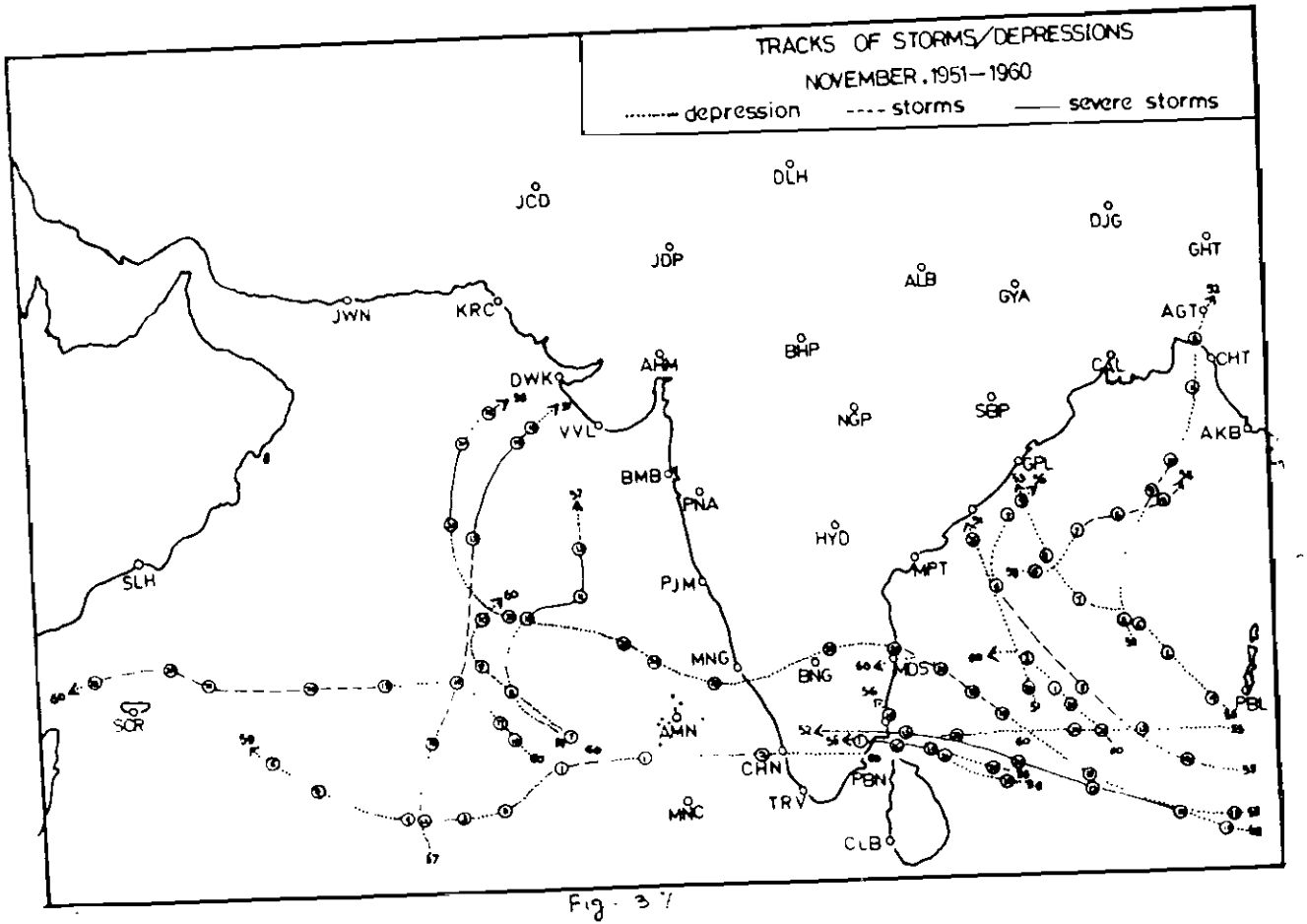
TRACKS OF STORMS/DEPRESSIONS
NOVEMBER, 1951–1960
depression
storms
severe storms
JCD
DLH
DJG
GHT
JDP
ALB
GYA
AGT
JWN
KRC
BHP
CAL
CHT
DWK
AHM
NGP
SGP
AKB
VVL
GPL
BMB
PNA
HYD
SLH
MPT
PJM
MNG
BNG
MDS
PBL
SOR
JMN
CHN
PBN
TRV
MNC
CLB

Fig. 3

1. P.A. Menon, 'Our Weather', New Delhi: N.B.T. Publication, 1989, p.140.

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3. Ibid, p.1

4. B.K. Basu, 'Storm Surge associated with the Paradip cyclone of 1982' Mausam, 37 (3), 1986, pp. 343-346.

5. H.J. Critchfield, ' General climatology,' New Delhi: Prentice Hall of India, 1987, p. 108.

6. Arthur N. Strahler, 'Physical Geography, ' Singapore: John Wiley & Sons, 1975, p.189.

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9. Nootan Das, et. al; 'Cyclones and depressions over the Indian ocean during 1988' Mausam, vol.41, No.1 1990, pp. 1-10.

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11. H.J.Asthana 'Radar observation of thunder storms from cyclonic disturbances,' Mausam, 31 (4), 1980, p.43.

12. P.A. Menon, op.cit. p.145. 13. Ibid, p. 146.

14. B.K. Basu, op.cit, pp.343-346.

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20. Mathura Singh and S.N. Bhattacharya, 'Amplitude spectra of microseisms generated by cyclonic storms." Mausam, 1986, 37, 3, pp. 391- 396.

21. G.S. Mandal, op.cit., p. 327.

22. S.P. Saxena, 'Disaster forecasting and warning services for Tropical cyclones of Indian Seas' in Report on SAARC seminar on Disaster Management, Hyderabad: National Institute of Rural Development, 1987, p.37.

23. Ibid, p.38.

Chapter IV

Impact of Cyclones on People of Orissa And Andhra Pradesh

CHAPTER IV

Impact of Cyclones on People of Orissa and Andhra Pradesh

In India, cyclones occur over the Bay of Bengal and the Arabian Sea and usually travel west or north west wards. On an average, 5 to 6 tropical cyclones are formed every year of which 2 or 3 could be severe. More cyclones occur in the Bay of Bengal than in the Arabian Sea, the ratio being 4:1. Nearly 10 percent of the world's tropical cyclones originate over the Bay of Bengal and the Arabian Sea.[1] Of these, the majority have their initital genesis over the Bay of Bengal and strike the east coast of India. The effects of cyclones have always been more pronounced in the states located on the east coast of Bay of Bengal namely West Bengal, Orissa, Andhra Pradesh and Tamil Nadu. Following table shows a comparative stduy of the occurance of cyclones on East and West coasts of India.

Table 4.1

Frequencies of cyclones crossing coasts in various districts during 1891-1989.

WEST COAST		EAST COAST	
STATION COASTAL DISTRICTS	NUMBER OF CYCLONIC STORMS DURING 1891-1989	STATION COASTAL DISTRICTS	NUMBER OF CYCLONIC STORMS DURING 1981-1989

1. National Commissiona on Floods, Vol. 1, G.O.I, New Delhi : Ministry of Energy and Irrigation, 1980, p 343.

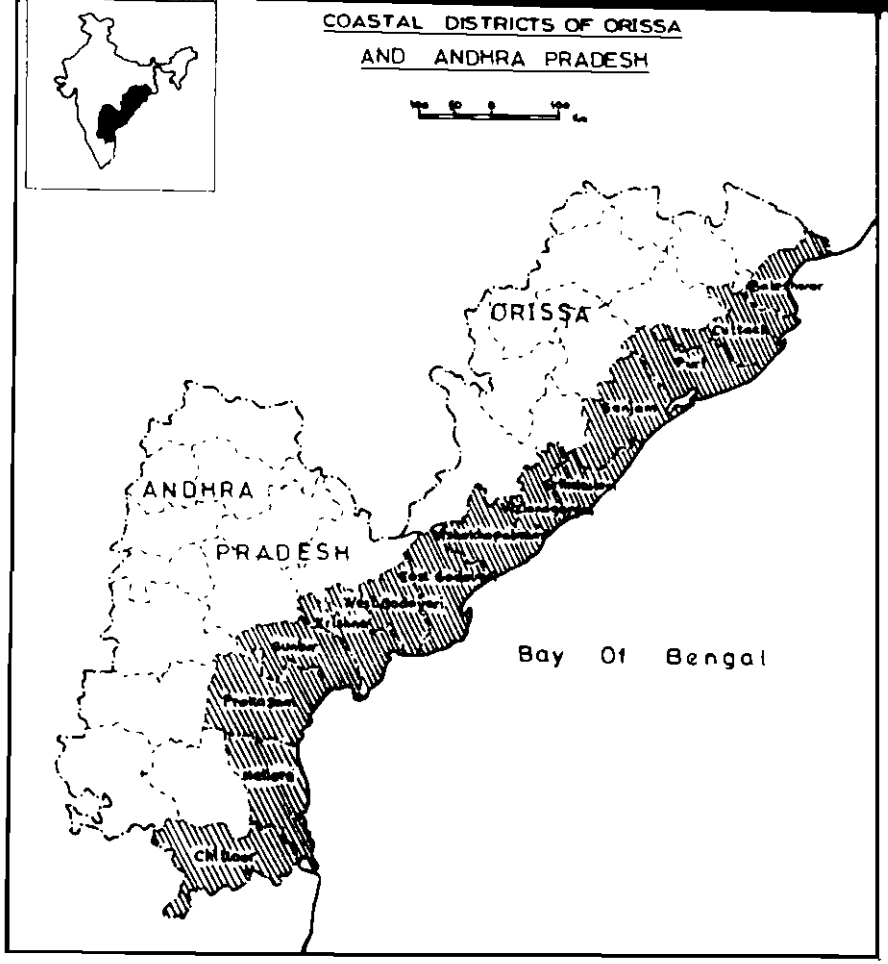
COASTAL DISTRICTS OF ORISSA
AND ANDHRA PRADESH
ORISSA
ANDHRA
PRADESH
Bay Of Bengal

Fig 4 1

KERALA		**WEST BENGAL**	
TRIVANDRUM	1	24 PARGANAS	23
QUILON	0	MIDNAPORE	12
ALLEPPEY	0		
ERNAKULAM	1	**ORISSA**	
TRICHUR	0	BALSORE	19
MALAPURAM	1	CUTTACK	17
CALICUT	2	PURI	10
		GANJAM	7
KARNATAKA			
CANNANORE	1	**ANDHRA PRADESH**	
S.KANARA	2	SRIKAKULAM	14
N.KANARA	0	VIZAG	8
		E.GODAVARI	8
GOA		W.GODAVARI	0
GOA	0	KRISHNA	14
		GUNTUR	3
MAHARASHTRA		NELLORE	21
RATNAGIRI	2	(Including	
COLABA	3	PRAKASAM)	
THANA	1		
BUISAR	1	**TAMILNADU**	
		CHINGLEPUT	15
GUJARAT		S.ARCOT	5
SURAT	0	(Including	
BAROACH	1	PONDICHERRY	
KAIRA	0	TANJUVAR	13
AHMEDABAD	0	RAMNATHPURAM	3
BHAVANAGAR	2	TIRUNELVELI	2
AMRELI	0	KANYAKUMARI	0
JUNAGAD	10		
JAMNAGAR	3		
KUTCH	3		

Source : G.K. Mishra, et. al. 'Natural Disaster Reduction' Ed; New Delhi : Reliance Publication, 1993, p.138.

Some of the most severe cyclones in this century which took a heavy toll of human lives and property in Orissa and Andhra Pradesh :-

ORISSA

9.10.1967	Orissa coast between Puri and Paradeep	The severe cyclonic storm caused serious devastation in coastal Orissa. The death toll was about 1000 persons and 50, 000 cattle. The damage to property ran into a few crores of rupees.
30.10.1971	Near Paradeep	The tidal wave went inland for a distance of 15 to 25

		kms. causing complete destructions to standing crops. About 10,000 human lives and one lakh cattle etc. were lost. The damage to property ran to about Rs. 300 crores.
DHRA PRADESH		
11.1927	Near Nellore	Destroyed the town of Nellore, submerged thousands of acres of crops, paralysed communication and caused considerable loss of life.
.11.1949	Near Machilipatnam	Winds speed reached 100 Kms. per hour. In effect, a tidal wave of 3 to 5 mts in height inundated the coast to a distance of 15 kms. A million acres of crops of ripening paddy were submerged. About 800 people died and thousand were rendered homeless.
.11.1969	Near Kakinada	Took a heavy tool of about 900 lives and property loss of nearly 100 crores.
9.11.1977	Near Chirala	This cyclone was the most intense cyclone of this century. A tidal wave reaching 5.5 metres height inundated the coast to a distance of 25 kms. The whole taluk was destroyed. About 10,000 human lives and 6 lakhs of cattle were lost. Total damage to property ran to about 200 crores.

Source : 'Natural Disaster', A Guide for Relief works', New Delhi : Joint Assistance centre, 1980. pp. 19-20.

Impact of Cyclones in Andhra Pradesh

Andhra Pradesh is India's fifth largest state. It has a long coast line of 1030 kms. which is one fifth of the total coast line in India. There are seven coastal districts of Andhra Pradesh which are periodically swept by cyclones. These districts

re - Srikakulam, Vizag, East Godavari, West Godavari, Krishna, Guntur, and Nellore. Of these, Nellore, Krishna and Srikakulam have been hit many times in the past. All these coastal districts are primarily agricultural and some of them are noted for their complex and productive network of irrigation. During 1892-1984, the Andhra coast line was subjected to 60 cyclones.

Table 4.2

District wise cyclones in Andhra Pradesh during 1892-1984.

District	Cyclonic storms	Severe cyclonic storms	Total
Nellore	11	07	18
Prakasam	04	03	07
Guntur	-	-	-
Krishna	07	07	14
W. Godavari	01	-	01
E. Godavari	07	01	08
Visakhapatnam	-	02	02
Srikakulam	05	05	10
Total	35	25	60

Source : B. Raghavulu Naidu, 'Economic Consequences of 1977 cyclone in A.P.' Tirupati : Sri Venkateshwara University, 1989, p.76.

Cyclones in Andhra Pradesh during 1901-1947

Cyclones of less severity hit Andhra coast during 1903, 1916, 1927 and 1936. These cyclones did not take a toll of men, cattle and crops. But the magnitude of the devastation was not of the order of the cyclones of 1779, 1864 and 1977.[2] Nellore region was devastated by a cyclone on November 1, 1927, resulting in the death of 629 human beings and about, 50,000 cattle. Another cyclone swept the Bapatla taluk in Guntur district in October

2. B. Raghavalu Naidu, 'Economic Consequences of 1977 Cyclone in A.P.' Tirupati: Sri Ventakeswara University, 1989, p.86.

936 and resulted the loss of about 233 human lives. Several elief measures were initiated by the district authorities.

yclones since Independence

(i) On 27 October 1949, Machilipatnam was struck by a yclonic storm which killed 800 people and a million acres of addy were damaged.

(ii) On 7-8 November 1969[3], another destructive cyclone with meter high tidal wave ravaged the entire coastal region. 250 eople were killed, 35,000 livestock lost and 40,000 houses amaged.

(iii) A cyclone crossed South Andhra coast near Barua on 0th September 1972 resulted in death of 100 people.

(iv) Another cyclone crossed Andhra coast near Sri Harikota n the early night of 22nd Novermber, 1972.

(v) On 4th November 1976, the cyclone crossed Andhra coast ust north of Machilipatnam. In this loss of life was 18 and here was considerable damage to houses and crops.

(vi) 19 November, 1977 was the darkest day in the history of ndhra Pradesh in the recent past. The low pressure formed in the ay of Bengal on November 16 changed its course more than 30 imes, picked up momemtum and finally crossed the coast line at etapalem on the evening of November 19, 1977. There was a tidal ave with 6 meters height which inundated an area of 15 sq.kms in rishna district. The cyclone caused destruction upto 75 miles nland; and Krishna and Guntur districts suffered extensive amage due to multiple effects of rain, wind and tidal wave.

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3. Ibid, p.86.

cording to an estimate death toll was 10,000. Nearly 2.5 lak cattle and 4 lakhs of poultry perished. The extent of cro mage was 12.12 lakh hectare and the total loss was estimate round Rs. 10,000 crores.[4]

(vii) On 12 May 1979, [5] The Andhra Pradesh experience nother major cyclonic storm with a core of Hurricane winds. It esulted in unprecedented havoc including heavy loss of life, ivestock and enormous damage to public and private properties i he districts of Prakasam, Nellore, Guntur, Krishna and East odavari. The fields of Krishna district were damaged by salt eposits.

(viii) The cyclone on November 12, 1984,[6] swept coastal ndhra, leaving behind 565 dead, 516 in Nellore district alone nd damaging property worth of Rs. 207.87 crores.

mpact of cyclones on Orissa

Orissa is 10th largest state of India. It has a coast line f 432 Kilometers which is 6th longest coastline in India. There re four coastal districts of Orissa which are affected by yclones. These districts are Cuttack, Puri, Balasore and anjam. These coastal districts have alluvial soils which are very productive but the calamity of cyclonic storms has badly affected these coastal districts. Orissa's agro-based economy is always upset by some natural calamities like flood, drought, tornado or cyclone. Cyclone has become a regular feature like flood or drought.

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4. Deccan Chronicle, Hyderabad, 23 November 1977.
5. Economic Times , New Delhi, 14 May 1979.
6. News Time, Hyderabad, 19 Nov. 1984.

Some cases of cyclonic storms in Orissa after 1970

i) The 30th October 1971 cyclone hit the Orissa coast near Paradeep. The tidal waves affected coastal area from paradeep to Balasore. Cuttack and Balasore were worst affected. About 10,000 people lost their lives, 50,000 heads of cattle perished and 8 lakh houses were damaged.[7]

ii) Chandbali cyclone of 6-12 October 1973, caused heavy rains and floods in Orissa. About 1.5 million people were affected by flood and more than 60,000 houses damaged in north Orissa.

iii) On 28th September 1974, a cyclone hit Paradeep of Orissa coast. It was a weak storm and did not intensify, only widespread rain occured.

iv) The cyclone of 12 Sep. 1976,[8] crossed Balasore district of Orissa. About 40 persons lost their lives and 4000 heads of cattle perished in these areas. Many trees and telephone post were uprooted. Several thousands of houses were damaged.

v) On 27 August 1978, the cyclonic storm crossed north Orissa coast between Chandbali and Balasore. It was a weak storm. only some trees were uprooted in Balasore district due to gales associated with the cyclone.[9]

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7. P.K.Das, et. al.,'Cyclones and Depressions of 1971', Indian Journal of Meteorology, Hydrology and Geophysics, October 1972, vol. 23 (4), p. 459.

8. P.S. Pant, et. al., 'Cyclones and Depressions in the Indian Seas in 1976, Indian Journal of Meteorology, Hydrology, and Geophysics, 1978, 29(4), p. 617.

9. Times of India, New Delhi, 30 August 1978.

vii) Severe cyclonic storm of 7th August 1979, crossed Orissa near Balasore. Wide spread rain occured in Orissa. Road and rail communication were disrupted due to flooding. Many trees and electricity and telephone lines were uprooted.

viii) Severe cyclonic storm of 4-11 December 1981 affected Balasore, Cuttack and Puri districts. Cuttack was the worst affected. About 2800 villages and population of about 13 lakh were affected. Cropped area of 57,571 hectares was affected due to cyclone and saline inundation leading to a loss of about 90 lakhs worth property. There was no loss of human life but about 400 live stocks were lost.[10]

viii) On 3rd June 82, a severe cyclonic storm hit Orissa coast. It cuased considerable damage in Cuttack, Puri and Balasore districts of Orissa. The worst affected being Cuttack. Damage to Paradeep port was severe. A total population of 73.23 lakhs covering 25,000 sq.km. in Orissa were affected. Total number of human casualities were 245, injured 493 and cattle head were 11,463. Number of houses fully collapsed were 8.19 lakhs.[11]

ix) Bay cyclonic storm of 20th September 1985, crossed Orissa coast near Puri. Several villages in Ashtrang block of Puri district in Orissa were submerged under water. Six fishermen were drowned in Chilika lake. It caused widespread damage to

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10. Telegraph, Calcutta, 15 December 1981.

11. Patriot, New Delhi, 6 June 1982.

paddy crops, roads and prawn culture tanks in Puri district.[12]

x) On 16th October 1985, a severe cyclone crossed north Orissa coast near Balasore. It affected Cuttack, Balasore and Keonjhar districts of Orissa. 38 persons were reported missing and 1073 cattle heads were perished. Crops in 3,24,795 hectares in cuttack, Balasore, Keonjhar, Dhenkanal and Mayurbhanj districts were affected.[13]

xi) The cyclone of 8th November 1986, touched south Orissa coast. It led to heavy rainfall for two days over Orissa. Considerable damage occured to paddy and rabi crops in Balasore, Cuttack, Puri and Ganjam districts of Orissa. Many people lost their houses due to inundation by lake water.[14]

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12. Nootan Das, 'Cyclones and Depressions over the Indian Seas and the Indian Subcontinents in 1985', Mausam, 1987, 38, p.12.

13. Deccan Herald, Banglore, 20 October 1985.

14. Patriot, New Delhi, 11 November 1986.

Chapter V

Assessment And Management of Impact of Cyclone: A Suggestive Strategy

CHAPTER - V

Assessment and management of Impact of Cyclone: A Suggestive Strategy

From the time immemorial, humanity has been the victim of natural disasters, which exalted a heavy toll of death and suffering. Disasters are a recurring phenomenon of nature and inflict untold misery on vast number of people. The history of mankind is full of disasterous calamities and catastrophic events. Earthquakes, landslides, floods, cyclones, hurricanes, volcanic eruptions wildfires and such other natural calamities have claimed more than 2.8 million lives all over the world in the past 20 years, adversely affecting 820 million people.[1] The loss of life is invaribly accompanied by devastating ecomomic loss and hardship for the survivors. The damage to life and property is very high particularly in the developing countries which have litle capacity to withstand disasters years after year. The Asia-Pacific Region faces 60% of the natural disasters occuring in the world.[2]

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1. M.M. Jacob, in presidential address to the **Symposium on preparedness, Mitigation and Mahagement of Natural Disasters**, New Delhi, 1989, p.3.

2. 'Natural Disaster Management in India', **Stop Disasters**,No. 15 , September - October, 1993, p.18

The scenario in our country is not different as it has been hit by at least one major disaster every year. The devastating floods, cyclones, earthquakes droughts and other disasters have brought not only misery ot the people but have seriously affected the country's development progress.

India with total area of 32,87,782 sq. kms. and north to south and east to west stretch of 3214 kms. and 2933 kms respectively, is a country of subcontinental order. Because of the wide variation in geographical and climatic conditions, different parts of the country are exposed to different types of natural calamities. In order to assess the disaster potential of this country, India can be roughly divided into five zones-[3]

i) Northern Mountain Region: The lofty Himalayan mountain and their foot hills are often prey to strong snow- storms leading to landslides and strong coldwaves. This zone is also prone to earthquakes.

ii) Indo-Gangetic Plains: This part of the country contains some of the oldest and largtest river systems of the country. The melting snow from the Himalayas, and rainfall during the monsoon can lead to floods in the various rivers and their tributaries, bringing havoc to the

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3. Dr. B.K. Verma, 'The Disaster Profile of India' in a Report on **Disaster Management**·**Nagpur**: Ministry of Health and Family welfare, G.O.I., 1980, p.8.

millions of people who have made their homes on the banks of these rivers'

iii) Deccan Plateau: This part of the country does not contain snow fed rivers, whenever there is a shortage of rainfall during monsoon, this area faces dought.

iv) The Western Desert: The state of Rajasthan and part of Gujrat lie in the desert area. The rainfall in the 'Thar Desert' is scanty and unreliable, the people living in this areaoften face the problem of drought which culminats in an acute drinking water shortage.

v) Coastal Areas: In all the seven states which share the sea-front, that is Gujrat, Maharastra, Kerala, Tamil Nadu, Orissa, A.P. and west Bengal, there is problem of sea erosion, cyclones and tidal waves.

Besides this, the entire Northan part of the Indian continent from Hindukush to Eastern Himalayas lie in the earthquake-prone belt of violent subterranean volcanic activity"

The Indian subcontinent is exposed particularly to the adverse effects of recurrent cyclones and floods. While the effect of cyclones are felt mostly in the peninsular and Eastern India, the adverse effects of floods are spread over the entire conuntry. Floods occur independently and also as a consequence of cyclones. While the cyclones mostly occur in the months of May or with the receding monsoon in

October-November, heavy floods occur mostly with the heavy monsson. It has been identified that roughly 40 million ha area is prone to floods in this country. The area affected annually on an average is 8 million hectars which had risen to as much as 18.6 million hectares in 1988. On an average the area of crops affected annually is about 3.7 million hectars[4]

While it is not possible to prevent the occurance of these natural phenomena , the disasterous effects they generate can be avoided or at least reduced. Infact it is not the phenomena themselves but their interaction with human settlements and land use that constitute disasters. Unfortunately our coastal areas and the flood plains of our rivers which are the most vulnerable area, are also area of concentration of human settlements. In the view of S.V. Giri, the adverse effects of disasters can be minimised by a scientific study of these naturel phenomena and an orgainsed approach by way of advance warning, better and more efficient ways of organising the rescue and relief operations and systematise a body of knowledge for improving the methods of managing these disasters and improving the performance over a period of time.[5]

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4. 'Natural Disaster Management in India,' op. cit., p.18.

5. S.V. Giri, 'Management of Cyclones and Floods'in **Symposium on Preparedness, Mitigation and Management of Natural Disasters**' vol.II, New Delhi: 1989, p.9.

DISASTER MANAGEMENT:

Disaster management means a planned and systematic approach towards understanding and solving problems in the wake of disasters. The Disaster plan outlines measures to minimise human and economic losses from disasters and to facilitate effective rescue, relief and rehabilitation. The disaster plan spells out what is to be done before, during and after a disaster by whom, when and how. By anticipating these extraordinary events and acting to minimise their effects, a plan helps to secure the continuity of growth and development. The management aspects of disaster may be broadly looked at in terms of the following—

i) Earlier measures and warning system : An analysis of the techniques of disaster management over the past several years point out a major shift in the approach, especially after 1950. Under the colonial rule, the responsibility of the government was largely restricted to saving government properties. Warning were relayed to the public for saving lives as best as they could. Now the governmental responsibility extends from pre-disaster preparedness to rescue, relief, rehabilitations and reconstructions of the area. In recent times, voluntary organisations have also shared the responsibility.

In India, efforts for introducing disaster management as a systematic policy have been directed mainly towards

floods and management of emergencies caused by cyclones. It is these disasters which call for speedy operations involving greater expertise in view of the suddenness of their occurance, short duration and extensive damage. Much valuable work on this has been carried out by engineers, scientists, architects, planners and emergency managers. The 'Rastriya Barh Ayog' in 1980 made very valuable recommendations in respect of the management of the flood prone areas. The first national workshop on the subject of disaster management held at the 'Administrative staff college of India' at Hydrabad (Feb 1980) also created some awareness among all concerned on the need to define the concepts and techniques of disaster management in the Indian context, explore ways and means of creating community preparedness and response, identify primary and secondary support systems and role and scope of training at various levels.[6] Since then the college has been conducting short term courses in Disaster Management. The Government of Madhya Pradesh has set up 'Disaster Management Institute' at Bhopal in November 1987. Short term courses concerning disaster are being conducted at this institute. Tne 'Third Indian Engineering Congress' held a national seminar on 'Planning a decade for Natural Hazard Reduction' in the beginning of 1989.

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6. M.M. Jacob, op.cit, p.5.

A related problem with south west monsoon rainfall is drought. India's national approach to drought mitigation and management has evolved over a period of time and has undergone changes in the light of the status of resources and technical developments. 'A new forecasting technique known as Parametric and Power Retrogression Model (PPRM) has been developed by Indian Meteorological Department (IMD). This model uses 16 regional and global parameters physically related with s-w monsoon rainfall[7].The National Agricultural Drought Assessment and Monitoring System (NADMAS) provides periodic drought bulletins throughout the monsoon season for drought prone states. Forecasting and early warning systems contingency agricultural plainning, ensuring effective accessibility to foodgrains for the affected population, protection of cattle and provision of drinking water and health care facilities, constitute integral components of our response to drought situations. This integrated approach has done well" A 1987 study conducted by the Indian Councill for Medical Research, showed that the number of persons having energy intake below 500 calories (starvation level) was only 0.2% as compared to 36% in the earlier drought periods in Andhra

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7.'Natural Disaster Management in India' op. cit., p. 18.

Pradesh and Bihar.[8]

In the last decade or so, several significant measures have already been initiated notable among which are the installation of an advance warning system both in regards to floods and cyclones. The Central Water Commission (CWC) has established a series of gausing stations on the major rivers and an elaborate network of communications, where by it has become possible to study the rainfall pattern in the catchment areas of major rivers and to take necessary precautionary measures to avert loss of life and minimise damage to property. Similarly, the Indian Meteorological Department (I.M.D.) has been able to install a chain of cyclone warning stations along the sea coast which are in position to trace the movements of depressions and cyclones give advance warning on the likelihood of such events. Based on the experiences of 1977 Cyclones, the cyclone Distress Mitigation Committee (CDMC) report [9] recommended several measures. Long term measures like building of cyclone shelters, planting shelter bed plantations etc. help minimising the adverse effects on the occurance of such calamities. Regarding floods, the Central Water Commission

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8. Ibid., p.19.

9. S.P Cohen and C.V.Raghvulu, ' The Andhra Cyclone of 1977.' ' New Delhi: Vikas Pub, 1979, p.76.

has setup a network of 157 flood forecasting and warning stations on most of the interstate rivers in the country. The Eighth Five Year plan (1992-1997) [10] has emphasized the need for extending the forecasting network to other flood prone rivers, ensuring the close coordination and effective participation of the Meteorological Department and National Remote Sensing / ISRO etc. Thus the subject has been receiving a serious attention in the different national forums, but still there is a long way to go.

ii) **Prevention:** Prevention may be described as means designed to prevent the natural phenomena from causing or resulting in disaster. As of now, the technological efforts needed to overcome the fury of a cyclone are in experimental stages and have had only limited success. There is a concerted effort on an international scale for cyclone disaster mitigation. These efforts are meant to create better insight into the nature of cyclones.

iii) **Preparedness:-** Prevention of natural disaster may not be possible without proper preparedness and management. Therefore, disaster preparedness assumes greater importance and urgency in the immediate future. Disaster preparedness may be described as measures to organise and facilitate

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10. 'Natural Disaster Management in India' op.cit., p.18.

timely and effective rescue, relief and rehabilitation in case of disaster.[11] Preparedness therefore, means a readiness to cope with disaster situations or similar emergencies which can not be avoided (UNDRO) [12]

Preparedness includes forecasting and warning, education and training of the population, and setting up of organisations for managing disasters. The United Nations Water Conference (1977) observed [13] "High priority should be given to education, training and public information in disaster prevention and preparedness, both by individual governments and international organisations. This should be directed inter alia, to public officials, decision makers, professionals in building and construction industries, national health planners, public health workers and the general public situated particularly in vulnerable areas." A concerted effort towards long-term preparedness was started in our country for the first time after cyclone of 1969 in Andhra Pradesh. The CDMC submitted its report in 1971, and after that the governments of Tamil Nadu, Orissa and West Bengal appointed similar committees in 1971, 1972 and 1974

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11. B. Raghavulu Naidu, **'Disaster Management', Kavali** (A.P.): Sri Venkateswara University Post Graduate Centre, 1984, p.137.

12. Ibid., p. 138.

13. Ibid., p.138.

respectively. During last decade, emphasis was placed upon pucca housing programme and cyclone shelters as a major avenue for preparedness. An extensive programme for afforestation of coastal areas has been in operation since 1977.

iv). **Rescue operation and evacuation:**

In the immediate wake of the occurance of the calamity, it is necessay to carry out large scale rescue operation to evacuate people to safer places and relief camps. If there are building collapses, it is necessary to have trained manpower and equipment to recover survivors/ dead bodies from the debris and move them for treatment. Generally evacuation is carried out by government and voluntary agencies. In a well prepared community many people can move by themselves to safer places, provided a clear warning is given and understood with sufficient margin of time. Army rescue boats perform a significant service in these operations but their number and administrative delay is the limiting factor. So, it is better to organise and depend on local efforts and local resources of man and material for immediate rescue operations instead of depending too heavily on the army boats and manpower. Since it will take time to reach and their number also is likely to be limited, in exceptional situations helicopters are also pressed into service to rescue people.

v) **Relief Operations**

Supply of essential commodities is equally important. While it would be most prudent to stock essential commodities like rice, wheat, kerosene oil etc. in vulnerable areas well in advance of the occurance of the calamity, it would still be essential to resort to moving such supplies soon after the calamity occured. The extent of misery can be minimised by advance planning and identification of the requirements of vulnerable areas and securing adequate godown space to cater to the requirements of the periods for such areas. The local traders may also have to be given credit to stock such commodities.

Distribution of relief is taken up by teams comprising officers and staff of revenue and block administration with the help of voluntary organisations. During 1977 and 1979 cyclones more than hundred (including International) voluntary agencies participated in relief work.[14]

Restoration of surface supply lines by road and by water-should be given the highest priority since such communication is important for restoring normalcy in the area. Helicopters are also useful in airdropping the commodities in relatively cut-off areas.

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14. S.P. Cohen and C.V. Raghavulu, op.cit., p.97.

An important step in the management of disaster is guarding against spread of diseases in the areas where drinking water and drainage lines are affected. There is need for close surveillance for every symptoms of such occurance and for timely preventive measures. Supply of drinking water in cans including its air dropping where necessary and supply of chlorine tablet to improve the quality of water and destruction of bacteria should be given special attention. In 1977 cyclone, most of the hand pumps in affected area were either rendered disfunctional or, produced salt water. The restoration of drinking water facility had been done only after honest efforts of the administration.

vi) Cyclone Shelters

In case of evacuation of people in the 'affected area' the use of cyclone shelters during such emergencies is inevitable. 'These shelters are tall, single or two story buildings built all along the sea coast, near the village habitations at fairly elevated places. They are designed to accomodate about 50-100 families in the event of sea surge.[15] During cyclones and floods, the coastal villages are inaccessible. Evacuation of people to safer places

15. S.V. Giri, op.cit., p.9.

under such conditions has always been a problem. Some times the population is very reluctant to move out since they have to cover a long distance to return home. These shelters have been able to move in without serious dislocation. There is demand for more number of such shelters to be constructed. For the sake of maintainance and their continuous use, these shelters are expected to be put to some community use like schools, panchayat work or Mahila Mandals

viii) **Rehabilitation Measures**

Rehabilitation covers two phases-i) restoration of normal life for the victims and ii) restoration of public services and amenities. An important component of the rehabilitation effort is repairs/ reconstruction of houses damaged in the disaster. The issues involved in the efforts include funding the construction and availability of land whenever shifting of the site is involved. Sometimes redesigning of the houses and the revised layouts are also involved. The experiences also vary from partial funding to take care of the immediate requirements, to complete rebuilding of the houses by the Government. But there are some practical difficulties. The government, voluntary agencies and the people respond to disasters in uncoordinated and undemarcated ways creating confusion. Adhoc groups often dump relief materials in easily

accessible places. Impractical promises made by voluntary organisations and government contribute in promoting an attitude of dependence among the people.

Another constraint in matter of relocation is that immediately after the floods and cyclones people generally express the feeling that they would shift to places of safety but very soon the apprehension wears out and the reluctance to move out of familiar surrounding becomes very difficult to overcome. Such institutional and psychological obstacles are practical problems in such relocational exercises.'[16]

The 7th Finance Commission [17] provided Rs 18.60 crore for disaster relief and rehabilitation every year as recurring margin money. Disasters lead to diversion of large quantum of financial and other resources from normal developmental activities and put the developmental progress in the reverse gear, at least temporarily.

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16. Ibid., p.10.

17. K. Ramesh, 'Management of Cyclone Disasters : A System Approach' in "**Symposium on Preparedness Mitigation and Management of Natural Disaters**," vol.2, New Delhi, 1989, p.17.

Occupational Rehabilitation

In floods and cyclones, the occupation which suffers most is agriculture, after the standing crop is damaged. It may be possible to sow a second crop to take advantage of the season, but it is difficult to produce the right quality of seed and proper technical back up. Buffer stocking can be done to solve this problem, contingency agricultural plans and technology inputs for difficult crops is also an important requirement.

Flood and rains result in breaches to tank and canals leadng to heavy siltation and change in water courses resulting in erosion of valuable agricultural land. To reclaim such land is an expensive and time consuming proposition. Sand casting up to 30 cms can be removed and transported, but in case of heavier sand casting, the economies of reclamation will have to be considered with reference to the cost of the land. For all these cases, low concessional loans are being granted to facilitate such reclamation and subsidies in principal and interest are also given to small and marginal farmers.

In cases of loss of cattle or equipment such as handloom or tools of village artisans or loss of assets in case of small industries, the effort of the management should be to rehabilitate them in their normal vocations, as early as possible..

Indian economy during 1953-84 experienced severe damages from floods and cyclones. The loss has been estimated to the tune of Rs. 15, 406.43 crore of which crop damage accounting about Rs 8,630.10 crore [18]

ix) **Forecasting and Warning: The role of IMD and CWC warning system**

Thanks to advance space technolgy, it is now possible to predict with high degree of accuracy. any cyclonic storm 48 hours before it is expected to cross coastal areas. Prediction and warning signals are extremely useful for disaster preparedness, for they are not only reliable but communicated well in advance to all levels of government administration so that suitable precautionary measures are taken to reduce losses and damages.

The pre-cyclonic phase would include a package of interrelated activities and tasks that could be viewed as a 'system'. A system is defined as a set of elements that are fundamentally united in the accomplishment of specified objectives. [19] The elements of the system can be assembled in the form of a model for disaster mitigation.

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18. B. Raghavulu Naidu,"Economic Consequences of 1977 cyclone in Andhra Pradesh' Tirupati: S.V. University, 1986, p. 28.

19. K. Ramesh, op.cit., p.18.

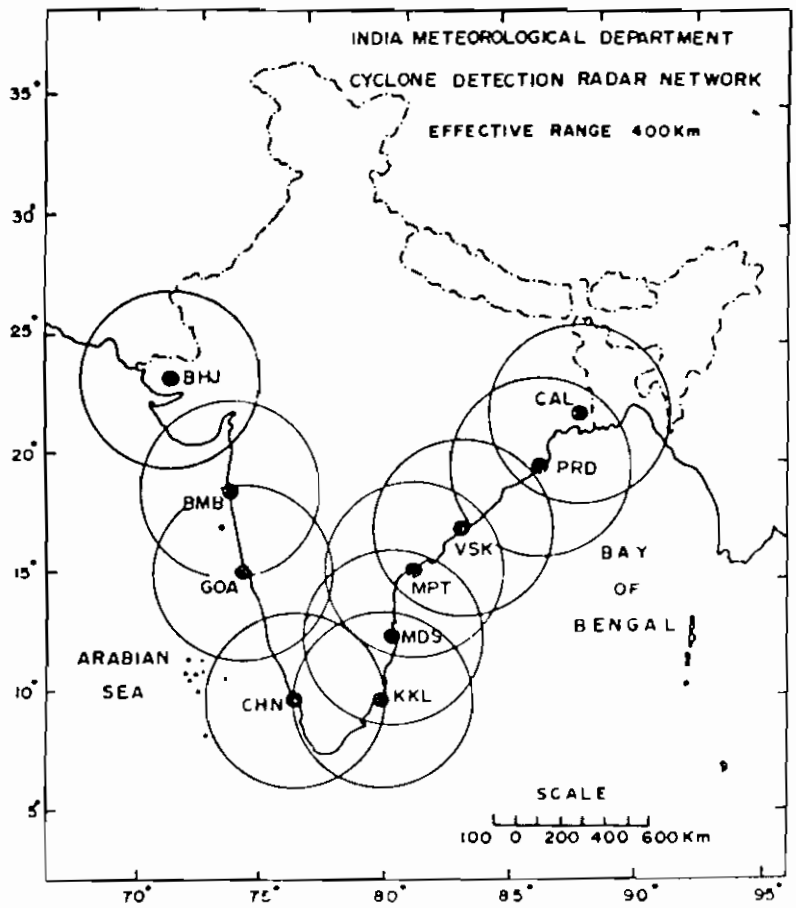

Figure : Cyclone Detection Radar Network

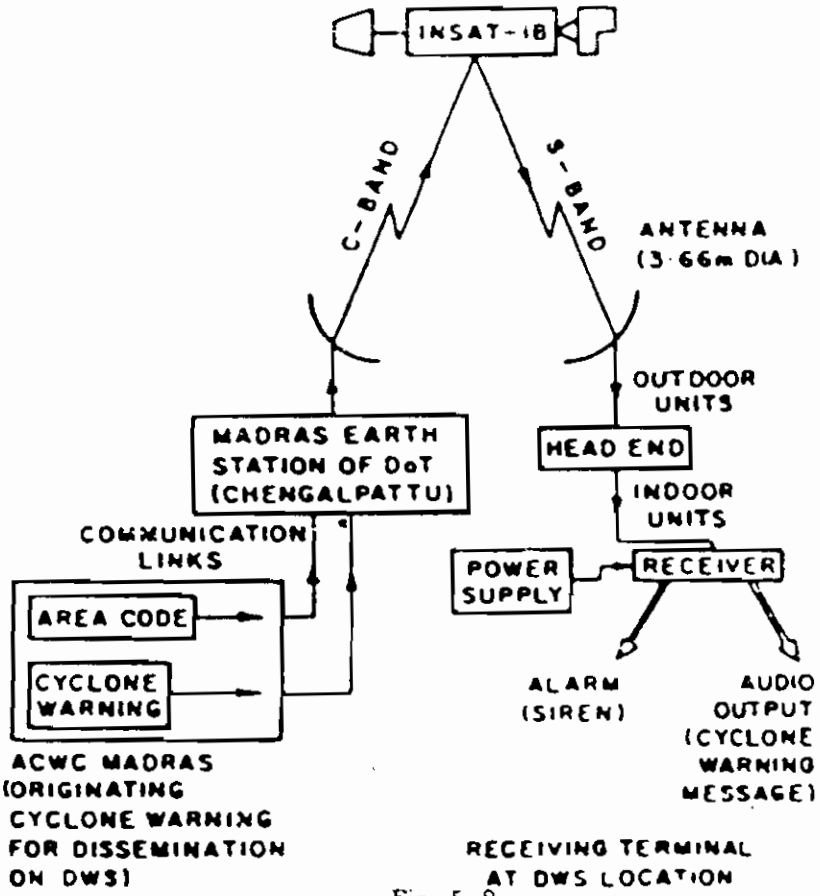
INSAT-1B
C-BAND
S-BAND
ANTENNA
(3·66m DIA)
OUTDOOR
UNITS
MADRAS EARTH
STATION OF DoT
(CHENGALPATTU)
HEAD END
INDOOR
UNITS
COMMUNICATION
LINKS
POWER
SUPPLY
RECEIVER
AREA CODE
CYCLONE
WARNING
ALARM
(SIREN)
AUDIO
OUTPUT
(CYCLONE
WARNING
MESSAGE)
ACWC MADRAS
(ORIGINATING
CYCLONE WARNING
FOR DISSEMINATION
ON DWS)
RECEIVING TERMINAL
AT DWS LOCATION

Fig 5·2.

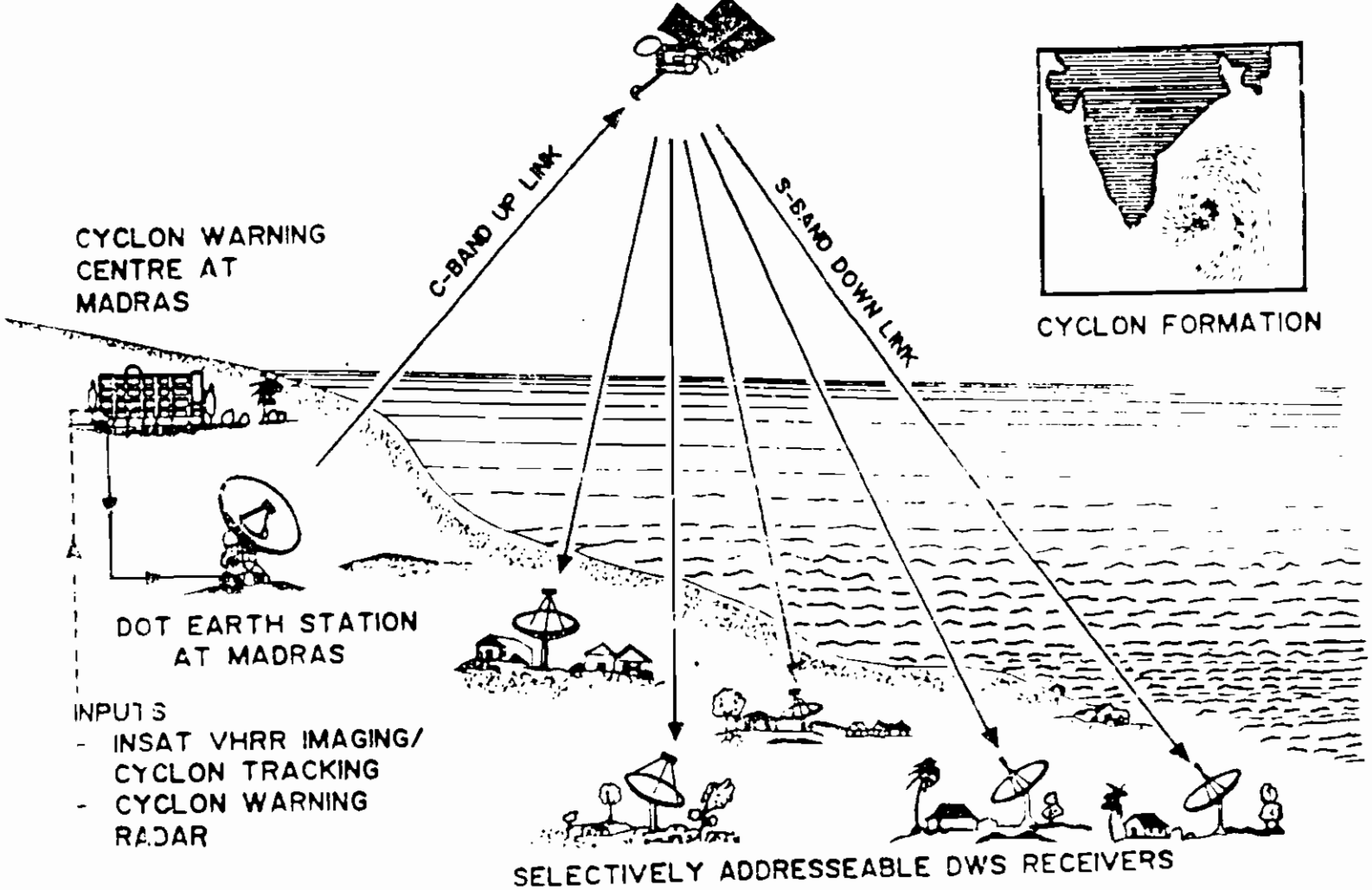
CYCLON WARNING CENTRE AT MADRAS
C-BAND UP LINK
S-BAND DOWN LINK
CYCLON FORMATION
DOT EARTH STATION AT MADRAS
INPUTS
- INSAT VHRR IMAGING/ CYCLON TRACKING
- CYCLON WARNING RADAR
SELECTIVELY ADDRESSEABLE DWS RECEIVERS

Fig. 5.3.

The first step of the warning system is forecasting of the disasters and the issue of appropriate warnings to all those who are concerned with disaster management and to the vulnerable community. A warning is expected to describe the time, intensity, scope and the area of strike, together with the measures to be taken. Forecasts, as distinct from warning, would normally be issued at fixed times, at intervals of 6 or 12 hours, or of course, more or less frequently according to individual requirements. Warnings are issued when the tropical cyclone poses a threat to lives and property.

For a long time, the meteorological reports from ships were the main source of information on the movements of cyclonic storms. During those days the delays in receiving and transmitting information on cyclonic storms contributed to heavy losses and damages. However, today, the warning systems have attained a fair degree of reliability after the launching of a meteorological satellite in 1960 by the U.S. An elaborate system of cyclone warning centres with advance communication network has been installed by the I.M.D. The courses of depression /cyclones in the sea are traced by these centres and necessary advance warning is given to the areas likely to be affected. The IMD also sends necessary warning messages to the state and district administration, port authorities and others according to an

album page entry system.

The first warning system in India was installed in 1865 at Calcutta which was one of the earliest warning systems in the world. In 1875, India Meteorological Department (IMD) was established. During the last 40 years, the IMD has set up chains of observatories. The IMD has also set up an 'S' band (10cms) radar in 1970 at Dolphins Nose Hills, Visakhapatnam for the first time. Now the Meteorological Department has installed cyclone surveillance Radars at Calcutta, Paradeep, Visakhapatnam,Machilipatnam, Madras and Karaikal in the east coast and at cochin, Goa, Bombay and Bhuj in the West coast. [20] Now it is possible to accurately track the course of the cyclones and warn the districts to be affected 18-24 hours before the strike. In April 1982, The Indian National Satellite (INSAT-IA) was positioned over the equator, which kept a continuos watch of cyclones and transmitted their pictures every half an hour to the Meteorological Data Utilization Centre (MDUC) at Delhi. Satellite picture receiving (APT) equipment of Delhi, Bombay, Pune, Madras, Visakhapatnam, Calcutta and Gauhati are receiving satellite pictures of the cyclones from the Polar- orbiting satellites of the U.S.A. and U.S.S.R. Since

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20. 'Hazards of Cyclones', New Delhi: I.M.D. Publications, 1989,p.8.

April 1982, A.V.H.R.R. (Advanced Very High Resolution Radio. meter) ground receiving equipment is operative at New Delhi. At this centre, very High Resolution cloud pictures in 5 channels as T.I.P. data (TirosInformation Processor) are being regularly received and are being achieved in Magnetic Tapes. [21] Further improvements in the cyclone tracking and forecasting have taken place after the Meteorological application programme of the Geo-stationary satellite INSAT-1B has become operational since october, 1983. It takes hourly pictures which are received by the Meteorological Data Utilisation Centre (M.D.U.C.) at New Delhi and are further disseminated to all the forecasting officers through Radio facsimile.

Cylclone operations are being done by the Meteorological Department through the Area Cyclone Warning Centre (A.C.W.C.) and the Cyclone Warning Centre (C.W.C.). A.C.W.C. at Calcutta and Madras and the C.W.C. at Bhubaneswar and Visakhapatnam are responsible for cyclone forecasting in the Bay of Bengal; Where as ACWC at Madras and Bombay and CWC at Ahmadabad are responsible for the cyclones in the Arabian sea. National forecast centre at Pune acts as co-ordinator. Computerised operational

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21. Ibid, p.10.

advisory forecasts on cyclone movements are being issued by the Numerical Weather Prediction (N.W.P.) division of the department at the H.Q. office at New Delhi.

Cyclone warnings issued to the Chief Secretaries, the Relief Commissioners and the District Collectors of the maritime states are very basic informations for cyclone distress prevention and mitigation. These are disseminated under a 'Two stage warning scheme' [22] The first stage warning known as the 'Cyclone Alert' is issued 48 hours in advance of the expected commencement of the adverse weather over the coastal areas. The second stage warning known as the 'Cyclone Warning' is issued 24 hours in advance. Both Cyclone 'Alert' and 'Warning' messages are passed to the AIR stations for repeated broadcast. For dissemination of cyclone warning, the meteorological department has to depend mostly on the Telecommunication channels of the P & T department consisting of landline telegrams, Teleprinter, Telex, Telephone etc. Incidentally, these channels are generally the first casualty in case of cyclonic storms. Communication systems immune of the effects of the cyclones are wireless, telegraphy, Radio telepathy, Fax Transmission system, very high frequency and Microwave communication system. From 1987, INSAT based Disaster Warning System (DWS)

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22. Ibid., p.10.

for South Andhra and north Tamil Nadu coasts has become operational, which is likely to circumvent failures of traditional communication systems. Under this scheme, the cyclone warnings are directly sent to the users through INSAT. Such facility is likely to be extended to other cyclone prone areas in near future.

x. **Assessment:-** Assessment is a pre requisite to effective post- disaster management. An estimate of the loss is necessary so that resources could be mobilised and distributed to the affected areas. Apart from that data on loss of human life and damage to property enable further analysis and programming to reduce such losses in future.

xi.**Planning:**

Besides the provision of infrastructural facilites for effective disaster management, the administrative machinery should be entrusted with the necessary powers to carry out disaster management programmes. District authorities should be directed to prepare model plans for disaster prone areas. The Central and State governments should prepare contingency plan of action demarcating the functions and responsibilities of various departments both in pre and post disaster situations. There must be interdepartmental and intradepartmental cooperation and coordination at national, regional, district, taluk or village level. It

should be done for all the stages of disaster-interdisaster, preimpact and disaster phase. [23]

xii. **Financial Arrangments**

Financial arrangement is the back bone of disaster management programme. The Government of India supplements the efforts of the State Governments under a set of well established norms governed by the recommendations of successive finance commissions. There is certain amount of money earmarked in the state and central budgets known as 'margin money', fixed for each state to be shared equally between the state and the centre. If the relief expenditure is expected to exceed the margin money, the state's requirements are assessed by the centre and assistance given mostly as a non-plan grant to the extent of 75% of the estimated expenditure and the state's share is remaining 25%. An amount of about 500 crore was given by way of approved ceiling of expenditure to the different states which faced cyclones/floods during 1988-89.

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23. B.K. Verma, op.cit., p. 14.

Table 5.1

Extent of central assistance approved for states for natural calamities relief in various plan periods-

S.No.	Period.	Total amount sanctioned (ceilings of expenditure crore Rs)	Average annual assistance (ceilings of expenditure crore Rs.)
1.	I Five year plan (1951-1956)	28.18	5.64
2.	II Five year plan (1956-1961)	38.55	7.71
3.	III Five Year Plan (1961-1966)	32.55	6.41
4.	Annual Plan (1966-67)	58.36	58.36
5.	Annual Plan (1967-68)	99.97.	99.97
6.	Annual Plan (1968-69)	105.54	105.54
7.	IV Five Year Plan (1969-74)	1197.97	239.59
8.	V Five Year Plan (1974-79)	651.40	130.28
9.	Annual Plan (1979-80)	341.43	341.43
10.	VI Five Year Plan (1980-85)	2791.97	558.39
11.	VII Five Year Plan (1985-90)	5129.91	1025.00

Source: J.C.Pant, 'Disaster Relief in India' in G.K. Mishra and G.C. Mathur, **Natural Disaster Reduction**, Ed., New Delhi: Reliance Publishing House, 1993,pp.89-90.

xiii. **Long Term Measures:** The approach to natural disasters is no more confined to rendering relief in the wake of natural calamities. It is one of comprehensive management covering all the stages from the stage of anticipation and preparedness to implementation of a comprehensive set of rehabilitation measures. For cyclones following longterm, medium term and short term measures be taken.[24]

Long term Measures:-

I. Strengthening of houses

II. Developing a system of land planning and regulation to reduce the risk.

III. Plant trees at some distance from houses to serve as wind and tide breakers.

IV. Loose material lying around inhabitations should be tightly fastened or removed.

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24. V. Ranganathan, 'Disaster prevention' in **'Report on SAARC Seminar on Disaster Management September 28-October 1, 1987'**, Hydrabad: National Institute of Rural Development, 1987, pp., 19-20.

Medium Term Measures:-

1. Communication network for early warning is the most important and should be finalised well in advance of the cyclone season.

2. Public education regarding cyclone.

3. Arrangement of emergency stores and first aid centres.

Short Term Measures:-

1. Contingency plans to be finalised

2. To issue regular warning and ensure that they are taken seriously.

3. Evacuation from vulnerable areas.

4. Public Health and sanitation measures.

XIV. Voluntary and Non-Governmental Organisations

The participation of voluntary organisations in the rehabilitation effort is a challenging and important task. While many philanthropic efforts come forth spontaneously in the wake of calamities, it is generally confiend to distribution of food grains and clothing and in some cases cash assistance. Non-governmental, organisations are mainly concerned with rendering relief works such as [25]

* Shifting of victims to safer places

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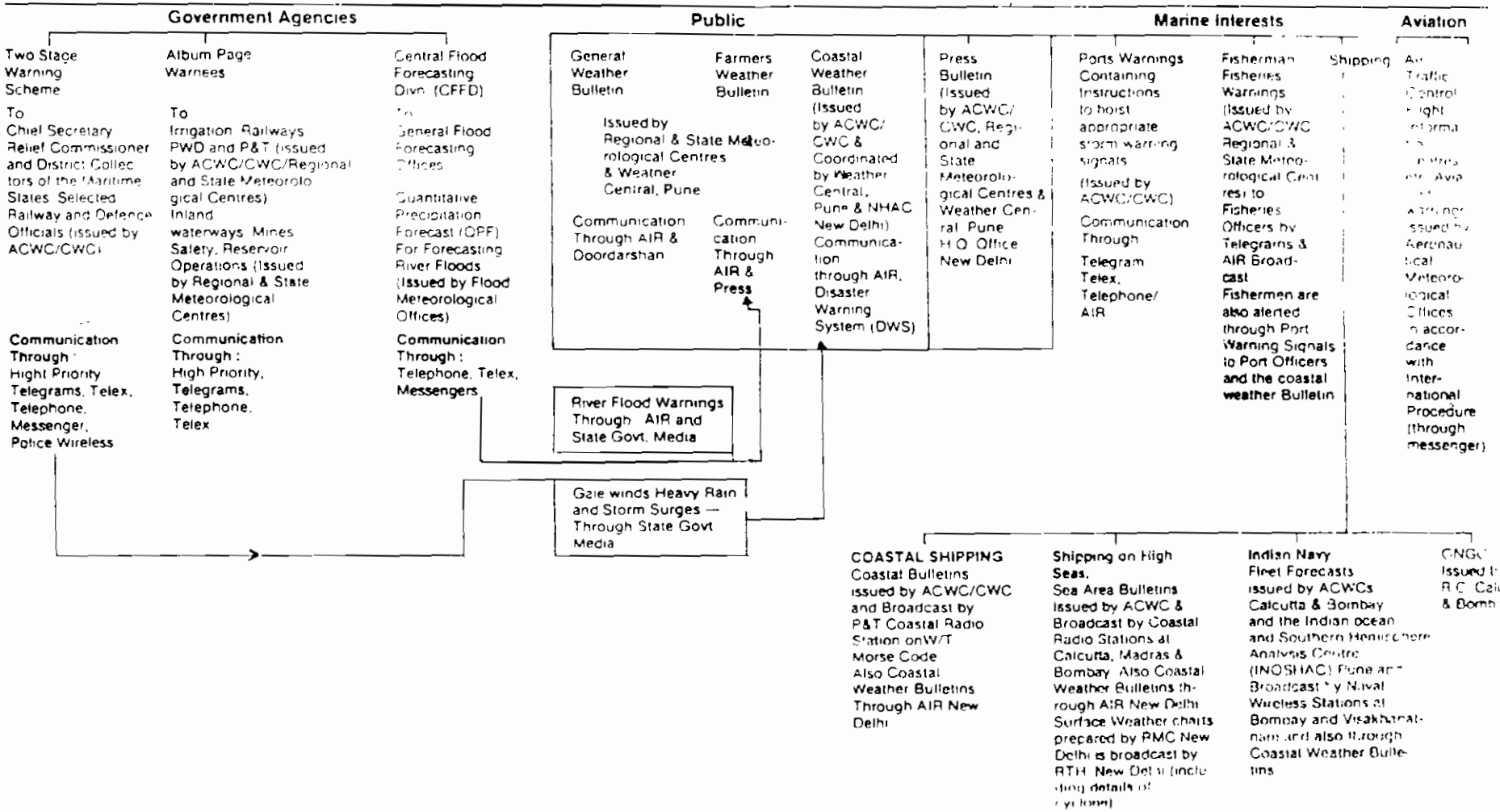
25. R.Raghavulu Naidu, 'Role of Government and voluntary Organisation in sample villages' in sample villages' in **Economic consequences of 1977 cyclone in Andhra Pradesh**' Tirupati: S..V. University, 1989, pp. 204-214.

DISSEMINATION OF THE CYCLONE WARNINGS



* Running relief camps,
* Distribution of clothes,
* Gratuitous relief for damaged houses,
* Distribution of Utencils,
* Medical Aid,

* Distribution of housing materials, etc.

There are many voluntary organisations at local levels in every district, which do significant work at the time of disasters. Some well known organisations such as Red Cross, Lion's Club, Rotary Clubs, CASA (Church's Auxillary for Social Actions) World Vision of India, Voluntary Health Association of India (VHAI), Wadia Muslim Mission (WMM), Relief wing of R.S.S., Village Reconstruction Organisation (VRO), CARTITAS- India, Appropriate Reconstruction Training and Information Centre (ARTIC), Evalengical Fellowship Of India Commission and Relief (EFICOR), National Service Scheme (NSS), Joint Assistance Centre (JAC) CARE (Cooperative for American Relief Every Where), PREPARE, IYDP, Ram Krishna Mission etc. have contributed significantly to the work of relief and reconstruction.[26] In the case of earthquakes in Maharastra (1993) many voluntary

26. Parvathi Menon, 'Life after Devastation', **Front line**, 5 Nov. 1993, pp. 9-10.

organisations came out for quick relief operation. At the same time international organisations also came for relief. UNICEF and UNDP had sent $ 160,000 while private donors have chipped in with $ 60,000 for Latur, apart from tents and medicines worth $ 3 million. [27]

XV. **Engineering aspect of Cyclone Disaster Mitigation**

Tropical cyclones cause considerable havoc destroying millions of houses and other structures along with killing people and livestock. The present level of R and D efforts towards better understanding of the effects of cyclonic winds on houses, buildings and structures is inadequate. Science and Technology can play an increasing role in improving our present knowledge in this area. Improved guidelines and techniques can be developed for design and construction of structures in cyclone prone areas to mitigate damage. R and D efforts have been made in this direction at the Structural Engineering Research Centre, Madras, Central Building Research Institute (CBRI) Roorkee, and Housing and Urban Development Corporation (HUDCO).

One of the important measures to mitigate cyclonic wind disaster is to improve upon the wind loading standards for

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27. Rahul Pathak, 'Can India Cope?' '**India Today**, oct. 31 1993, p.67.

design for buildings and structures. 'In order to determine accurately the cyclonic wind loads acting on various structures, there is a necessity to carry out risk analysis of cyclonic wind speed data and to compute characteristic cyclonic wind speeds corresponding to different mean return periods.'[28]

From the studies on damage suffered by buildings and structures in various parts of the world, the following failures may be identified—

1. Blowing off of roof sheets due to poor connections between structural elements in pitched roof buildings;
2. Failures of tiled and A.C. sheet roof system due to uplift forces owing to their light weight compared to R.C.C. roof system;
3. Collapse of boundary and gabled walls due to inadequate strength in resisting lateral high wind forces
4. Collapse of low-rise industrial sturctures, due to lack of roof and wall bracing system and
5. Failures of a few well-engineered structures due to design inadequacies and poor quality of construction.

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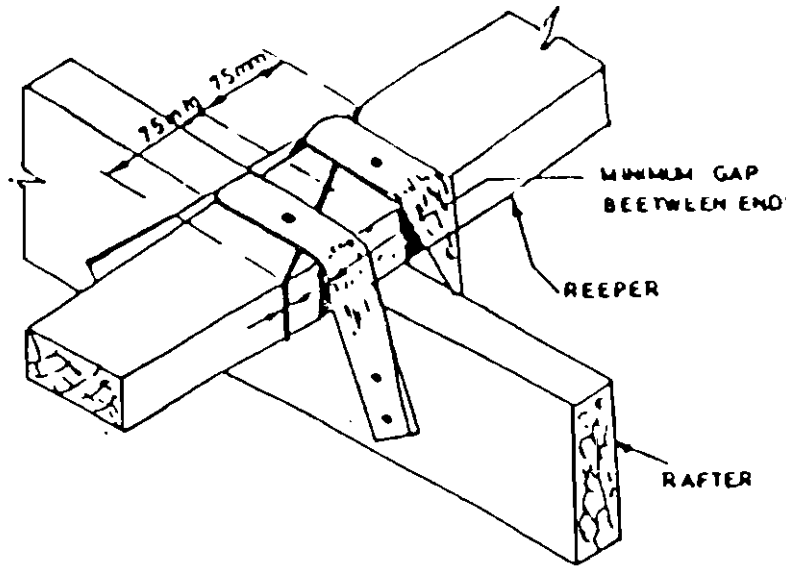
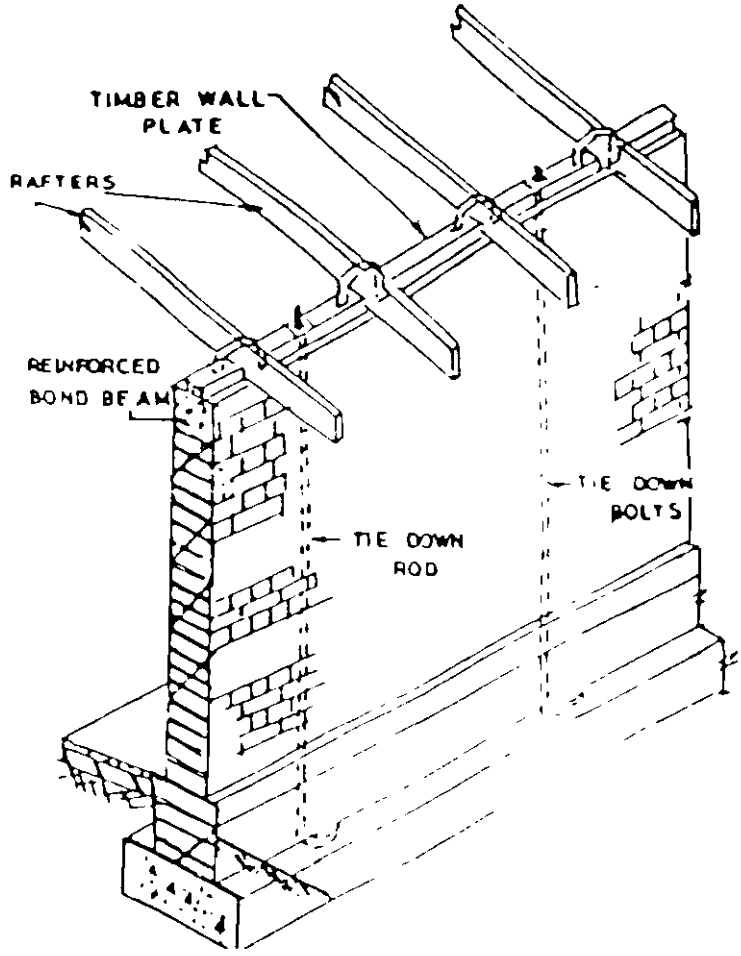
28. J. Shanmugasundaram, et.al., ' Engineering of Structures for cyclone Disaster Mitigation' in G.K.Mishra and G.C. Mathur's '**Natural Disaster Reduction**,' Ed., New Delhi: Reliance Publishing, 1993, p.161.

Building Structures in Cyclone Prone Areas:—



Use of Straps and Nails to Tie-down Rafter to the Top Plate



: Fixing of Walls to the Foundation Using Tie-Down Bolts

Fig. 5.4

The above types of failures can be minimised and the resistance of such structures against cyclones can be increased by adopting simple, improved design and construction techniques. Anchorage, bracing and continuity are the prime factors influencing the structural integrity.[29]

To ensure structural integrity the following measures may be adopted-

i) every part of a structure should be firmly tied or anchored to a secure point which can safely resist all the forces acting on it.

ii) roof and end walls must be properly braced to prevent overturning, sliding and rotation and

iii) each part of the structure must be properly connected to every other member along the strength chain from cladd-ing to foundation.

XVI. **International Decade for Natural Disaster Reduction**

A resolution proposing to designate the 1990s an IDNDR was jointly submitted by 93 countries and adopted by concensus at the 42nd session of the United Nations General Assembly in 1987. And finally the U.N. 44th General Assembly adopted a resolution, now co-sponsored by 155 countries, proclanning the decade starting in 1990 as

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29. Ibid., p. 168.

International Decade for Natural Disaster Reduction.

Objectives and goals of IDNDR [30] are –

a) To improve the capacity of each country to mitigate the effects of natural disasters particularly of the developing countries in the establishment of early warning systems, etc.;

b) To devise appropriate guidelines and strategies for applying existing scientific and technical knowledge to natural disaster reduction;

c) To foster scientific and engineering endeavours aimed at closing critical gap in knowledge ;

d) To disseminate existing and new technical information; and

e) To develop measures for the assessment, prediction, prevention and mitigation of natural disasters through programmes of technical assistance, technology transfer, education, training , etc.

XVII. **SAARC and Regional Cooperation in Management of Natural Disasters.** During the third SAARC summit at Kathmandu in November 1987, the heads of state expressed their deep concern at the fast and continuing degradation of

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30. Anand S. Arya, 'Internationl Decade for Natural Disaster Reduction,' in D.K.Sinha, Ed., **Natural Disaster Reduction for Nineties : Prospectives, Aspects & Strategies'**,Calcutta: International Journal Service, 1992,pp. 103-104.

the environment including extensive destruction of forest in the region. These degradations were severly undermining the development process and prospects of the member countries. So it was decided to intensify regional cooperation with a view to strengthening their disaster management capabilities. The Male Declaration of November 1990 expressed the hope for an action plan for meaningful cooperation in the field of Environment and Disaster menagement.[31] The terms of reference were—

i) country wise identification and study of natural disasters, their nature, extent, causes and consequences;

ii) country wise identification of different aspects of environmental degradation, the causes of their implications for natural disaster;

iii) countrywise survey of existing programmes for

a) the management of disasters including prevention/mitigation/relief and rehabilitation;

b) the protection, conservation and restoration of the environment;

iv) Identification of common areas of regional concern;

v) Identification of specific areas of national priority requiring further action; and

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31. C. Dasgupta, (SAARC and Regional cooperation in Managment of Natural Disasters' in D.K. Sinha, Ed; **Natural Disaster Reduction Nineties; Prospectives, Aspects & Strategies**', Calcutta: International Journal Service, 1992, pp. 165-172.

vi) Identification of measures and programmes at the regional level, for strengthening disaster management capabilities, and for the protection and preservation of the environment of the member countries

SOME RECOMMENDATIONS

1. There should be a national approach to disasters with national requirements, imperatives and global perspectives in the context of IDNDR.

2. There should be an appropriate interministrial group at the central level of coordination with states and territories, appropriate research community and professional organisations with the principal objectives of developing a common approach to future natural disaster managements.

3. There should be a legislation for establishing the Indian variant of IDNDR so as to serve the follwing purposes-

a) to focus on natural disaster reduction within India.

b) to establish links with U.N. member nations on a co-operative basis for reducing natural disasters throughout the world.

c) to augment existing programmes and collaborative efforts between governmental and non- governmental organisations.

4. An integrated programmeof IDNDR should stress the development of-

a) action agenda,

b) research agenda,

c) public information component.

5. Disaster consortica at regional and local levels involving community, government undertakins and NGOs with a multi- disaster focus and integrated and multiobjective planning at the district panchayat levels should be setup.

6. Basic research development on natural disaster should be given high priority.

7. There should be efforts for prevention of natural disasters and awareness in educational curriculum.

8. One planning process must reflect promotion of disaster reduction, non-governmental and voluntary organisations should be provided with support for dissemination of information and recovery, relief and rehabilitation projects.

TH-7263

9. Mechanism to continuously monitor and evaluate disaster reduction programme should be institutionalised.

10. Creation of full disaster reduction capability in the states frequented heavily by natural disaster should be accorded high priority.

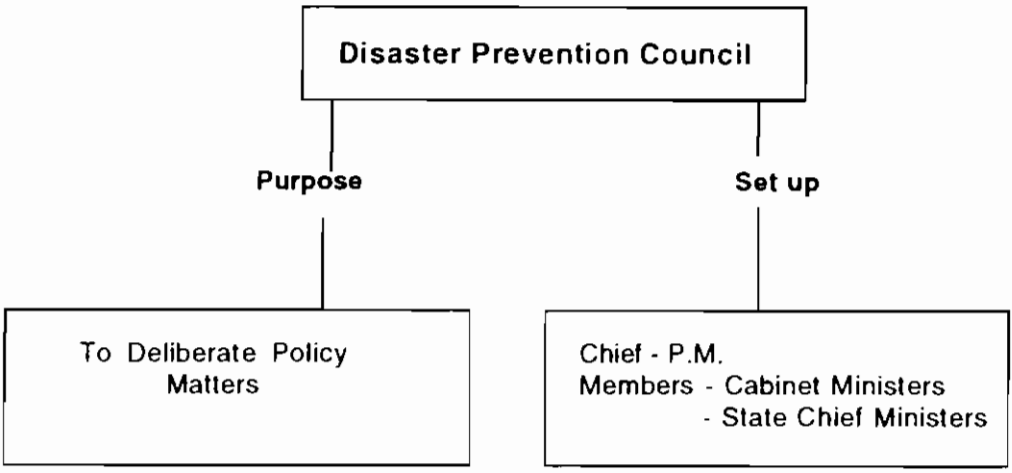
11. There should be professional programmes for different target groups such as, policy makers, planners, community and other interested groups.

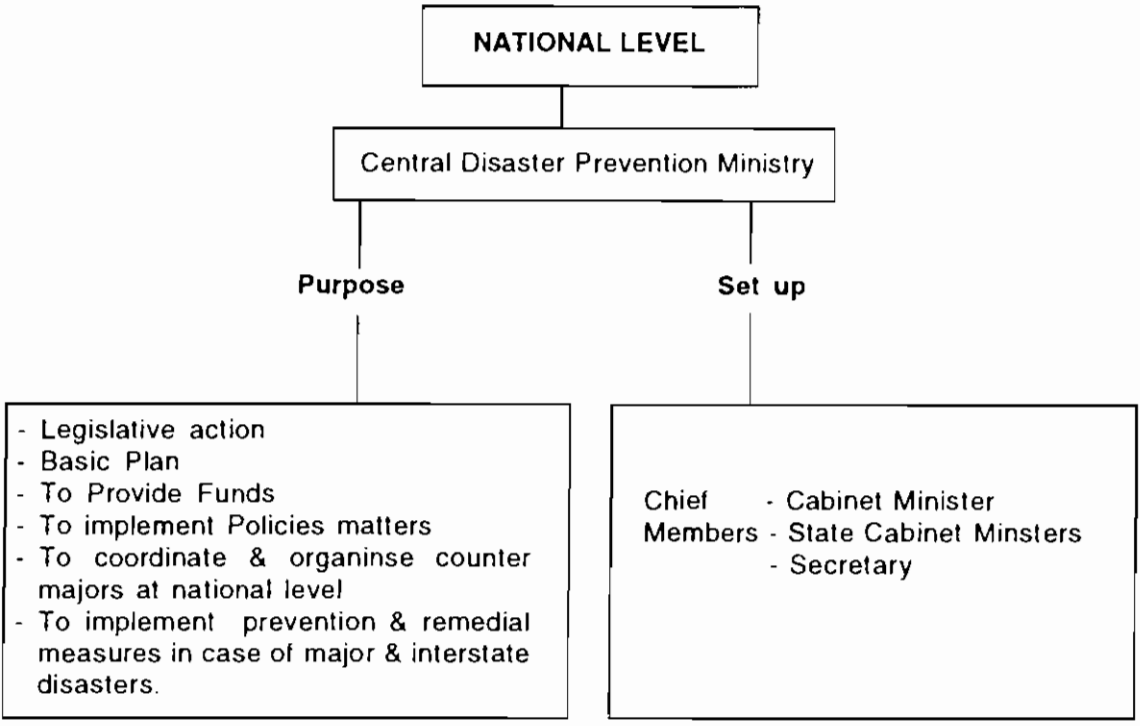
12. Development of Information Management System should be given a high priority.

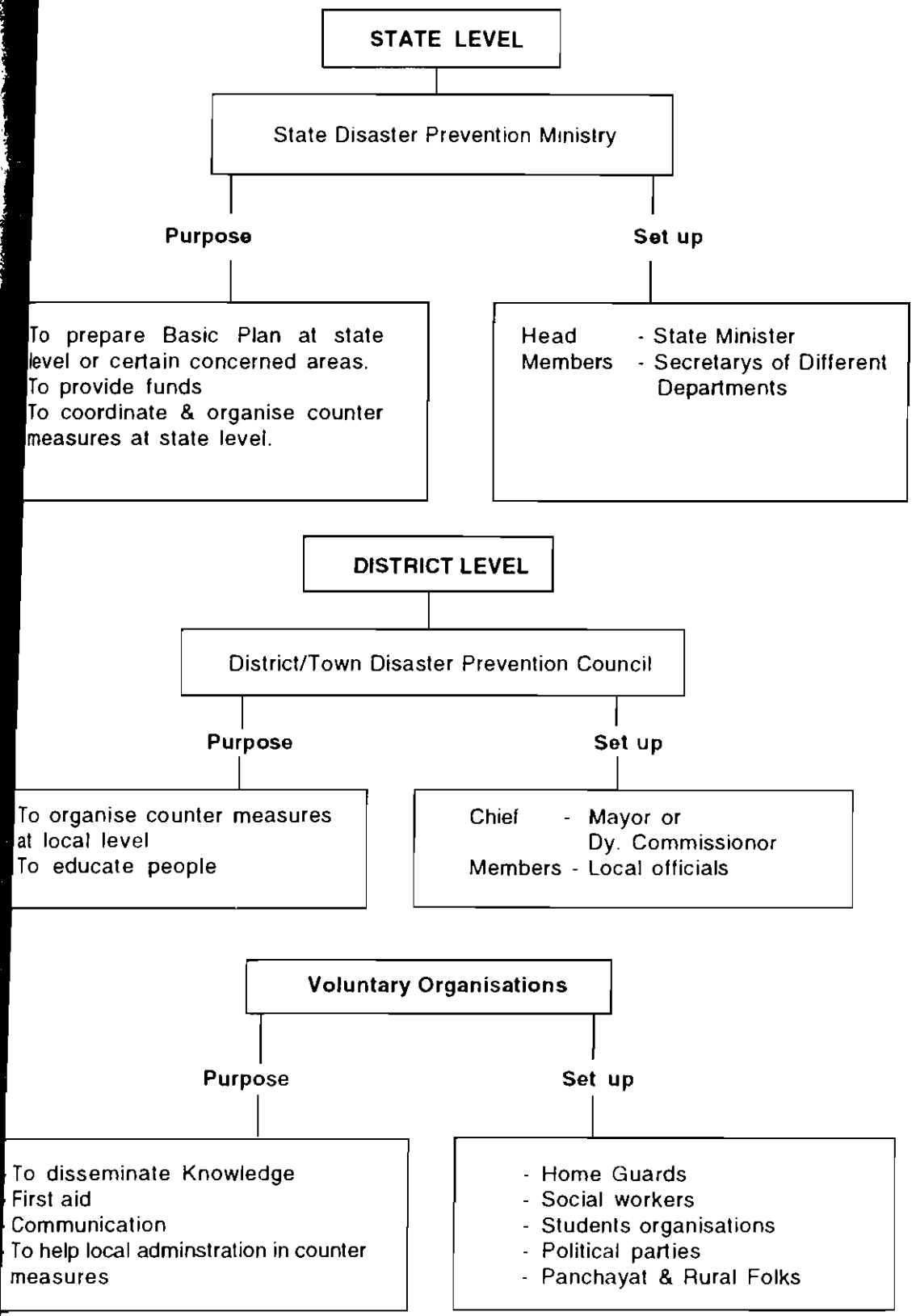
13. "Natural disaster" should be declared as one of the national missions at par with the existing ones, so that implementation strategies consisting of commitment, provison, access, effective warning systems, standardization etc. should be worked out.

14. 9th Oct of every year may be observed as "Disaster Preparedness Day" in the country.

DISASTER ADMINISTRATION SUGGESTED-INDIAN MODEL






STATE LEVEL
State Disaster Prevention Ministry
Purpose
Set up
To prepare Basic Plan at state level or certain concerned areas.
To provide funds
To coordinate & organise counter measures at state level.
Head - State Minister
Members - Secretarys of Different Departments
DISTRICT LEVEL
District/Town Disaster Prevention Council
Purpose
Set up
To organise counter measures at local level
To educate people
Chief - Mayor or Dy. Commissionor
Members - Local officials
Voluntary Organisations
Purpose
Set up
To disseminate Knowledge
First aid
Communication
To help local adminstration in counter measures
- Home Guards
- Social workers
- Students organisations
- Political parties
- Panchayat & Rural Folks

Conclusion

CONCLUSION

Humanity has been the victim of natural disaster from its very beginning. It has extracted a heavy toll of deaths and suffering to the human beings. Earthquakes, landslides, floods, cyclones, hurricanes, volcanic eruptions,wild fires and such other natural disasters have claimed millions of lives all over the world and have adversly affected billions of people. Disasters have multiplying effects as one type of disaster ends up in another.To exemplify a few floods may occur with cyclones and earthquakes either simultaneously or in a sequential pattern,causing dam failures,land slides, destruction of roads and bridges.The character and extent of the disaster depends upon the nature of the elements involved and on the resistance of a man made enviroment to these elements.

"Natural Disaster" is a global phenomenon and it does not recognise any national boundary.' But the worst sufferers are the developing countries which are badly equipped to deal with such events. The South Asian countries can be cited as examples which have economic dependence upon primary production and have primitive and inadequate technological infrastructure. This results in substantial loss of human life and social upheaval in the first instance, and the destruction and disruption of vital

production structures and communications in the second. Disasters are, thus, a significant obstacle to economic development, especially in lesser developed parts of the world , India being no exception.

Ever since the dawn of human civilization, man has always been struggling to control nature and environment. Infact, the goal of human destiny is to gain complete mastery over nature. But despite technical advances in the field of structural and non structural measures, the quantum of loss of life and damage to material assets is increasing. It may not be possible to prevent the occurance of these natural phenomenon but the disasterous effects they generate can be avoided or atleast reduced. In fact, it is not the phenomena themselves, but their interaction with human settlements and land use that constitude disasters.

In our country, a start has already been made in this direction and much valuable work on the reduction of loss from natural disasters has been carried out by engineers, scientists, architects, planners and emergency managers. Various aspects of disaster management such as prevention, preparedness, forecasting, warning, rescue and relief, rehabilitations, reconstruction, planning, financing, and education and research have been dealt by our disaster management programmes.

India's national approach to management has evolved over a period of time. A new forecasting technique known as parametric and power regression model (PPRM) has been developed by India meteorological department (IMD). This model uses 16 regional and global parameters physically related with south-west monsoon rainfall. National Agricultural Drought Assessment and Monitoring System (NADAMS) provides drought bulleteins throughout the monsson season for different states, Thanks to advanced space technology, it is now possible to predict with high degree of accuracy, any cyclonic storm 48 hours before it is expected to cross coastal areas. An elaborate system of cyclone warning centres (CWC) with advance communication network has been installed by IMD. The courses of depressions/cyclones in the sea are traced by these centres and necessary advance warning is given to the areas likely to be affected.

Each state has a corpus of funds called calamity relief fund (CRF), administred by state level committee headed by the Chief Secretary of the state government. A National Advisory Committee (NAC) on IDNDR (International Decade for Natural Disaster Reduction) has also been established under the chairmanship of the Union Agriculture Minister. It provides guidelines to several organisations. At the

apex level, a cabinet committee on natural calamities (CCNC) has been constituted to direct the implementation of programmes to give objectives of the IDNDR.

At regional level, seven countries of South Asia (SAARC COUNTRIES) have decided to intensify regional cooperation for management of disasters. They have become acutely aware that though they have had a different past individually, they certainly have a common future.

Declaration of 1990's as International Decade for Natural Disaster Reduction has given new dimension to management aspect. It advises to develop an harmonious approach towards disaster mitigation and economic development.

Now, the approach to natural disaster is no longer confined to rendering relief in the wake of natural calamities. It is one of comprehensive management, covering all the stages from the stage of anticipation and preparedness to implementation of a comprehensive set of rehabilitation measures. The vulnerable areas should be recognised and the developmental plans relevant for these areas should be framed. To apply the collective wisdom and knowledge in a 'now or never' style is the underlying philosophy of the International Decade for Natural Disaster Reduction 1990- 2000 AD.

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Appendix

APPENTIX I

LOSS OF LIFE BY DISASTER TYPE AND BY CONTINENTS 1947-1980

	Asia	Ocenia	Africa	Europe	South America	Caribbean & central	North America	Total
1. Floods	1,70,664	77	3,891	11,199	4,386	2,575	1,633	1,94,425
2. Typhoons cyclones and hurricanes	4,78,574	290	864	250	-	16,541	1,997	4,98,516
3. Earthsquakes	3,54,521	18	18,232	7,750	38,837	30,613	77	4,50,048
4. Tornadoes	4,308	-	548	39	-	26	2,727	7,648
5. Thunderstorms	20,210	-	-	120	60	310	244	20,944
6. SnowStorms	6,360	17	-	1,340	-	200	1,910	9,827
7. Heatwaves	4,705	100	-	340	135	-	2,190	7,470
8. Coldwaves	1,330	-	-	1,440	-	-	600	3,370
9. Volcanoes	2,805	4,000	0	2,000	440	151	34	9,430
10. LandSlides	4,021	-	-	300	912	260	-	5,493
11. RainStorms	1,648	-	05	26	145	-	49	1,873
12. Avalanches	335	-	-	340	4,350	-	-	5,025
13. Tidelwaves	4,459	-	-	-	-	-	60	4,519
14. Fog	-	-	-	3,550	-	-	-	3,550
15. Sandanddust Storms	150	-	-	-	-	-	10	160
Total	10,54,090	4,502	23,540	28,694	49,265	50,676	11,531	12,22,298

Source : B. Raghavulu Naidu, 'Economic consequence of 1977 cyclones in Andhra Pradesh'; Based on Bindi V. Shah : 'Is the Environment becoming more hazardous? A Global Survey : 1947 to 1980'

APPENDIX II

DAMAGE FROM FLOODS AND CYCLONES FROM 1953 TO 1982

ock riod	Area affected in lakh hectares		Population affected in lakh		Human lives lost		Crop loss Rs. in crore		Total damage Rs. in crore	
	Max[m]	Average	Max[m]	Average	Max[m]	Average	Max[m]	Average	Max[m]	Average
53-1962	111.70	68.29	309.50	156.09	1389	525.50	80.28	46.96	118.69	62.87
63-1972	132.50	65.74	596.50	239.83	3498	938.50	423.00	130.94	632.00	192.09
73-1982	344.00	135.96	705.00	462.70	11316	2690.40	911.00	496.10	1714.00	945.50

urce : Compiled from - 'The national Commission on Floods', Ministry of Energy and Power, Government of India, New Delhi, 1980.

APPENDEX III

MAJOR EARTHQUAKES OF 20TH CENTURY IN INDIA

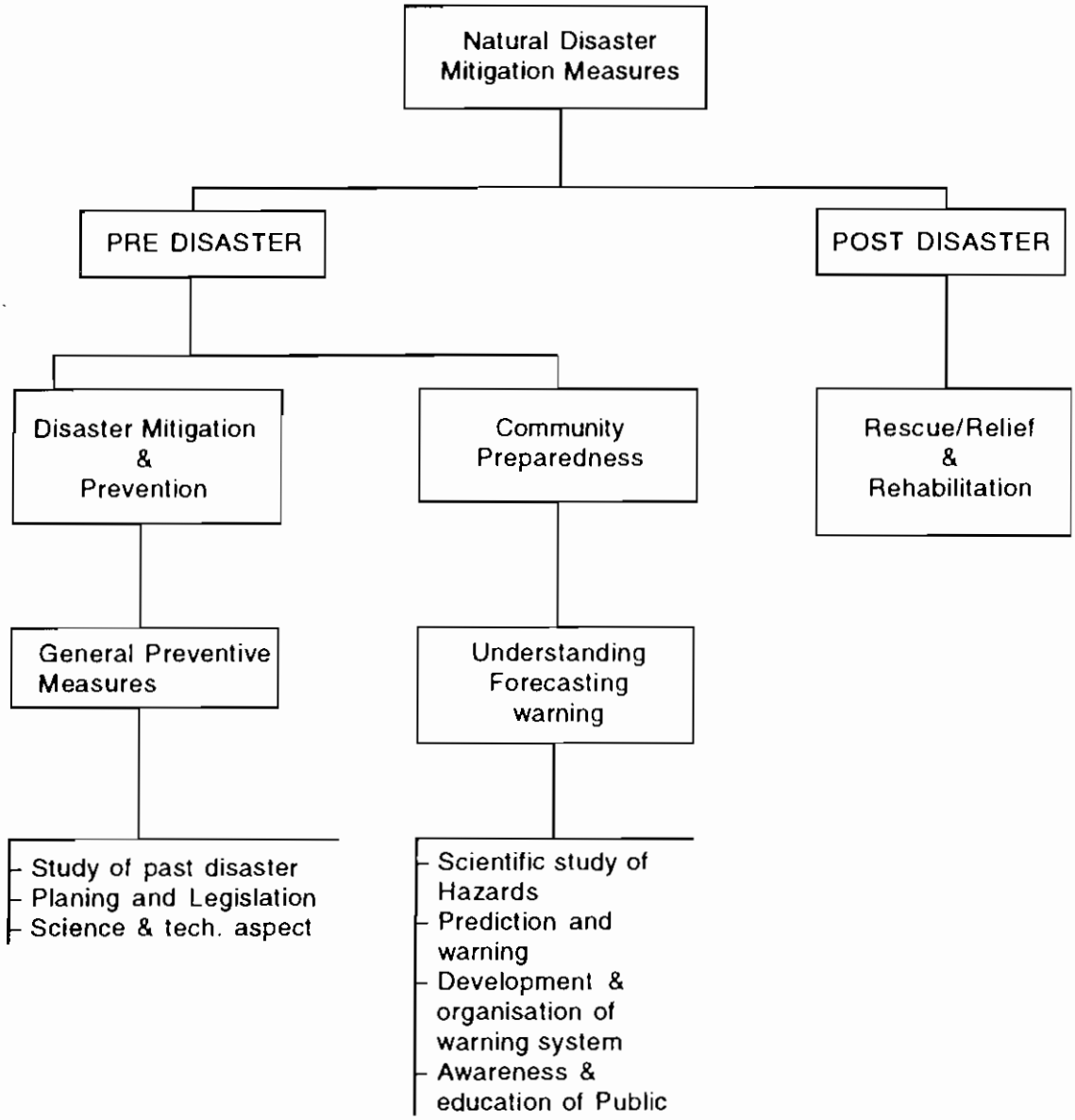
S.No.	Date	Area Affected	Magnitude	Description of Damage reported
1.	4.4.1905	Kangara Valley	8.7	Terrific landslides in Dhauladhar, north of kangara vallay. Water in canals rose as high as 6 feet above usual level. 2 miles long earth fissures on the banks of chanab river. Death toll was placed around 19,000.
2.	15.1.1934	Bihar Nepal	8.4	Structures slumped bodily in alluvium, subsidance of road and railway embankments, sand blows, and earth fissures were formed-one at champaran was 15 feet deep, 30 feet wide and 900 feet long. Death toll reported was 11,000.
3.	30.5.1935	Quetta Now in Pakistan	7.6 very close	Epicentre of the Earthquake was to the city resulting in higher death toll of 30,000.
4.	26.6.1941	Andaman Nicobar Islands	8.7	
5.	15.8.1950	Entire NEFA, Assam & Northen Burma	8.7 of earth	Earthquake was felt over an area of 1.75 million square miles. Number fissures were opened. Sand and water rushed out. There were prominent landslides. Total 1526 deaths were reported.
6.	11.12.1967	Koyna	7.5	Death toll was 200.
7.	21.08.1988	Bihar & Nepal	6.4	Large scale damage to life and property.
8.	1991	Uttarkashi	6.7	1000 killed and large scale damage reported.
9.	30.9.1993	Maharastra	6.4	10,000 people killed.

Source : (i) Table 1 of 'Symposium on Preparedness Mitigation and Management of Natural Disasters Vol. II, New Delhi, 1989.

(ii) Raj Chengappa 'Where Next', India Today, october 31, 1993.

APPENDIX IV

Components of Disaster Mitigation Measures



APPENDIX V

Community Preparedness Plan in respect of cyclones and Earthquakes