RECEIVED
16 NOV 1976
School of Development Studies

UNIVERSITY OF BRADFORD

DISASTER RESEARCH UNIT/SCHOOL OF SCIENCE AND SOCIETY

NATURAL DISASTERS - AN INTERMEDIATE TEXT

DR. RANDALL BAKER
OVERSEAS DEVELOPMENT GROUP
UNIVERSITY PLAIN
NORWICH NOR 88C ENGLAND

K.N. Westgate and P. O'Keefe

OCTOBER 1976

UNIVERSITY OF BRADFORD

DISASTER RESEARCH UNIT/SCHOOL OF SCIENCE AND SOCIETY

NATURAL DISASTERS - AN INTERMEDIATE TEXT

K.N. Westgate and P. O'Keefe

OCTOBER 1976

DT3

PREFACE

The ideas in this volume are the result of two years work at the Disaster Research Unit. During that time the current approach to disasters was challenged and the Disaster Research Unit developed a theoretical approach to disaster which drastically called for a serious rethinking of the way disasters are handled at present.

The material in this book is, to a large extent, based upon the ideas thus developed. But it would be futile to view the Disaster Research Unit's approach in isolation. The material, therefore, includes close reference to and scrutiny of previous research.

The volume is intended to be a course book for second-year students undertaking the half-option in "Natural Disasters" with the School of Science and Society at the University of Bradford. It does not supplant the short, first-year introductory booklet issued to all students during an introductory week on "Disasters" but rather considerably extends the argument presented in that booklet.

The authors would like to express their considerable gratitude to Ben Wisner, Temporary Lecturer in Geography at the University of Sheffield, for his substantial contributions to sections 14 and 16. He has also been instrumental in the development of the ideas expressed herein and contributed much to the nature of the work undertaken at the Disaster Research Unit. In this respect also, we acknowledge the work of Alec Baird during the initial stages of the development of the theory.

The authors would further like to thank Mike Lear of the Cartography Unit, Department of European Studies, University of Bradford, for the preparation of the maps in Section 7.

Finally, thanks are extended to Jean, who patiently typed the manuscript and to Paula who greatly aided the collation.

Ken Westgate
Phil O'Keefe
Disaster Research Unit,
University of Bradford.
October 1976.

TABLE OF CONTENTS

		Page
PART 1:	INTRODUCTION	
1.	Definitions of Disaster	1
2.	A Brief History of Disaster Research	7
PART 2:	DISASTER TYPES	
3.	Seismic Phenomena	14
4.	Climatological Phenomena - Hurricanes and Tornadoes	21
5.	Climatological Phenomena - Floods	29
6.	Long-term Ecological Phenomena - Drought and Famine	31
PART 3:	THE GLOBAL CONTEXT OF DISASTER	
7.	Global Distribution of Disaster Types and Related Socio-Economic Data	35
PART 4:	THE ECONOMIC AND SOCIAL IMPLICATIONS OF DISASTER	
8.	The Social Aspects of the Disaster Event	50
9.	The Social Aspects of the Disaster Environment	57
10.	The costs of Disaster	63
11.	The Costs of Disaster Prevention	77
PART 5:	CASE STUDIES OF DISASTER	
12.	Case Studies I: Three Recent Earthquakes	98
13.	Case Studies II: Hurricane Fifi, 1974	105
14.	Case Studies III: Drought - a Case Study of Africa	118
PART 6:	THE RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT	
15.	Sources and Analysis of Data on World Disaster Occurrence	133
16.	The Data Interpreted: the Relationship Between Disasters and Development	151
PART 7:	DISASTER TECHNOLOGY	
17.	Traditional Approaches to Disaster Technology	163
18.	An Integrated Approach to Disaster Technology	165

Page

PART 8: DISASTER RESEARCH APPLIED - THE PLANNING FRAMEWORK

19. Disasters and Planning 166
20. Preventive Planning for Disasters - a Long Term Strategy? 172

APPENDICES 179

LIST OF TABLES

		Page
1.	Nine-year Totals Reported Foreign Disaster Statistics and Emergency Relief Costs	64
2.	Guatemala: Initial Cost Estimates of Earthquake Damage	67
3.	St. Lucian Banana Production (Actual Tons)	81
4.	Average Return Period Per Disaster in Years	82
5.	Average Damage Value Per Event	82
6.	Calculation of Annual Premium: Results	84
7.	Estimation of Loss as a Percentage of Sum Insured	86
8.	Premium Rate Expressed Per Mille	86
9.	Revised Premium Calculation	87
10.	Revised Premium for Storm Damage	87
11.	Annual Cost of Insurance	88
12.	Honduras: Disaster History, 1968-73	108
13.	Honduras Planning Council: Damage Assessment	111
14.	Honduras: Percentage Industry Controlled by Foreigners	114
15.	UNESCO: Disasters by Type and Region, 1969	134
16.	United Nations Economic and Social Council: Natural Disasters Occasioning a Major Appeal on the Part of the League of Red Cross Societies, by Type and Region, 1961-1970	136
17.	UNDRO: Disasters Ranked According to Region, 1919-1971	137
18.	UNDRO: Disasters Ranked According to Region, 1951-1971	138
19.	UNDRO: Disasters Ranked According to Region, 1968-1971	139
20.	UNDRO: Number of Disasters by Type, 1968-1971	140
21.	USAID: Number of Disasters by Region, 1968-1971	142
22.	USAID: Disaster Occurrence by Region and Type, 1968-1971	143
23.	Smithsonian Institution, Centre for Short-Lived Phenomena: Disaster Phenomena, 1968-71	144
24.	Natural Hazard Research Group: Number of Large Area Disasters by Type and Region, 1968-1971	146
25.	Non-Governmental Organisations: Number of Disasters by Type and Region, 1970-1972	148
26.	Insurance Companies: Disasters by Type and Region Based on Reinsurance Data, 1968-1971	149

LIST OF DIAGRAMS

		Page
1.	Continental Shelves Colliding	16
2.	One Continental Shelf Dipping Under Another	16
3.	The Development of a Tsunami Showing Tsunami Speed at Various Ocean Depths	19
4.	Collision of Opposing Trade Winds: Earth's Rotation Causes Air to Whirl Counterclockwise in Northern Hemisphere	22
5.	Hurricane Development: Warm Moist Air Over Tropical Ocean Rises, Surrounding Air flows in, Becomes Warm and Moist and Rises	24
6.	Hurricane Development: Water Condenses as Moist Air Rises Releasing More Heat and Causing Air to Rise Faster	25
7.	Hurricane Development: Hurricane as Seen From Above - Winds Whirl Around a Calm "Eye" in the Centre	26
8.	Hypothetical Impact of Bahamas Building Code on Hurricane Damage in Bahamas	92
9.	Global Disasters 1947-1973: Five Year Moving Average	152
10.	Number of Disaster Strikes by Per Capita Income of Disaster Strike Area	155

LIST OF MAPS

		Page
1.	World Seismic Belts	37
2.	Recorded Earthquakes, Volcanic Eruptions, Storm Surges and Tsunamis, 1969	39
3.	World Annual Precipitation	41
4.	World Tropical Cyclone Activity	43
5.	World Protein - Calorie Malnutrition	45
6.	World Urbanisation	47
7.	World Estimated GNP Per Capita in US Dollars for 1972	49

PART 1: INTRODUCTION

1. Definitions of Disaster.
2. A Brief History of Disaster Research.

1. DEFINITIONS OF DISASTER

1.1. Involvement in disaster by international and national organisations and academic institutions has led to a number of individual views on disaster. This summary will attempt to reveal the alternative approaches to disaster, their shortcomings and the need for a more comprehensive outlook on disaster in order that the latter's real nature may be understood.

1.2. Organisations Connected with Disaster

a. International organisations (for example, the United Nations and its constituent parts).

b. National governments.

c. Non-governmental, voluntary organisations (for example, the League of Red Cross Societies, Catholic Relief Services, World Council of Churches, etc.)

d. Academic Research Institutions (for example, the Smithsonian Institution for Short-Lived Phenomena and the Natural Hazard Research Group, both centred in the United States).

e. Private insurance companies.

1.3. All of these have, from time to time, produced data on disaster occurrence and underlying this data production, each organisation has its own conception or definition of disaster. The main points which emerge from these definitions can be summarised as follows:

a. 'Disaster' does not presuppose the existence of a population and its associated infrastructure.

b. 'Disaster' presupposes the existence of a population and its infrastructure.

c. 'Disaster' refers to that period of actual impact and the succeeding period of emergency.

1.4. Other organisations, while not explicitly defining disaster per se, implicitly refer to disaster as being that period immediately after actual impact and the associated deaths, destruction and relief requirements. The only organisation which attempts to define the situation in a different way is the academic research organisation, the Natural Hazard Research Group,

who refer to 'natural hazard' rather than 'disaster'. This approach recognises disaster potential rather than disaster per se and refers to a situation observed in areas where there is a disaster threat and not the immediate, post-impact period of death and destruction. This

> '... post impact situation is of lesser importance than the alternatives available for reducing damage from future occurrences'.
>
> (Hewitt and Burton, 1971)

1.5. A survey of these various organisations reveals the following approaches to disaster:

a. Disaster can refer to thephysical agent.

b. Disaster can refer to the combination of a physical agent and a population and its associated infrastructure.

c. Disaster can be a function of a physical event and a social state.

1.6. The type of definition most prevalent among these organisations is that which refers to a time period involving actual disaster strike and the succeeding emergency period. But, on the whole, a survey of definitions utilised by organisations connected with disaster reveals a lack of consensus.

1.7. Definitions from Academic Research

Systematic academic study of disaster began in the United States in the early nineteen-fifties and has gained momentum to the present day. The initial impetus for this systematic research came from the situation of Cold War between the USA and USSR and the accompanying nuclear threat. Much of the research was funded by United States Defence Agencies who required to know how populations were likely to behave in a nuclear attack. Lacking the opportunity for empirical study of actual nuclear attack situations, the agencies turned to natural disasters for data on human behaviour in such situations of stress, as an indication of likely behaviour in the event of nuclear war. It is clear, therefore, that the academic tradition of disaster research is grounded in the twin disciplines of sociology and psychology and concentrates heavily on the disaster event and the succeeding emergency period.

1.8. Anderson (1969) considers that 'disaster' can refer to:

a. The physical agent.

b. The physical consequences of the agent, i.e. damages and deaths.

c. The way in which the impact of the physical agent is evaluated.

d. Social disruption and social changes brought about by the physical agent and its impact.

1.9. Reference to the physical agent alone clearly is not adequate. A hurricane far out over the Atlantic Ocean, or an earthquake in an uninhabited mountain region hardly constitute a disaster but remain, in this state, purely physical phenomena. Only when the physical agent comes into contact with groups of people, their associated infrastructure and means of livelihood can we talk in terms of 'disaster'. A physical agent, therefore, cannot be seen in isolation. For the purposes of 'disaster', a physical agent must be seen as one side of an interaction between two factors.

1.10. Having suggested that disaster involves two basic elements - a physical agent and a human group - it is necessary to impose some limitation on the concept of disaster as it applies to collections of people given that the latter is the less consistent element involved. The physical agent can be assessed and measured within a range of frequencies, velocities and magnitudes. But how are we to measure the people side of the interaction? What factors within groups of people apply to and create a situation that can be delimited 'disaster'?

1.11. A simple starting point would be to assess disaster in terms of numbers: so many people dead or injured constitutes a disaster. The problem here is where to draw the line. A better approach would be to envisage a state of normality which a society enjoys from day to day and which is disrupted when that society interacts with a potentially harmful physical agent. Disaster, in this sense,

> '... is an event (or series of events) which seriously disrupts normal activities'
>
> (Cisin and Clark, 1962)

This is an important concept because it highlights the need to observe disaster as an extension of everyday life, a situation in which individuals and groups of individuals are asked to behave and make decisions which are outside the scope of everyday life while remaining within the normal societal structure. A society does not take on a separate and unique structure to cope with a disaster event.

1.12. Taking this one stage further, many societies, in areas where physical phenomena are potentially harmful, contain an anticipatory element which forms a part of normal existence and leads to a degree of continuity of activity from non-disaster to disaster situations. This notion accepts that the threat of impending disaster is as important to the comprehension of disaster as the disaster event itself. It is this threat and the perception of this threat which places an understanding of disaster in an ecological and dynamic context.

1.13. Hewitt and Burton (1971) develop this theme of potential threat, refusing to discuss disaster per se, but preferring to talk in terms of 'hazards'. Firstly, they accept that a hazard of any sort is a function

> '...both of the physical event itself and the state of human society ...'

where hazard refers to the threat from physical phenomena, the potential for disaster. Secondly, they accept that hazards form a part of everyday life.

> 'Hazards are largely implicit in the ordinary conditions, and it is important to define the latter, as well as the extremes'.

1.14. The hazard approach recognises the continuing man/environment relationship. Man selects his sites because of resources, favourability, etc., and many hazard environments contain these requirements (flood plains, volcanic soils, etc.). In accepting sites which are more favourable to his needs, Man also accepts the extremes of that environment. His perception of these extremes leads to the creation of a hazard factor and this hazard factor is countered by Man attempting to negate the hazard

factor through a series of responses and adjustments to this factor. All of this takes place outside of an actual disaster event, in 'normal' times. It is strongly contended, therefore, that to thoroughly comprehend disaster as a dynamic feature of the man/environment relationship, it is important to see disaster as the extreme situation which is implicit in the everyday condition of the population.

1.15. Many of the definitions covered above refer to the disaster event and the succeeding emergency period. The importance of the disaster event cannot be underestimated: it is the ugly manifestation of the extremes of the environment. Many of these manifestations are to be seen in developing countries. Indeed, a recent analysis of available data on disaster occurrences suggests that disaster events in developing countries are on the increase (vide 2.6). In the light of this premise, and the preceding discussion, the Disaster Research Unit have devised a set of workable definitions which can be applied to locations for which an understanding of disaster is most needed. Three initial points must be stated:

a. It is essential to view disaster as an extreme within a series of non-extreme events - an extension of everyday life where the latter is as important to an understanding of disaster as the disaster manifestation itself.

b. In all disaster situations, one word is operative. Societies and populations are always vulnerable. Disasters occur because communities are vulnerable to the vagaries of the environment.

c. Placing points (a) and (b) together, it can be asserted that disaster events occur at the interface between extreme natural or physical phenomena and a vulnerable human group.

1.16. Bearing these three points in mind, the following workable definitions can be devised which are applicable to any situation where potential disaster exists and to attempts at the mitigation and prevention of the potential effects of disaster manifestations.

a. The Disaster Event. The manifestation of an interaction between extreme physical or natural phenomena and a vulnerable human group. The manifestation reveals itself in terms of general disruption and destruction, loss of life and livelihood and injury.

b. The Disaster Context. The sum total of the possibilities, probabilities and frequencies of the occurrence of various disaster agents and events, including the histories of any previous disaster events, in any given location, which render that location vulnerable.

c. The Disaster Environment. The combination of the disaster context and the social, economic and political conditions prevailing within any given location.

d. The Disaster Process. The dynamic operation over time of the distinctive elements contained in the Disaster Environment and their interrelationship.

e. Vulnerability. The degree to which a society is at risk from the occurrence of extreme physical or natural phenomena where risk refers to the perjorative probability of the occurrence of a disaster event, and the degree to which socio-economic factors affect a community's capacity to absorb and recover from the effects of extreme phenomena. The term should be applied to the Disaster Context, the Disaster Environment and the Disaster Process.

REFERENCES

ANDERSON, W.A. (1969). Local Civil Defense in Natural Disaster: From Office to Organisation. Disaster Research Center, Report Series No. 7, Ohio State University, Columbus.

CISIN, I.H., CLARK, W.B. (1962). 'The Methodological Challenge of Disaster Research'., in G.W. Baker and D.W. Chapman (eds): Man and Society in Disaster. Basic Books, New York.

HEWITT, K., BURTON, I. (1971). The Hazardousness of a Place: A Regional Ecology of Damaging Events. University of Toronto Press, Toronto.

2. A BRIEF HISTORY OF DISASTER RESEARCH

2.1 Systematic disaster research is a product of the twentieth century and primarily the period post 1930. However, the trends which lead to systematic research and the development of a knowledge of disaster events as social science laboratories can be found in considerably earlier periods. This chapter will outline the research line to the present day and will concentrate on that research which has tended to observe the totality of a disaster event. The reader is asked to be aware of the work on specialised disaster-related topics such as earthquake engineering which paralleled much of the work discussed in this chapter. Here, the concentration will be on the social sciences because they have contributed most to an understanding of disaster.

2.2. Disaster events are the problem of a minority of the world's population. Thus, the majority of us rely on second-hand information via the media. This has always been so. Accounts of disasters can be found in the Bible and in the literature of other ancient civilizations. Prior to 1920 most available literature was of this type, based on hearsay and observation. Some accounts were more comprehensive than others. Mostly narrative, occasionally discussive, these reports came from travellers, officials and philanthropists who happened to be present at the time of the disaster strike. These accounts were often romantic in construction and contained awe-inspiring description and metaphor to stun the reader. But they also contained the embryo of future behavioural research in disaster. Examples of the more comprehensive accounts can be found on the Lisbon earthquake of 1755 (see Appendix I), the Messina, Sicily, earthquake of 1908 (Niddrie, 1961) and the Irish famine of the mid-eighteen hundreds (Ayckroyd, 1974). Accounts of such historic disasters as the Krakatoa eruption of 1883, the Mount Pelee eruption of 1902 and the San Francisco earthquake of 1906, exist in abundance.

2.3. Another important contribution to disaster-related literature came about as a direct result of the Industrial Revolution in Western Europe. Accompanying the rapid drive towards industrialisation was inevitably the factory and pit disaster. The form

in which these disasters were recorded was not necessarily a narrative although narrative accounts do exist. Poetry and folk-song were the prime means of expression among the people actually experiencing the disaster. This grassroot expression is an important contribution to the wealth of knowledge and came to be exploited later as it was realised how much actual behaviour in disasters differs from expected behaviour. (See Appendix II for examples of folksongs from this period.)

2.4. 1920 marks a turning-point in disaster-research. This year saw the first systematic, social science study of a disaster event. The event in question was the catastrophic explosion of a munitions ship in the harbour of Halifax, Nova Scotia in December 1917. The explosion killed 2,000, injured a further 6,000, left 10,000 homeless and laid waste 300 acres of land and property. The study was intended to be

> "... an intensive study of two social orders between which stands a great catastrophe, and its thesis is the place of catastrophe in social change."
>
> (Prince, 1968).

Prince's intention was to look at the social order in Halifax before the explosion and then attempt to analyse how the explosion had changed that order. In carrying out this work, Prince presented the first detailed sociological account of a disaster event, recognised many of the psychological factors involved in disaster behaviour which were later to be analysed in depth during the 1950s and 1960s, surveyed organisational responses to disaster, laid down several principles of relief distribution, examined the part played by governments in disaster, and undertook to examine the whole recuperative quality of a community. Much of this work was to be utilised by disaster researchers in future attempts at systematic research.

2.5. The next three decades saw no real progress in the development of a <u>systematic</u> research line on disasters. Disaster research began to crystallise itself within the United States. Two distinctive events revealed the importance of disaster in American life. Firstly, the Dust Bowl of the 1930s shockingly advertised

the need for careful consideration of the man - environment relationship and led to comprehensive integrated planning programmes. Secondly, the U.S. Government were experiencing problems in controlling some of the major rivers of the United States. This latter problem was later to lead directly to a distinctive socio-geographical disaster research paradigm (vide section 9). In the late 1920s, however, it was recognised that flood losses were rising even though the U.S. government had instigated heavy engineering measures (such as dams) to control flooding. This apparent paradox led Chicago geographers under White to begin a reappraisal of the whole flood control situation. They pleaded the case for the consideration of a wide range of possible ways of controlling floods instead of relying solely on the construction of dams.

2.6. The Second World War and immediate post-war period gave psychologists an opportunity to study the behaviour of human beings under stress. Much of this research was to be of value during the later period of more intensive disaster research. Examples of such research included the study of the human consequences of blanket bombing campaigns on Japanese and German cities, the social problems of wartime evacuations and the problems of training civil defence personnel. Janis was an important figure to emerge due to his post-war synthesis and analysis of human response to bombing campaigns. Janis viewed his study as an examination of the stresses to which people are subjected in disaster and the responses that these stresses promote (Janis, 1951). Much of the pioneer psychological analysis is attributable to him.

2.7. The turning point for disaster research came in 1950. The reason for the upturn in activity was strategic. By 1950, Winston Churchill had delivered his famous "Iron Curtain" speech and the Cold War was well-established. Accompanying this state of mind was the fear of nuclear attack. United States defence agencies required to know how populations were likely to react and respond to such an attack. Lacking the nuclear war situations required for empirical study, the U.S. government reasonably assumed that

empirical data could be collected from natural disaster situations and this information would give a guide to the population's behaviour in times of nuclear war. Thus, in 1950, the National Opinion Research Center in Chicago, armed with Army funding, undertook to investigate eight community disaster events within the U.S.A. over a period of four years. They also prepared a comprehensive list of disaster study literature.

2.8. The major breakthrough in disaster research came in 1952 with direct government involvement in the field. In that year the National Research Council of the National Academy of Sciences set up a Committee on Disaster Studies. The funding was again primarily from government defence and civil defence departments while later, health agencies also contributed. At first, the National Academy of Sciences saw its role as one of co-ordination. As such it promoted and publicized research and actively supported research programmes. Its intention was

> "... to understand disasters as overall phenomena without prejudice to the fields of knowledge and research implied... The Committee is interested in the reactions of the American people to disaster situations and in the problem of how available resources, people, equipment and physical facilities are employed in response to disasters. It is the utilization of these resources rather than the equipment and physical facilities per se that is to be studied by the Committee."
>
> (Williams, 1954).

Thus the Committee's interests were primarily orientated towards the human and social problems of disaster events. Based upon the growing number of individual field studies the Committee's chief contribution to disaster research (apart from the publication of the field studies themselves) was in the delimitation of a number of phases of disaster and an analysis of the behaviour and social response attached to each phase. These phases can be summarised as:

1) The warning phase
2) The threat phase
3) The impact phase
4) The inventory phase
5) The rescue phase
6) The remedy phase
7) The recovery phase

All but the recovery phase were areas for research under the aegis of the National Academy of Sciences. Whereas the early years of the Academy's interest were mainly concerned with accumulation and the establishment of the research potential, later, with the formation of a Disaster Research Group, which had a more active and positive role to play than the Committee, more detailed analysis and consolidation was possible.

2.9. The termination of the Academy's active interest in disaster research in 1963 coincided with the formation, within the Department of Sociology at Ohio State University, of the Disaster Research Center. The research field was now ready for more detailed specialisation. The 1950s had begun with an interest in individual response to disaster and this had further developed into community and social concerns. Now the Disaster Research Center began to look at individual sections of social systems, especially those with responsibilities in times of emergency. This organisational study was based on the assumption that

> "... effective response to a disaster is a matter of the preparations and response activities of groups and organisations."
>
> (Quarantelli, 1972).

The research was still sociological and still utilised the field study as its effective tool but it was also more systematic, more highly-co-ordinated than previous attempts and made definite attempts to find a place within national attempts at disaster planning.

2.10. While the sociological research line was developing through the National Academy of Sciences and the Disaster Research Center, the geographers of Chicago University, who had been concerning themselves with the problems of America's flooding rivers in the 1930s (vide 2.5.), now had established a socio-economic research approach on the problems of disaster potential in certain areas of the United States. The chief concept in this approach was that of "adjustment", the adjustments that individuals and communities make to the disaster potential in their environment. (The full research paradigm is discussed in section 9.)

Three decades were spent in the crystallisation of this approach until in 1968, the Natural Hazard Research Group was set up jointly at the Universities of Toronto, Clark (Massachusetts) and Colorado. Field studies began to be carried out in locations other than the United States and the concentration on hazard (the implicit disaster potential in an environment) rather than disaster (the explicit manifestation of this potential) created a distinctly different approach to problems of disaster yet a logical extension to studies of disaster events.

2.11. Much has been left out of this section which could have been included - many smaller research programmes, individual studies and theses and more highly specialised lines of approach. The future should take a practical course. The Disaster Research Center is continuing but there are doubts as to whether its research is for academic satisfaction or practical applicability. Natural Hazard Research has reached a crossroads and diversified into two distinct research approaches: the Research Programme on Technology, Environment and Man (based at Colorado University) and the Environmental Hazards Research Group (based at Clark University in Massachusetts). Meanwhile available figures on disaster occurrence reveal that concentration of effort should be towards underdeveloped countries (vide section 16). International organisations and individual countries are slowly becoming aware of the need for long-term planning rather than a concentration on disaster events and the associated relief aid. The Disaster Research Unit at the University of Bradford exists to promote precautionary planning, especially in underdeveloped countries. Its research is primarily devoted to longer-term planning, to an understanding of precautionary planning as a part of development planning, and to a concentration on the most vulnerable groups in socio-economic terms.

REFERENCES

AYCKROYD, W.R. (1974) The Conquest of Famine. Chatto and Windus, London.

JANIS, I.L. (1951) Air War and Emotional Stress: Psychological Studies of Bombing and Civil Defense. McGraw-Hill, New York.

NIDDRIE, D.L. (1961) When the Earth Shook. Hollis and Carter, London.

PRINCE, S.H. (1968) Catastrophe and Social Change: Based Upon a Sociological Study of the Halifax Disaster. AMS Press, New York.

QUARANTELLI, E.L. (1972) "Study and Research in the United States." In Proceedings of the Japan-United States Research Seminar: Organisational and Community Responses to Disaster, September 11-15, 1972. Disaster Research Center, Columbus, Ohio.

WILLIAMS, H.B. (1954) "Fewer Disasters, Better Studied". Journal of Social Issues. Vol. 10. No. 3, pp.5-11.

PART 2: DISASTER TYPES

3. Seismic Phenomena.
4. Climatological Phenomena - Hurricanes and Tornadoes.
5. Climatological Phenomena - Floods.
6. Long-term Ecological Phenomena - Drought and Famine.

3. SEISMIC PHENOMENA

3.1. This section deals with the physical processes of seismic phenomena - earthquakes and volcanoes.

3.2. Earthquakes can be roughly of three types:

a) Those caused by tectonic movements of the earth's crust.

b) Those induced by volcanic activity.

c) Those induced by supplementary phenomena such as the collapse of old mine tunnels.

Because earthquakes induced by supplementary phenomena are special and very detailed cases, they have been omitted here. Suffice it to say that they are part of a rather unique hazard environment. This section concentrates on tectonic movements of the earth's crust because they produce most of the world's most devastating earthquakes. Volcanoes are dealt with elsewhere in this section.

3.3. It is generally agreed among scientists that major earthquakes involving tectonic movements of the earth's crust are caused by continental drift. The theory of continental drift first put forward by Wegener in 1912 has recently been strengthened by scientific expeditions and examinations of the bed of the ocean. The theory holds that at one time the present land masses of the world were joined together in one continental mass called Pangea. Then at various times over the next few million years changes occurred with parts of the continental mass breaking away. Later still as the arrangement of land masses came to look similar to today's map, various parts of the mass moved still further while others moved closer together. This process is still going on today and although it may only be a few centimetres a year, the movements are enough to provide quite significant results.

3.4. For example, the continent of South America is moving north-westwards while at the same time the South-east Pacific bed (known as the Nazca bed) is moving towards South America at the rate of approximately 11 centimetres per year. It is no coincidence that the Western coast of South America is one of the most earthquake-prone in the world.

3.5. It is these movements of continental and oceanic shelves relative to each other which produce an earthquake. This happens when:

a) the shelves are moving away from each other tangentially, or

b) the shelves are colliding, or

c) one shelf is dipping under another.

3.6. The process by which an earthquake occurs is a function of these relative movements. Where such movement occurs, many millions of tons of rock are deformed and energy accumulates in them rather as in the tension of a spring. Sooner or later,

> "... the forces accumulated in this spring will be greater than the friction retaining them and then one shelf will snap past the other one and release the energy which would be noticed by us as an earthquake. This explains why we notice more than just the main shock in connection with large quakes. As the load is not uniformly distributed, a fracture occurs at a critical point, thus causing a quake. In so doing, the tensional energy is redistributed and further fractures occur, causing further quakes. This process continues until the tension has found a new temporary equilibrium."
>
> (Munchener Ruckversicherungs Gesellschaft, 1973).

Diagrams 1 and 2 illustrate examples of shelves which collide and those which dip under one another.

3.7. Earthquakes, therefore, are produced by movements of continental and oceanic shelves. Consequently the main earthquake areas are to be found at the boundaries between shelves where continental drift is most pronounced. A fuller discussion of the location of the main earthquake region will be found in Section 7.

3.8. Earthquakes can be measured in terms of <u>magnitude</u> and <u>intensity</u>. The two terms are not to be confused. The magnitude of an earthquake is measured on the <u>Richter Scale</u>. This is a logarithmic scale of energy measurement indicated by figures and decimals. Because it is a logarithmic scale, an earthquake of magnitude (M) 8 should not be considered as slightly greater than an earthquake of M 7. The difference in energy is comparable to that between a 30 kg bomb and a 1,000 kg bomb.

DIAGRAM 1: CONTINENTAL SHELVES COLLIDING

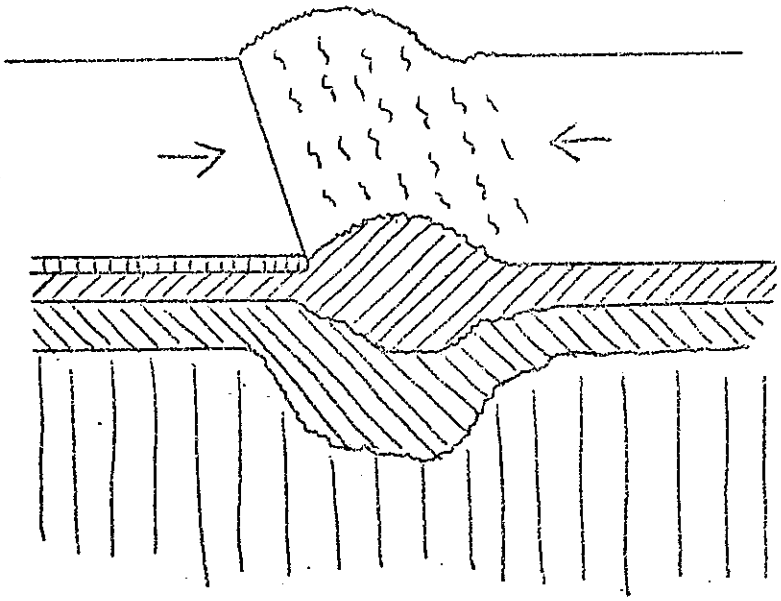
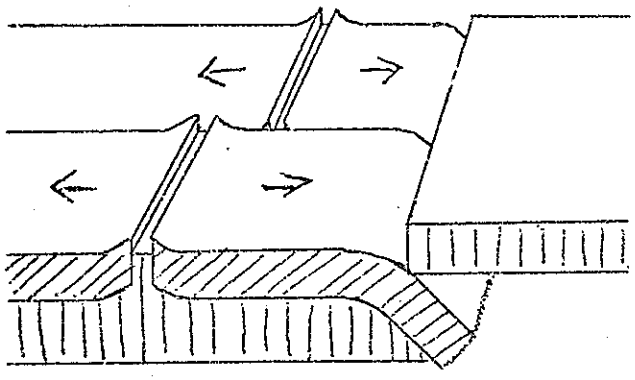


DIAGRAM 2: ONE CONTINENTAL SHELF DIPPING UNDER ANOTHER



Source: Munchener Ruckversicherungs-Gesellschaft, 1973.

3.9. The intensity of an earthquake is measured on the Modified Mercalli Scale (MM). This scale measures the effects of an earthquake that can be felt and observed and utilises a series of Roman numerals, the higher the rating, the greater the intensity.

3.10. It is important to note that measures of magnitude and intensity are not easily comparable. The effects of a quake depend very much on the distance from the focus or epicentre of the earthquake, the geology of the region and other factors such as the quality of the building materials. The magnitude is not affected by these factors. For example areas of damage according to MM VI or above would perhaps cover 50,000 km^2 for an earthquake of M 7 and 150,000 km^2 for an earthquake of M 8.5. (These figures are based on a hypothetical earthquake in Northern Anatolia, Turkey). A list of indices used in earthquake measurement is given in Appendix III.

3.11. Volcanoes are also associated with continental drift and the boundary regions between continental shelves. Sometimes, when two shelves or plates are drifting apart, basaltic magma (molten rock) will flow into the cracks between the diverging plates. This is normally restricted to submarine activity. Alternatively, volcanic activity occurs where two plates collide, the force of collision resulting in cracks opening in the surface of the continental plate, through which pours molten material.

3.12. Volcanic activity is manifested by the transference of magma from within the crust or below it to the earth's surface as flowing lava or explosive pyroclastic deposits which in decreasing order of size are boulders, bombs, lapilli (walnut-sized cinders), sand and ash. Steam emissions, gas and hot mud pools are also manifestations.

3.13. Wright explains how this material is conveyed to the surface:

> "(It can).....be conveyed....along essentially tubular conduits to build conical or dome-shaped volcanoes whose form and size depend on the abundance, viscosity and composition of the magma.

> Alternatively, the magma may rise through crustal fissures to form plateau accumulations of horizontal lava sheets. The amount of material added to the earth's surface by volcanism in any particular region may be quite small when the activity consists of only small cinder cones and thin lava flows. At the other extreme it may be prodigious, great volcanic domes such as Hawaii and Kilimanjaro involving thousands of cubic kilometres of lava; elsewhere, as in north-western peninsular India, hundreds of thousands of cubic kilometres have been erupted from fissures to form great continental basalt plateaux. Eruptions from fissures are also responsible.....for the ocean floors, which cover about 70% of the Earth's surface."
>
> (Wright, 1973).

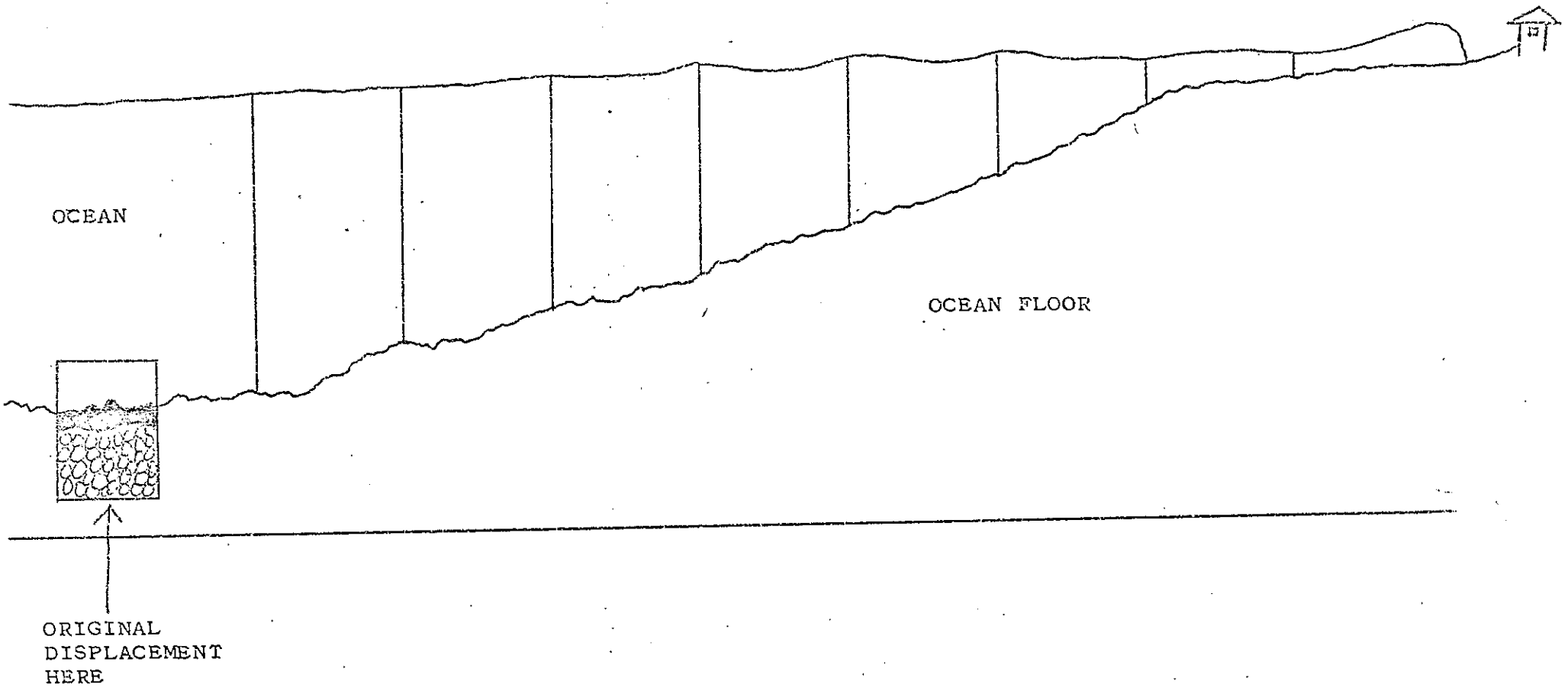
3.14. There is a great correlation between earthquake activity and volcanic activity, the main concentration of the latter being around the margins of the Pacific. Section 7 will discuss the location of volcanic activity in more detail.

3.15. A tsunami is a series of travelling ocean waves of extremely long length and period. In the deep ocean, the crest-to-crest distance may be great and individual crest heights may be barely perceptible. Yet a tsunami is as deep as the ocean and even in the deepest parts of the ocean it will be touching the bottom. In deeper water it will also be travelling at great speeds. As the tsunami reaches shallower water its speed diminishes but the height of each individual crest increases. By the time it reaches a coastline, its speed may only be 30 m.p.h. but the height of the wave can be 100 feet or more. Diagram 3 illustrates the speed and wave heights of a tsunami at various ocean depths. A tsunami is normally heralded by a recession of the sea; this is the trough which is found in between two crests.

3.16. Tsunamis are believed to be created by vertical displacements of ocean water. Although there is a need for a great deal more evidence concerning tsunamis, it is generally agreed that submarine seismic activity can promote tsunamis provided that they impart some vertical movement to the column of water. It has also been postulated that submarine avalanches are a cause.

DIAGRAM 3: THE DEVELOPMENT OF A TSUNAMI SHOWING TSUNAMI SPEED AT VARIOUS OCEAN DEPTHS

SPEED (MPH)	670	600	519	424	299	212	94	30
DEPTH (FEET)	30,000	24,000	18,000	12,000	6,000	3,000	600	60



Some investigators, rather than looking towards direct seismic activity, believe that long-period ground waves produced by earthquakes are the cause of tsunamis. These waves deform the sea floor as they travel through it and sufficient activity could provide the vertical displacement necessary.

3.17. If, as is generally believed, there is a positive relationship between earthquakes and tsunamis, then tsunami magnitude is a function of earthquake magnitude and depth as well as depth of water where the tsunami is generated, extent and velocity of crustal deformation and the efficiency of energy transfer from the earth's crust to sea water. The speed of tsunamis varies with depth of water and this permits prediction of tsunami arrival times around the Pacific Ocean. But as yet it has proved difficult to predict the actual size of an arriving tsunami and whether the destructive component of a tsunami will be in its powerful surge across the beach, or in a gradual raising of sea level followed by a rapid draining back to sea.

REFERENCES

MUNCHENER RUCKVERSICHERUNGS-GESELLSCHAFT (1973) Earthquakes. Munich.

WRIGHT, J.B. (1973) "Volcanism and the Earth's Crust." In GASS, I.G.; SMITH, P.J.; WILSON, R.C.L. (Eds). Understanding the Earth: a Reader in the Earth Sciences. The Open University Press, the Artemis Press, Sussex.

4. CLIMATOLOGICAL PHENOMENA - HURRICANES AND TORNADOES

4.1. This section deals with the various climatological phenomena which may, for convenience, be grouped under the collective title, storms. The history and anatomy of any storm is complex both in terms of the processes involved in the actual life-cycle of the storm and in terms of the conditions necessary for the production and continuation of individual storm types. The section will attempt to draw a very simple picture of the life-cycle of various storm types. For more detailed information, readers are requested to consult the list of further reading located at the end of this book.

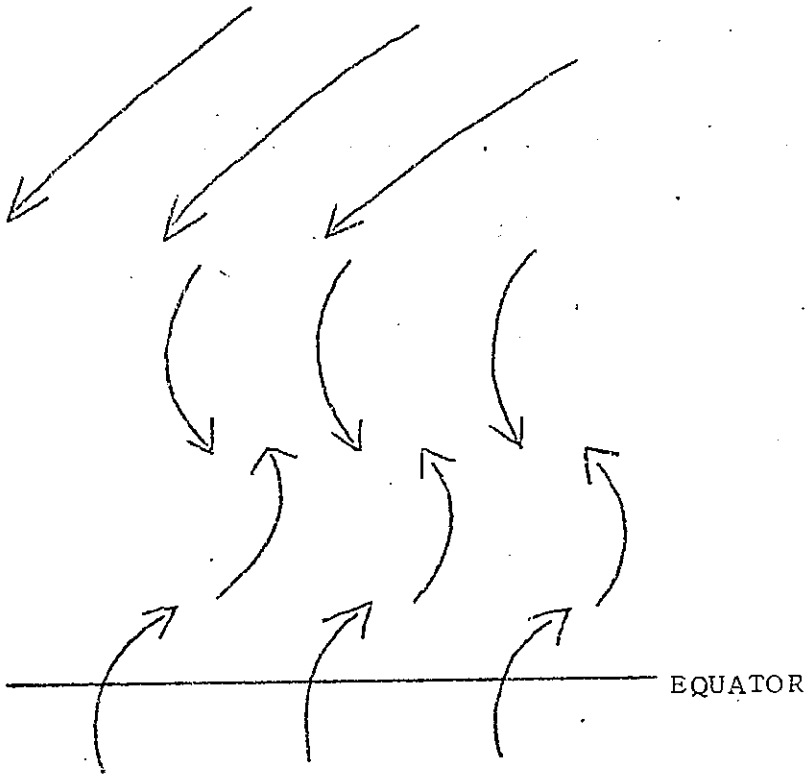
4.2. A hurricane is described as an intense tropical storm containing wind speeds of more than 74 miles per hour. The name "hurricane" is applied to intense tropical storms of the Caribbean, Atlantic and North American areas. In other parts of the world, these tropical storms are called by different names: "cyclone" in the Indian Ocean, "typhoon" in the Pacific and "baguio" in the Philippines. But although there are many different names, they are all referring to the same phenomenon. Throughout this section the word hurricane will be used for simplification.

4.3. Basically, all tropical storms have their genesis at great distances from the areas in which they achieve hurricane status. Hurricanes which affect the Caribbean and North America often begin on the other side of the Atlantic as far east as the Cape Verde Islands off the coast of Africa. Here, just north of the equator, the south-east trade winds of the southern hemisphere meet with the north-east trade winds of the northern hemisphere at the Inter-Tropical Convergence Zone (ITZ) or what is known as the "Doldrums" in maritime parlance. As these trade winds collide the earth's rotation causes the air to move in an anti-clockwise direction (Diagram 4). In the southern hemisphere this movement would be clockwise in direction.

4.4. At this point it must be stated that despite much scientific research over recent years, the actual mechanism which triggers a hurricane is still not clear. Many of the embryonic storms

DIAGRAM 4: COLLISION OF OPPOSING TRADE WINDS - EARTH'S ROTATION CAUSES AIR TO WHIRL COUNTERCLOCKWISE IN NORTHERN HEMISPHERE

NORTHEAST TRADES



SOUTHEAST TRADES

dissipate harmlessly before they ever reach the status of a hurricane. All that is known is that, given the right conditions, some of these initial small disturbances travel the width of the Atlantic and in doing so reach hurricane force.

4.5. A hurricane begins to form when moist air, heated by the sun rises from the surface of the warm tropical seas and is funnelled upwards in a natural updraft rather like the updraft which draws hot air in a house up a fireplace flue (Diagram 5). As this moist air rises it cools and condenses into rain (Diagram 6).

4.6. A feature of the condensation process is the feeding back into the air of massive amounts of heat which add to the storm's updraft and which thus provides the hurricane with a main source of its power. Air continues to go spiralling up and more hot moist air from all sides rushes in to replace it and keep the updraft moving.

4.7. The motion of the earth's rotation makes the winds move in an anticlockwise direction. The winds move faster and faster and at 74 m.p.h., the storm is officially designated a hurricane.

4.8. Viewed from above a hurricane resembles a "Catherine Wheel" of spiralling, anticlockwise wind movements around a calm eye in the centre (Diagram 7). The destructive winds extend 100 to 500 miles in diameter with a vertical depth of 7 - 12 miles. The storm is characterised by winds of between 74 m.p.h. and 200+ m.p.h., high tides and torrential rain. Winds are strongest around the eye of the hurricane which itself may be up to 2 miles across and is an area of calm weather with perhaps light rain. Hurricanes move forward at about 10 to 20 m.p.h. over tropical seas and sometimes up to 50 m.p.h. in higher latitudes before blowing out. No two hurricanes take the same path. This erratic nature makes warning at one and the same time essential but difficult. Appendix IV gives definitions of terms used in describing tropical storm activity and the classification of tropical cyclones.

4.9. Tornadoes are highly localised phenomena of short duration that are almost peculiar to the United States. Tornadoes have been observed elsewhere, even in the United Kingdom, but the destructive

DIAGRAM 5: HURRICANE DEVELOPMENT - WARM MOIST AIR OVER TROPICAL OCEAN RISES, SURROUNDING AIR FLOWS IN, BECOMES WARM AND MOIST AND RISES

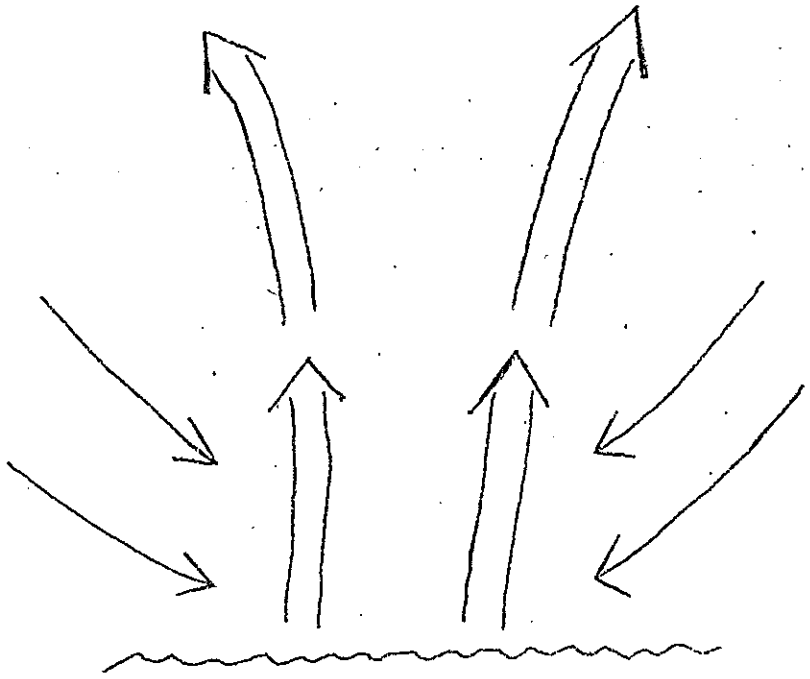


DIAGRAM 6: HURRICANE DEVELOPMENT - WATER CONDENSES AS MOIST AIR RISES, RELEASING MORE HEAT AND CAUSING AIR TO RISE FASTER

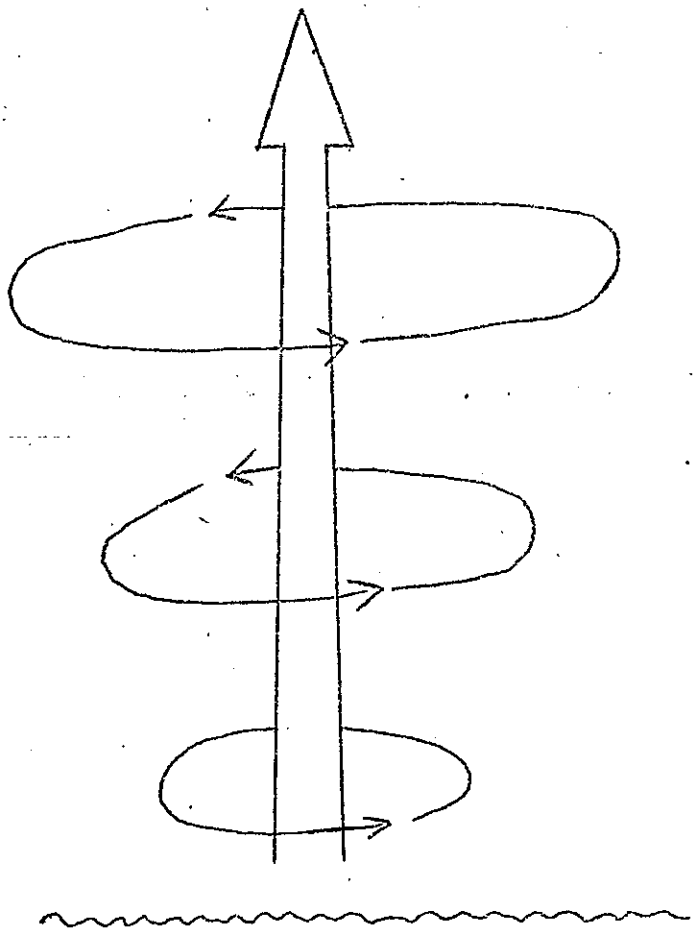
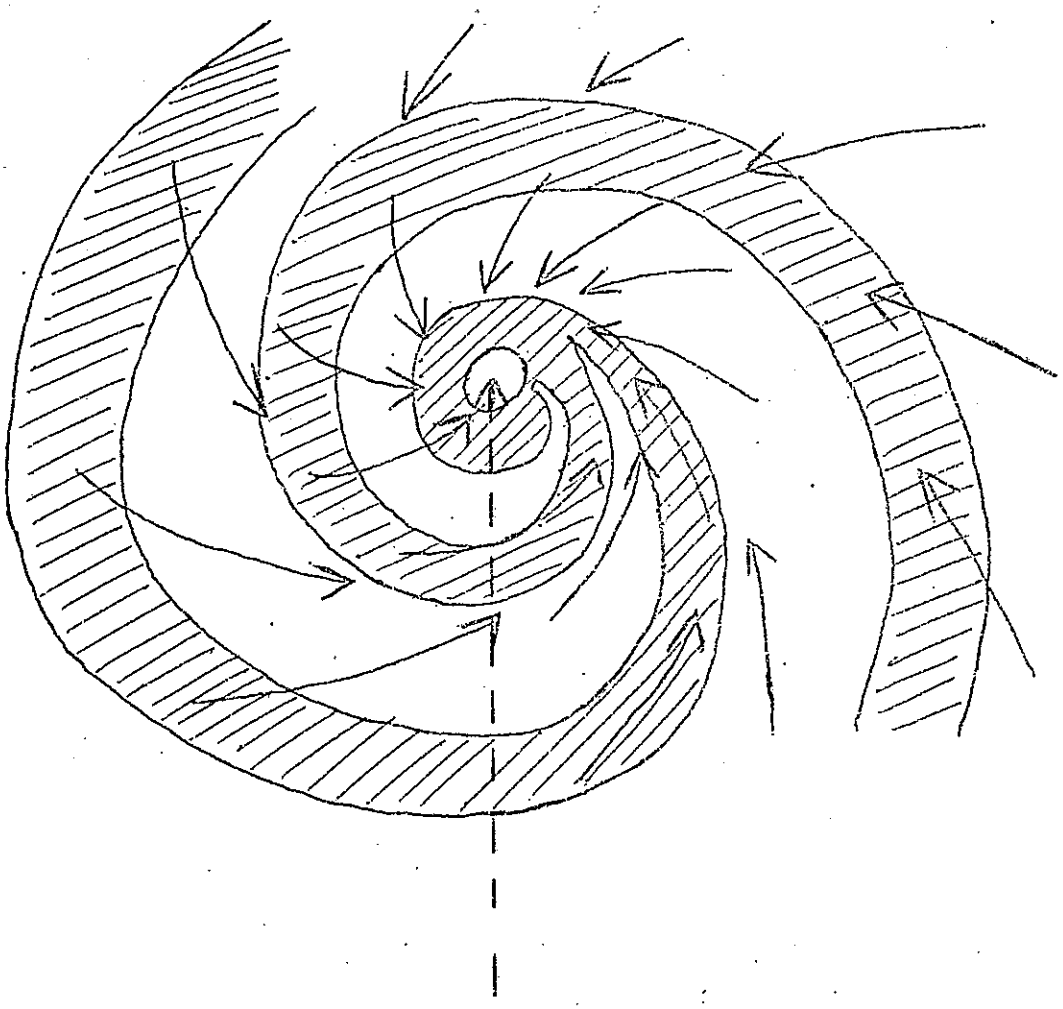


DIAGRAM 7: HURRICANE DEVELOPMENT - HURRICANE AS SEEN FROM ABOVE, WINDS WHIRL AROUND A CALM "EYE" IN THE CENTRE



quality of the tornadoes in the United States is extreme.

4.10. The appearance of a tornado is

> "..... visible as a vortex, a whirlpool structure of winds rotating about a hollow cavity in which centrifugal forces produce a partial vacuum. As condensation occurs around the vortex a pale cloud appears - the familiar and frightening tornado funnel. Air surrounding the funnel is also part of the tornado vortex; as the storm moves along the ground, this outer ring of rotating winds becomes dark with dust and debris, which may eventually darken the entire funnel."
>
> (U.S. Department of Commerce, Environmental Science Services Administration, 1966).

4.11. Tornadoes usually appear during warm, humid unsettled weather and form several thousand feet above in earth's surface usually in conjunction with a thunderstorm. Tornadoes often form at intervals along the path of the storm, travel for a few miles and then dissipate. A tornado funnel is an extension of the cumulo-nimbus storm clouds and while some funnels never reach the ground and others touch the ground only momentarily before dissipation, the destructive tornado travels along the surface, its base bent by friction. Tornado paths average only 440 yards in width and barely travel more than 16 miles but severe tornadoes can reach a width of over a mile and travel more than 300 miles. It has not been easy to measure the wind speed of a tornado but estimates put it at upwards of 300 m.p.h.

4.12. Two theories have been suggested as to the formation of tornadoes although many scientists believe formation to be a combination of both:

a) <u>Thermal</u>:

> "... the result of forces set up by the imbalance created when cool systems override warm systems. The imbalance is compensated by rapid upward convection from the lower layers of warm air which becomes a rotary flow and forms the tornado vortex."
>
> (U.S. Department of Commerce, Environmental Science Services Administration, 1966).

b) Mechanical:

"Slowly rotating air currents are constrained by external forces. As the radius of rotation lessens the speed of rotation increases.... Ultimately, these converging, accelerating, rotary winds set up the tornado vortex."

(U.S. Department of Commerce, Environmental Science Services Administration, 1966).

The destructive capacity of tornadoes is due to the combined action of the strong rotary winds and the partial vacuum in the centre of the vortex.

REFERENCE

U.S. DEPARTMENT OF COMMERCE, ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION (1966). Tornadoes. Washington D.C.

5. CLIMATOLOGICAL PHENOMENA - FLOODS.

5.1. Floods is a collective term for excesses of water. More specifically it refers to excessive water in river channels brought about by higher than average rainfall or snow-melt.

5.2. The first phase of a river channel flood is connected with the land. It occurs when, after excessive rainfall, the land can no longer hold water and the excess runs off the surface by a series of small rills into the main stream channel. This process may last only a few hours after which the worst is over as far as the farmer is concerned while problems still remain downstream.

5.3. The run-off of excess water from the land begins the generation of the flood. The channel stage of a flood begins when the surface run-off enters the river channel. The river levels begin to rise as they accommodate this extra water. This is the phase generally referred to as a "flood" because it is the most spectacular and most destructive part of the flood sequence.

5.4. Hoyt and Langbein describe the activities of the flood water during this channel phase:

> "....waters rejected from the land pour down steeply sloped headwaters, scour channels, engulf bridges, wash away culverts, transport silt, clean out debris and debouch their sediment-laden waters into main channels. Depending on the flow from the tributaries, the flood waters of the main channel gradually rise, overflow on to the flood plains....., inundate and deposit debris, and, depending on velocities, wash away homes, factories, railroads, highways and all the works that busy mankind has crowded against the river."
>
> (Hoyt and Langbein, 1970).

5.5. During a flood the river and its associated channels act as a natural reservoir. At the beginning of a flood the water flowing from surface run-off and tributary streams exceeds channel outflow and the channel stage rises accordingly. The further downstream a flood travels, the more it diminishes in height and the greater its length and duration. The total amount of time taken for the discharge of a floodwave can be anything from a few hours for minor streams to

several weeks for major channels such as the Mississippi.

5.6. The intensity of flooding is dependent on several factors. Meteorological conditions, of course, are the most important factor involved but the condition of the ground on which the precipitation falls is a factor which affects the timing, peak, volume and duration of floods. Also man-made structures can aggravate flood conditions. Obstructions or channel encroachments in river channels or on flood plains can cause much local damage where, under more natural conditions, the flood peak might have been inocuous. Extreme examples of aggravation

> "...are failure of inadequately designed and poorly built dikes or dams and high backwaters resulting from unreasonable encroachment by bridges or hills in channels."
>
> (Sturgis, 1957)

5.7. Another meteorological phenomenon similar to standard flooding in cause and form but different in terms of impact, is flash-flooding. Flash-flooding follows closely the stages of a normal flood except that everything occurs in a much shorter time period. Flash floods are closely associated with short periods of exceptionally heavy rainfall where surface rainfall far exceeds channel outflow and the volume of water in the channel builds up to over flood level in a very short time, or with the collapse of man made structures such as dams, which release a large volume of water, all at once.

REFERENCES

HOYT, W.G.; LANGBEIN, W.B. (1970) Floods. Princeton University Press, Princeton, New Jersey.

STURGIS, S.D. (1957) "Floods". Annals of the American Academy of Political and Social Science, Vol.309, January, pp. 15-22.

6. LONG-TERM ECOLOGICAL PHENOMENA - DROUGHT AND FAMINE

6.1. Drought usually signifies water deficiency. In geomorphological studies, drought is frequently defined through an analysis of precipitation or stream discharge which is compared to an expected mean distribution. The limiting value adopted does not necessarily imply that a disaster has occurred for the limiting value might be below the threshold of damage to the human system. In geomorphological studies, drought can be identified as

a. Precipitation drought.

b. Run-off drought

c. Groundwater drought. (Hewitt and Burton, 1971)

Water shortage may be similarly expressed in terms of water balance by calculating potential evapotranspiration. (Chorley, 1969)

6.2. In Natural Hazard Research (vide 2.10.) drought is defined as a period in which moisture availability falls below the current requirements of some or all of the living communities in an area and below their ability to sustain the deficit without damage, disruption or excessive costs. It is almost impossible to analyse drought as a clear function of water supply.

6.3. Deciding when a drought has occurred may be easy for a climatologist. To decide when drought damage is occurring is far more difficult. Natural water supply is frequently below the optimum for crop growth but crop yields below the maximum are not used to define drought. A drought can only be defined ex post facto, when it is well underway or over, and when damage information is available. It has no clear beginning and can be terminated at the onset of rains.

Damage from drought includes

a. Withering of vegetation, including crops.

b. Dehydration of animals, including man.

c. Excessive 'overdraft' on controlled water supplies particularly to urban areas.

d. Insufficient natural running water for public utilities, waste, transport etc.

6.4. Drought environments can be subdivided into various water shortage situations

i. Permanent drought - all years.

ii. Secular drought - a sequence of years.

iii. Contingent drought - random number of years.

iv. Seasonal drought - within a year.

6.5. Despite the numerous articles and books that have described drought there is still an inherent confusion in much literature that assumes drought is synonymous with famine. Drought is a purely physical phenomenon associated with water deficit. It can be measured by calculating the difference between available water supply and potential evapotranspiration. This calculation gives an indication of the land utilisation policy that could be formulated to cope with drought conditions. Such an approach would allow a review of the cost-effectiveness of a range of alternatives from high cost, high technology inputs involving irrigation through medium cost, medium technology inputs of drought-resistant varieties to low cost, low technology inputs that peasant farmers already practise throughout many arid and semi-arid regions of the world. Famine, however, is a facet of the human, not the physical, milieu. It is a social phenomenon which can only be explained by a detailed consideration of the political economy of the areas affected by famine. Drought can exacerbate famine conditions but there is rarely evidence to suggest that drought causes famine (O'Keefe, 1976). Wisner clarified this issue when he wrote on the Sahel,

> "One view of the famine holds that it is essentially the small farmers' and pastoralists' own fault. The argument is often embellished by including such extenuating factors as effective demand for beef in Nigeria's coastal cities or the exclusion of rainfall to the wet side of the mean during the 1960s, both factors tempting the individual to extend his activity into dangerously marginal lands. The core of the argument remains the same: the peasants of the Sahel have been guilty of practising an ecologically imbalanced management of resources and now they have been severely punished by nature.

> Another view sees famine in the Sahel as a side effect of the articulation of the capitalist and peasant modes of production, the dominance of the capitalist mode and the distortion of the local economies by continued reliance on the monocrops favoured by the neo-colonial relation."
>
> (Wisner, 1976)

Most literature adopts the first view of famine although this ideology is not always obvious (for example, Dalby, D. and Harrison Church, R.G. 1973). Baker (1976) has indicated that the major problem of the famine is a problem of accurate information without which one cannot possibly contend that the famine is a result of ecological mismanagement by either the small farmer or the pastoralist. More importantly, there is a growing body of literature which does not accept that natural disasters are natural (O'Keefe, P. et al, 1976); this literature sees the basic cause of disaster as the exploitative relationship between the capitalist metropole and the subsistence or the semi-subsistence periphery.

REFERENCES

BAKER, R. (1976) "The Sahel: an Information Crisis." Disaster, Vol. 1, No. 1. (forthcoming).

CHORLEY, R.J. (Ed) (1969). Water, Earth and Man. Methuen, London.

DALBY, D.; HARRISON CHURCH, R.J. (Eds) (1973). Drought in Africa: Report of the 1973 Symposium. Centre for African Studies, School of Oriental and African Studies, University of London.

HEWITT, K.; BURTON, I. (1971). The Hazardousness of a Place: a Regional Ecology of Damaging Events. University of Toronto Press, Toronto.

O'KEEFE, P. (1976) " 'REHAB - Drought and Famine in Ethiopia' - a Review." Disaster, Vol. 1, No. 1, (forthcoming).

O'KEEFE, P., WESTGATE, K.; WISNER, B. (1976). "Taking the Naturalness out of Natural Disasters." Nature, Vol. 260, April 15, pp. 566-567.

WISNER, B. (1976) Man-made Famine in Eastern Kenya: the Interrelationship of Environment and Development. Discussion Paper 96, Institute of Development Studies, University of Sussex, Brighton.

PART 3: THE GLOBAL CONTEXT OF DISASTER

7. Global Distribution of Disaster Types and Related Socio-Economic Data.

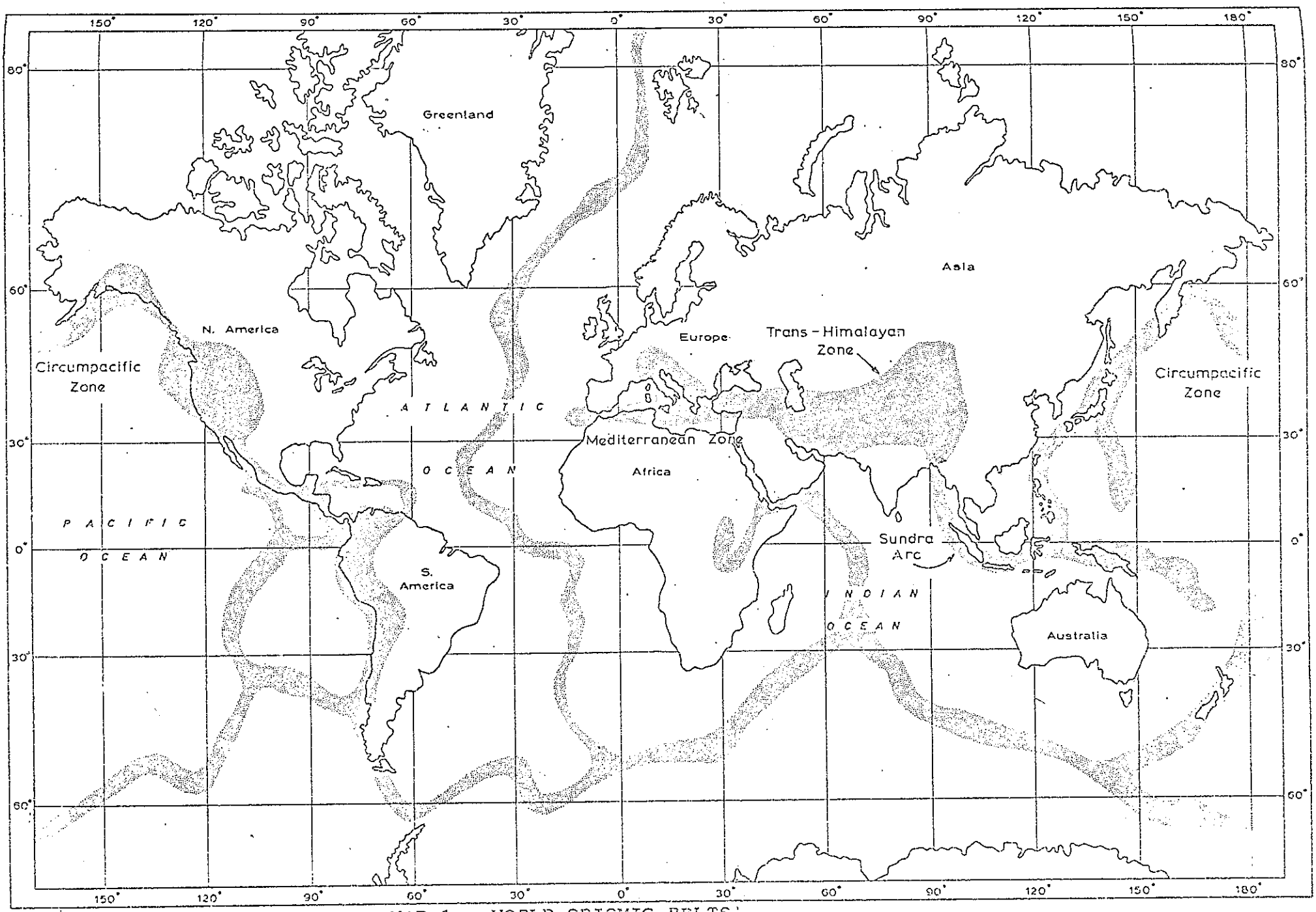
7. GLOBAL DISTRIBUTION OF DISASTER TYPES AND RELATED SOCIO-ECONOMIC DATA

7.1. Introduction: Global Mapping of Natural Disaster

The following maps provide a visual image of the disaster process. As such, they are gross simplifications of the actual situation on the ground but they provide an insight into the nature of the physical and socio-economic nature of disaster. It is suggested that the maps be considered as a series of overlays which give a composite picture of the global scene.

7.2. Map 1

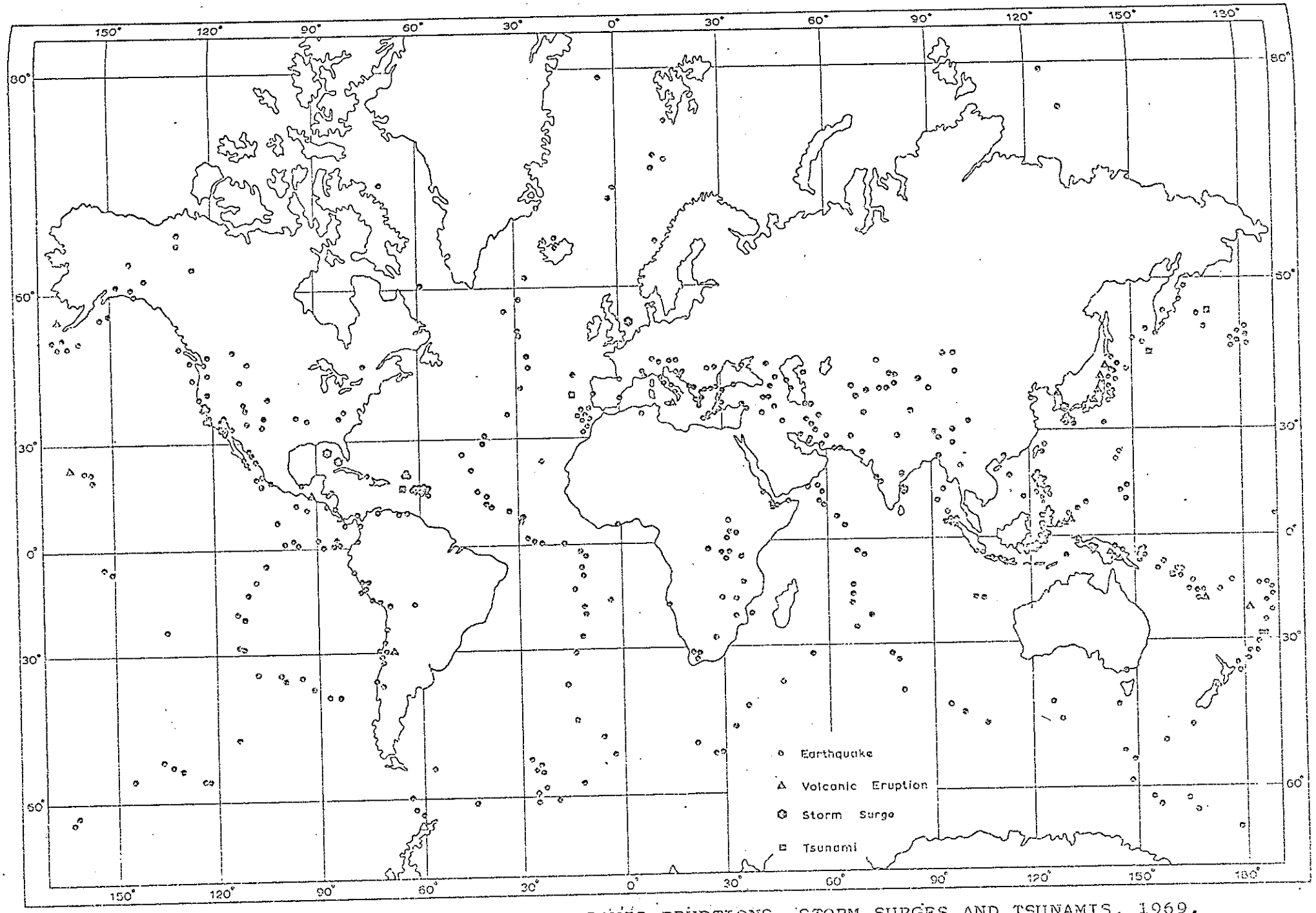
Map 1 shows the major seismic zones of the world. Much of the seismic zone covers sea area rather than land area. The most important arc of seismicity is the Circumpacific Zone sometimes called "The Ring of Fire". The extension of this arc affects the Caribbean. The other major zones affecting people are the Trans-Himalayan and Mediteranean zones.



MAP 1: WORLD SEISMIC BELTS

7.3. Map 2

Map 2 shows the recorded earthquakes, volcanic eruptions, storm surges and tsunamis for 1969. Earthquakes predominate but these are most frequent in oceanic areas. In fact, only ten of these recorded events were recorded as "destructive disasters".

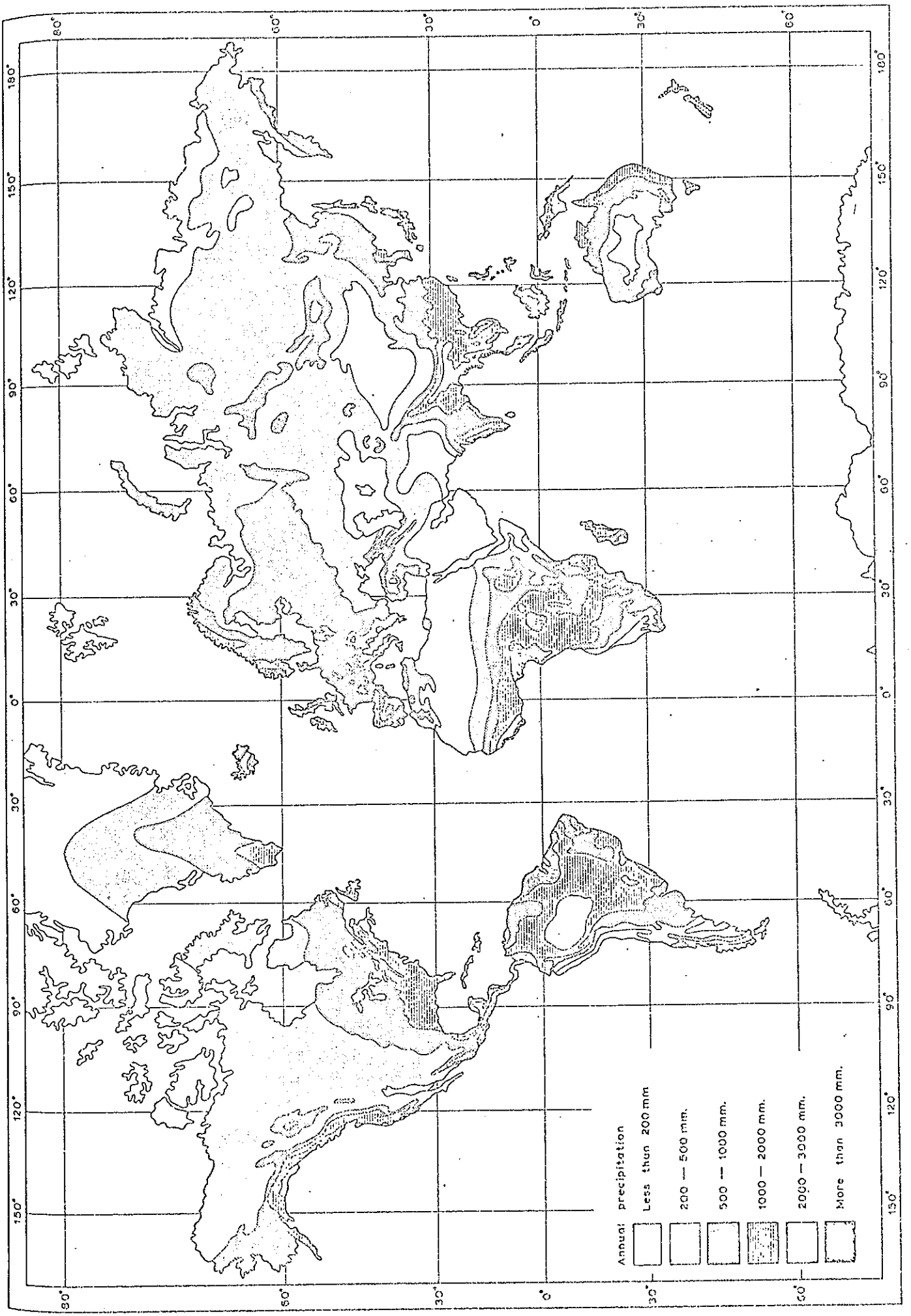


MAP 2: RECORDED EARTHQUAKES, VOLCANIC ERUPTIONS, STORM SURGES AND TSUNAMIS, 1969.

SOURCE: UNESCO (1971) - Annual Summary of Information on Natural Disasters, Paris.

7.4. Map 3

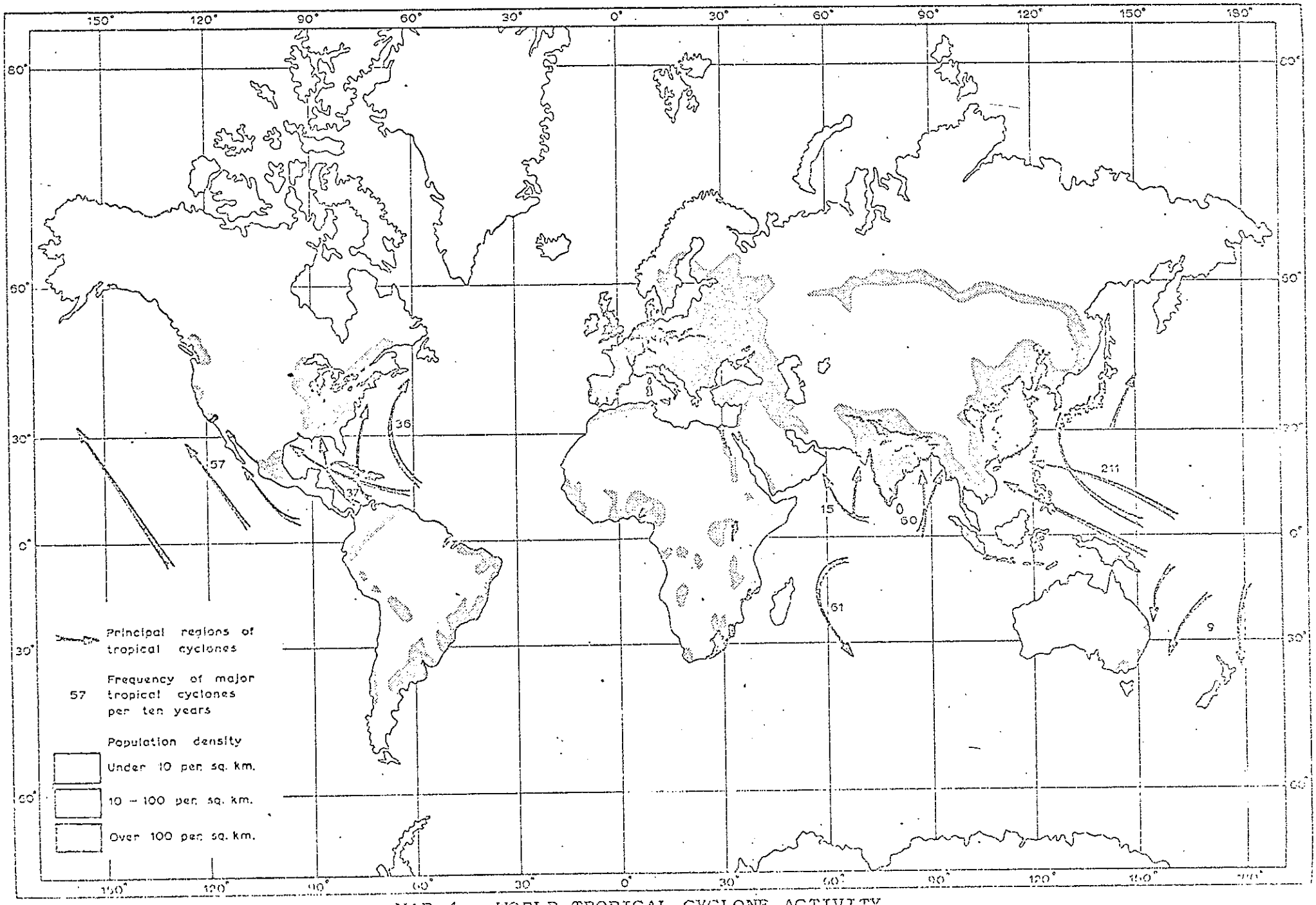
This contains information on annual precipitation throughout the world. Any area with less than 500 mm rainfall can be classified as arid; less than 1000 mm of rainfall is semi-arid. This is not a reliable manner in which to understand the nature of drought because of the temporal and spatial variation within the mean figures but it provides a general impression of the more arid areas of the world.



MAP 3: WORLD ANNUAL PRECIPITATION

7.5. Map 4

This map indicates the principal regions of tropical cyclones in the world. The area of cyclones relates to the position of the Intertropical Convergence Zone. It can be seen that, with the major exception of Western Europe, tropical cyclones affect the more populated areas of the world. The arrows give the general direction of the storm movement and the numbers indicate the average frequency of cyclones per ten years.



MAP 4: WORLD TROPICAL CYCLONE ACTIVITY

7.6. Map 5

This map provides a general impression of PCM (Protein Calorie Malnutrition). It can be seen from this that most of the Third World countries, particularly in the Asian continent, suffer from PCM. This is not due to the poorer quality of land but to the existing socio-economic conditions which give rise to a mode of agricultural production that focuses on the industrial needs of the developed countries rather than the subsistence needs of the underdeveloped countries.

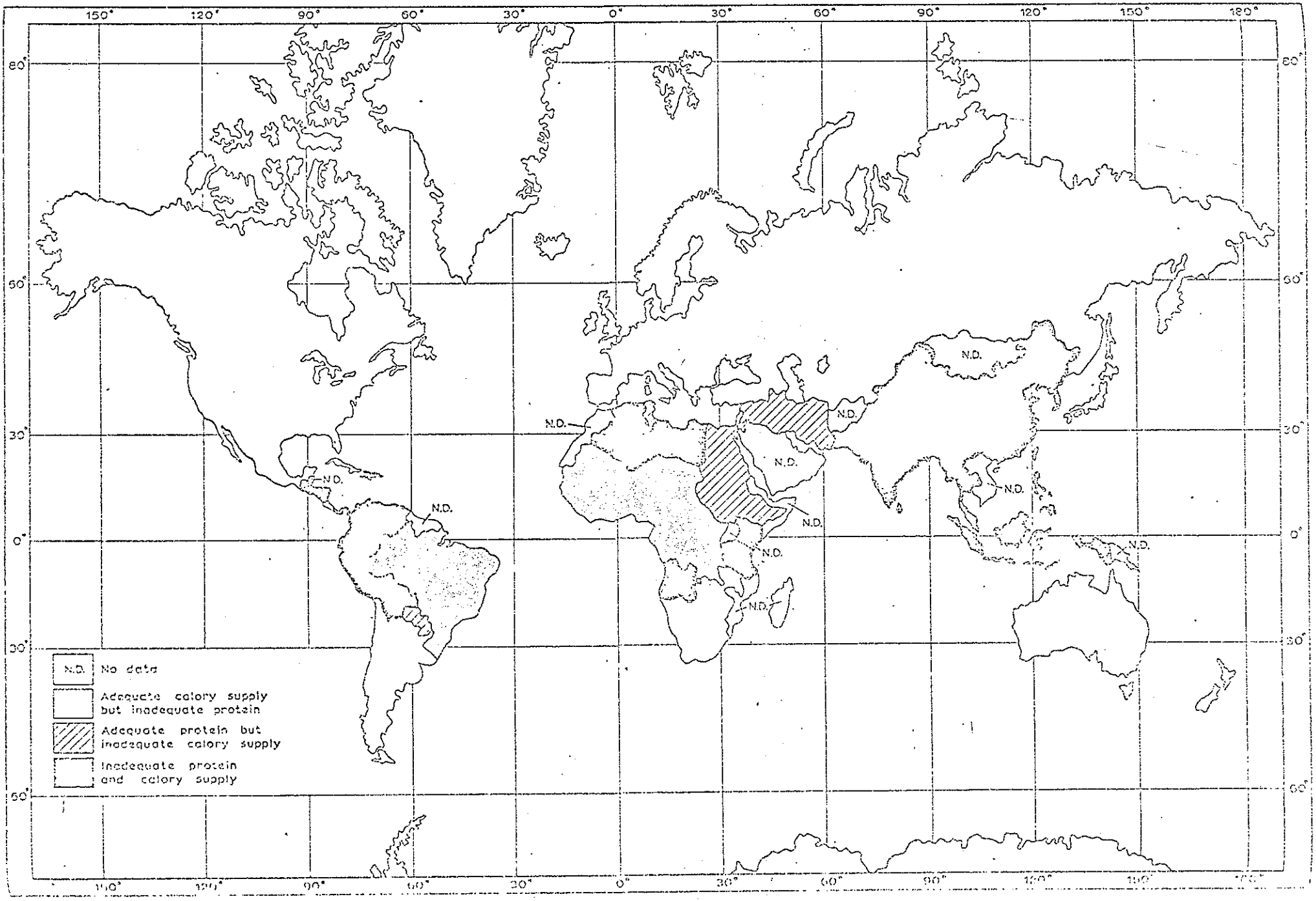
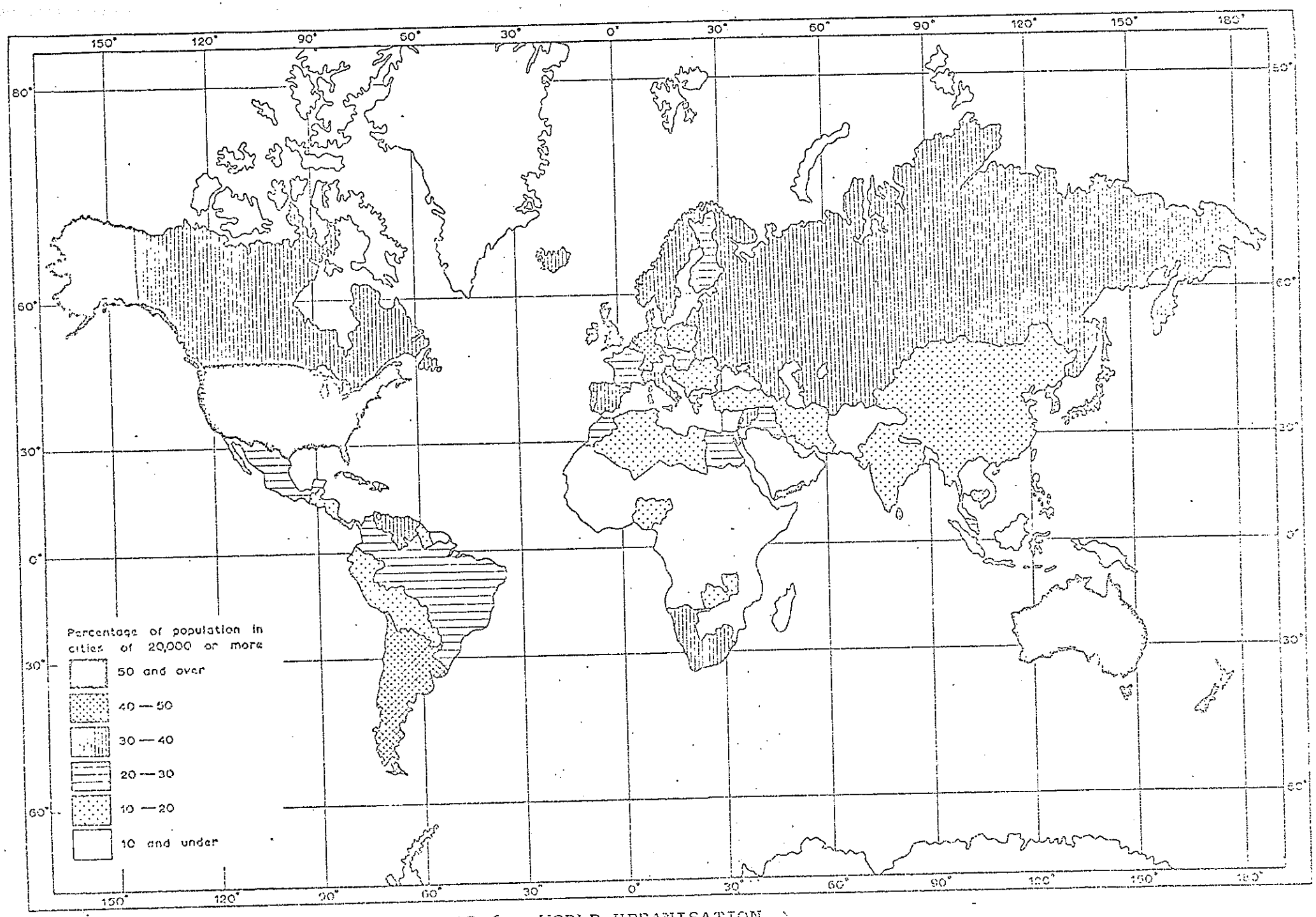


TABLE 5: WORLD PROTEIN-CALORIE MALNUTRITION

7.7. Map 6

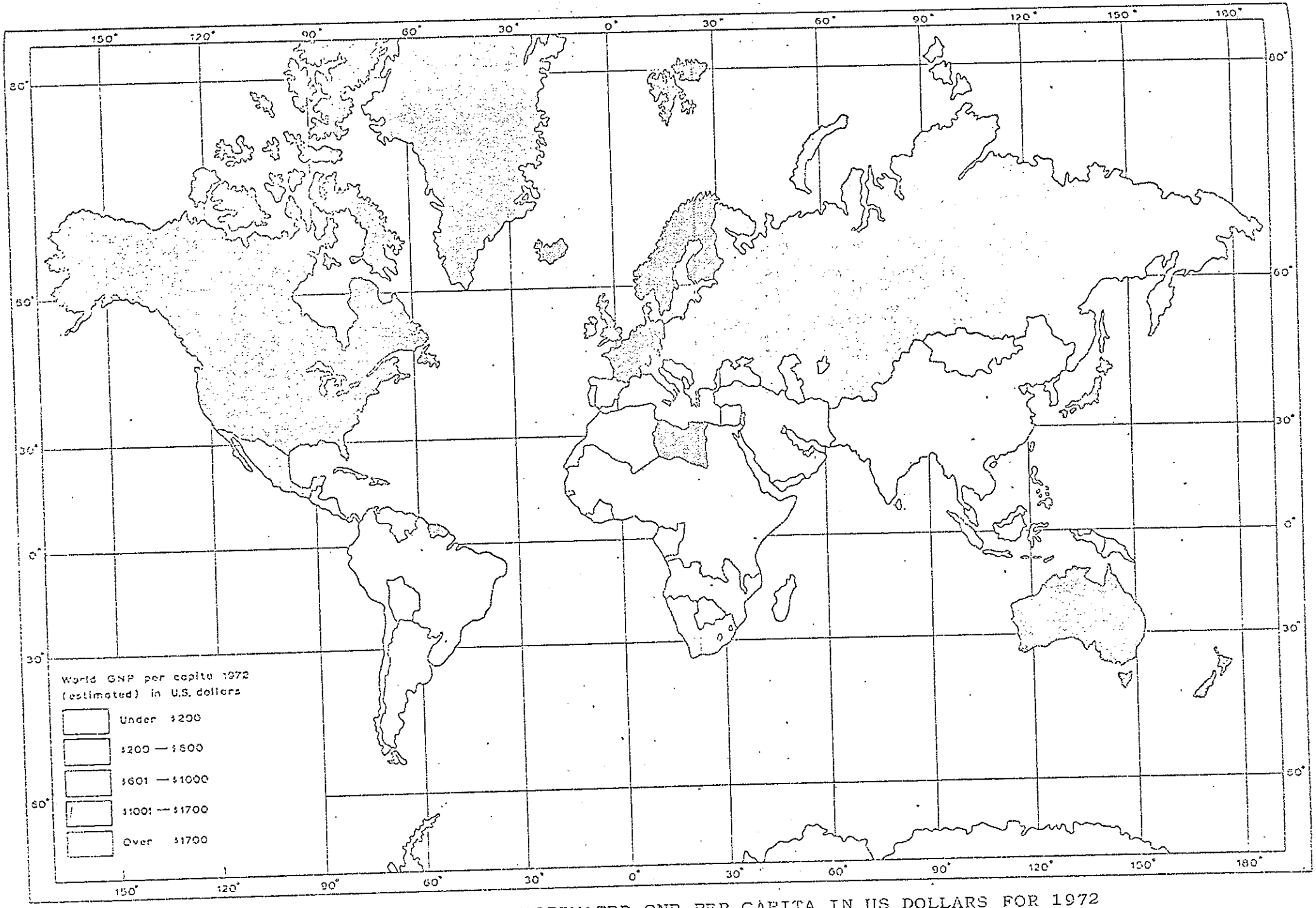
The problem of PCM identified in the previous map is exacerbated by the migration of the population from the rural areas. Although urbanisation is often considered a phenomenon of the developed industrialised world, urban centres are well developed in western South America, North Africa, Middle East and Asia. As metropolitan centres, these cities tend to look towards the developed world rather than within their own societies increasing problems of vulnerability for the marginalised population in both shanty towns and poorer rural areas.



MAP 6: WORLD URBANISATION

7.8. Map 7

This map indicates the Gross National Product of the world on a country/per capita basis. The poorest areas are those which lie on the major hazard belts, suffer from PCM and increasing urbanisation that is not orientated towards the needs of the local population and are consequently most vulnerable to disaster.



MAP 7: WORLD ESTIMATED GNP PER CAPITA IN US DOLLARS FOR 1972

PART 4: THE ECONOMIC AND SOCIAL IMPLICATIONS OF DISASTER

8. The Social Aspects of the Disaster Event.
9. The Social Aspects of the Disaster Environment.
10. The Costs of Disaster.
11. The Costs of Disaster Prevention.

8. SOCIAL ASPECTS OF THE DISASTER EVENT

8.1. Social aspects of disaster can be divided into two categories according to distinctive disciplinary traditions:

a. The social aspects of the disaster event, the pre-disaster warning and immediate threat phases and the post-disaster emergency phase - behavioural studies grounded in the twin disciplines of sociology and psychology.

b. The social aspects of the disaster environment: responses to and awareness of natural hazards and disaster potential - primarily geographical studies with contributions from perception psychology and economics.

The majority of the systematic social research on disaster events and the disaster environment emanates from the United States. The reader is, therefore, asked to be guarded in his interpretation of the material. Many of the conclusions from this United States-dominated research are based on United States case studies and are concerned with the particular societal and cultural characteristics to be found in that ultra-sophisticated developed society. Transference of these research conclusions to other parts of the world could lead to a confused assessment of the actual situation.

Sections 8 and 9 will briefly outline some of the major research conclusions from the American programmes; Section 8 will concentrate on the Social Aspects of the Disaster Event and Section 9 on the Social Aspects of the Disaster Environment.

8.2. The Social Aspects of the Disaster Event, etc.

Systematic study of disaster events was heralded by the Cold War, the threat of nuclear attack and the need for empirical data on the behaviour of populations in times of community stress (vide 2.7)

8.3. The first of these systematic studies was that of the National Opinion Research Council (NORC) in Chicago, from 1950 - 1954 (vide 2.7). The NORC researched a number of natural and civil disaster events in the United States and produced basic data and crude hypotheses for the use of future systematic research programmes. Three tentative but important conclusions were reached concerning individual and group behaviour during and immediately after disaster events.

a. Panic and other such uncontrolled behaviour is only evident to a limited extent.

b. An adequate warning system may lead to less losses than no warning at all.

c. Emotional behaviour may be aggravated by separation from family and kinship groups or by proximity to the dead and injured.

8.4. The interest in disaster behaviour was taken up by the United States government's National Academy of Sciences (NAS) who, in 1953, formed a Committee on Disaster Studies to co-ordinate the disaster research effort in the USA (vide 2.8). Subsequently, a Disaster Research Group was formed which, in addition to the co-ordination of existing research, carried out its own research programme. The NAS's specific disaster interest lasted until 1963 and during these ten years research findings led to a structural understanding of disaster events and immediate pre-disaster and post-disaster activity through the identification of various disaster time phases:

a. Warning
b. Threat
c. Impact
d. Inventory (the taking of stock)
e. Rescue
f. Remedy
g. Recovery

8.5. Research findings from the NAS can be classified according to the behaviour types apparent in each of the seven time phases:

a. The Warning Phase

i. Apprehension and ways of coping with it are preparatory reactions for the actual responses made in the impact and post-impact phases.

ii. Extreme behaviour is rare and people carry on their normal activities with the addition of a degree of precautionary activity to offset the danger.

iii. Warnings are ambiguous and tend to promote a wide range of behaviour types.

b. The Threat Phase

i. The errors of warning-issuers can be attributed to poor communications, competition among warning agents and bad public relations.

ii. The behavioural elements present in the warning phase are also present in this phase but they gain more urgency.

iii. People are appreciative of warnings if they believe a disaster will occur, but not necessarily with premature or overcautious warnings or false alarms.

iv. With regard to the content of warning messages, there is a problem of getting the appropriate blend of reassurance and urgency.

c. The Impact Phase

i. Following from the NORC findings relating to panic, the NAS endorsed the fact that panic is virtually absent from disaster situations and that further, conditions of panic exist only where people perceive imminent or immediate personal danger, where people recognise that escape routes are limited and those existing are blocked, and/or where people receive no contradictory information.

ii. Ad hoc leaders tend to emerge who have no tested leadership qualities, but who have skills to offer which are needed in the situation.

iii. Following from this ad hoc leader emergence, designated leaders tend to be discarded or ignored.

d. The Inventory Phase (the taking of stock)

i. People fit enough to engage in search and rescue do so and the location of family and kinfolk assumes priority. Rumours and false information lead to the re-emergence of behaviour types first seen during the Threat Phase.

ii. Social co-ordination gives way to loose, informal, ad hoc organisational structures among and within groups.

e. The Rescue Phase

i. The appearance of 'disaster syndrome' behaviour has been recognised during the Rescue Phase. This behaviour

reveals itself as a docility, and passivity in people, an immobility which renders people receptive to suggestion and to degrees of authority. It is important to note, however, that the disaster syndrome does not appear in all cases and is often restricted to large disaster events where there is great disruption and destruction.

ii. Those trained to act in emergency situations generally adapt well but often fail to perceive the enormity of the problems confronting them.

iii. Convergence behaviour is typical during this phase, including onlookers, relatives of those within the disaster area and rescue workers.

iv. Short-term mental illness is virtually absent.

f. The Remedy Phase

i. Emotional tension in some victims emerges.

ii. Children take the longest to recover emotionally, especially if they have lost family or relatives.

iii. Grieving families tend to attempt to confine the grief to one person with other members playing supportive roles.

iv. There is a heightening of the interaction between individuals and groups with class barriers breaking down and outside rescue groups experiencing the community's ostracism.

The NAS carried out no detailed research on the Recovery phase.

8.6. Although this outline of the research findings of the NAS has been necessarily brief it goes a little way in elucidating the areas of orientation. The research, though, has definite weaknesses which one would expect to find in a field with such blurred boundaries. Newman has stated that the disaster research field is

> "....politically controversial, empirically weak, and experimentally difficult."
>
> (Newman, 1963).

Nevertheless, academics involved in disaster research have not been complacent and have indulged in open criticism of their own field. Baker has outlined eight such weaknesses within the

research programmes of the NAS which are criticisms which can be applied to aspects of the research field in general and not merely the NAS programmes in particular (Baker, 1964).

a. No one single category of behaviour in disaster has been studied to a point where it is possible to provide the answers to a whole range of related questions on these particular categories.

b. No one disaster type has been studied in enough detail with respect to individual community reactions.

c. Most of the disaster studies carried out by or under the NAS contain little full analysis of behaviour before, during and after an event.

d. A heavy emphasis in the field research is placed upon the post-event interview which tends to restrict analysis to the content of such interviews, these being composed of personal experiences and reminiscences of immediately before, during and immediately after the event.

e. There has been very little emphasis on cross-cultural study.

f. The study of the effects of a large-scale disaster on a number of social institutions or regions has not been included among the work carried out under the NAS.

g. The results of the field research on natural disasters have not been extrapolated to provide answers on man-made disasters.

h. No organisation exists to co-ordinate the material produced by research organisations and the operations of various agencies with responsibilities in times of disaster.

8.7. Despite these valid criticisms, however, the NAS research programmes were important in the context of the development of behavioural research in disasters. The NAS conducted and promoted an ongoing and systematic research programme, the first major systematic programme in disaster research. It added greatly to the accumulated store of knowledge on disaster and exposed areas of further research needs. It gave disaster research an acceptibility as a viable, separate, if somewhat diverse, research field. Given the warning about the cross-cultural transference of research findings observed earlier in this section (vide 5.1.), the NAS initiated a methodology of approach to the problems of human response to disaster.

8.8. The work of the NAS was carried on, from 1963, by the Disaster Research Center (DRC) based at Ohio State University (vide 2.9.). Effectively the DRC considered areas of research not previously studied in any great depth and provided a continuation of the NAS's mainly sociological approach. Thus, organisational response and community preparedness in general has taken up much of the DRC's time and there has been an awareness of the need to apply research conclusions to actual situations.

8.9. The work of the DRC has been primarily in two main areas.

a. The explosion of certain myths concerning disaster behaviour - misconceptions built up from folklore and the media, and

b. Observations regarding specific organisational problems emerging from field studies of organisational and community response.

8.10. Two further areas of DRC activity have been the development of the nation of "subcultures" arising in disaster-threatened locales (the incorporation of disaster response elements into the local culture by communities with frequent and repetitive interaction with disaster-producing phenomena), and the possibilities for cross-cultural research, the latter seen as an important requirement by the DRC because of an apparent increase in the "social cost" (deaths and damage) of disaster events throughout the world.

8.11. The value of the work of the DRC is in pointing out, in the American context, where some of the important problems concerned with disaster events may conceivably lie. It is research based on observation and, as such, is considerably qualitative. The research presents a number of individual pictures resulting from field study, from which general features emerge which can be identified in each case. However, the amount of field research is not as yet sufficient for the DRC to make the broad sweeping conclusions that are often implicit in its findings.

REFERENCES

BAKER, G.W. (1964) "Comments on the Present Status and Future Direction of Disaster Research."

In Grosser, Wechsler and Greenblatt (Eds.) The Threat of Impending Disasters: Contributions to the Psychology of Stress. MIT Press, Cambridge, Massachusetts.

NEWMAN, S.M. (1963). "Review of 'The Occasion Incident: the Structure of Social Responses to Unanticipated Air Raid Warnings'." American Anthropologist, Vol. 65, pp. 990-991.

9. THE SOCIAL ASPECTS OF THE DISASTER ENVIRONMENT

9.1. This particular research line concentrates on the disaster potential in any given environment and a community's or individual's response to that potential. The research has been pursued primarily by the Natural Hazard Research Group, based jointly at the Universities of Toronto, Colorado and Clark in the United States and Canada. The methodology has derived from an interest of the University of Chicago School of Geography in the efforts of the United States Government to control flooding on major American rivers, and from Professor Gilbert White's interest in the flood problem in the nineteen-thirties (vide 2.5.)

9.2. In determining the need for developing a range of alternative methods of flood control other than the reliance on heavy technology, the Chicago geographers asked themselves a number of questions in order to gain the information they considered relevant to any flood control policy.

> "1) What is the nature of the physical hazard involved in extreme fluctuations in stream flow?
>
> 2) What types of adjustments has man made to those fluctuations?
>
> 3) What is the total range of possible adjustments which man theoretically could make to those adjustments?
>
> 4) What accounts for the difference in adoption of adjustments from place to place and time to time?
>
> 5) What would be the effect of changing the public policy insofar as it constitutes a social guide to the conditions in which individuals or groups choose among the possible adjustments?"
>
> (White, 1973)

9.3. These questions formed the basis of the research paradigm. Basically, the model of economic optimisation used in the technological answers to flood problems was replaced by a model of <u>bounded rationality</u>. This model accepted that man <u>satisfied</u> rather than optimised. The model did not accept that man optimised resources according to perceived economic gains and losses alone but that there were other factors which impinged upon the situation such as the

information available to him, his own personal experience of hazards, the nature of hazards, etc. The model was thus concerned with choice, this choice being based on the perception by the resource user of the nature of the process of interaction between a human use system and a physical environment system. Perception became an important part of the development of the research and highlighted aspects of the utilisation of certain hazard control policies, such as the difference between a resource user's perception of a problem and, say, a scientist's perception of a problem.

9.4. These ideas were expanded into a research paradigm which formed the basis of the work of the Natural Hazard Research Group, instigated in 1967 (vide 2.10.). The principal features of the research paradigm follow.

9.5. The research is based on the idea of interacting systems. This recognises that social systems cannot operate in isolation from the physical and natural systems operating within the environment and that they carry the appropriate and growing technology to modify the biosphere.

9.6. Definitions of the important factors in the paradigm are as follows:

a. A natural hazard is defined as

> "...an interaction of people and nature governed by the co-existent state of adjustment in the human use system and the state of nature in the natural events system. Extreme events which exceed the normal capacity of the human system to reflect, absorb or buffer them are inherent in hazard".
>
> (White, 1974)

b. An extreme event is described as any event in the geophysical system showing a relatively high variance from the mean.

c. An adjustment was defined as any human response which sought to alleviate the negative impact of an extreme event.

d. The organisation of stimuli relating to an extreme event or a human adjustment is the result of perception and perception is employed in a wide context in finding out how people view the threat or occurrence of a hazard and the choices of adjustments open to them.

9.7. The paradigm recognises the distinction between adjustments involving an adaptation of the human use system and those which cope without a modification of the use system. Also, it is assumed that the awareness of extreme events and opportunities for the alleviation of the hazard involve far more than merely perception.

9.8. Out of the original paradigm, a series of hypotheses were formulated which have never remained rigid but have constantly been reviewed. These five hypotheses basically are:

a. The justifications of occupants of areas of recurrent hazard for their continued occupance can be listed as:

> "1. Superior economic opportunity;
> 2. Lack of satisfying alternative opportunities;
> 3. Short-term time horizons;
> 4. High ratios of reserve to potential loss"
>
> (White, 1974)

b. The types of response to natural hazards can be characterised as:

> "1. Folk, or pre-industrial adjustments which involve a wide range of adjustments requiring more modifications of behaviour in harmony with nature than control of nature, are flexible and easily abandoned, are low in capital requirement, require action only by individuals or small groups, and can vary drastically over short distances.
>
> 2. Modern, technological, or industrial adjustments which involve a more limited range of technological actions emphasising control of nature, are inflexible and difficult to change, are high in capital requirements, require interlocking and interdependent social organisation, and tend to be uniform.
>
> 3. Comprehensive or post-industrial adjustments which combine features of both earlier stages so as to involve a larger range of adjustments, greater flexibility and variety of capital and organisational requirements."
>
> (White, 1974)

c. The variety encountered in perception and estimation of the hazard can be accounted for by a combination of the following factors:

"1. Magnitude and frequency of the hazard;

2. Recency, and frequency of personal experience with intermediate frequency generating greatest variation in hazard interpretation and expectation;

3. Importance of the hazard to income or locational interest;

4. Personality factors such as risk-taking propensity, fate control and views of nature.

This variation is not related to common socio-economic factors as age, education and income".

(White, 1974)

d. Choice of adjustment for individuals is a function of:

"1. Perception of the hazard;

2. Perception of the choice open to them;

3. Their command of technology;

4. The relative economic efficiency of the alternatives;

5. The perceived linkages with other people".

(White, 1974)

e. The process of estimating economic efficiency, for individuals,

"...is related to the perceived time horizon, the ratio of reserves to anticipated loss, and the degree to which choice is required".

(White, 1974)

f. Choice of adjustment is a function, for communities, of

"...perception of hazard, choice and economic efficiency as influenced by the stability and the power structure of government".

(White, 1974)

9.9. The importance of the Natural Hazard Research Group's paradigm and subsequent field studies cannot be overestimated. Its importance lies in the emphasis that it maintains away from studies of particular disaster events to the hazard or disaster environment, the potential for disaster which exists within the day-to-day environmental process. In this respect, the research has much to offer policy formulators as its involvement in the flood control programmes in the United States in the nineteen-thirties shows.

9.10. Two important factors emerge from Natural Hazard Research concerning the state of disaster occurrence in the world today and the need for mitigation.

a. There is a need for a sharing of information internationally if the threats to life and property from extreme natural phenomena are to be minimised.

b. Societies cannot possibly hope to cope with extreme natural phenomena solely by employing advanced technological methods. In the natural environment man has already learnt by experience to employ a wide range of adjustments to the vagaries of the hazard environment and to depend on one kind of social policy is actually to court disaster.

9.11. Natural hazard research asserts that unless the perceptions of the people interacting with the hazard are taken into account then government programmes are likely to go astray. Nevertheless, the research programme can offer advice on the limitations and incentives to effective remedial action in hazard prone areas to governments in the formulation of policy. It points to the need internationally for an integrated approach to disaster problems rather than seeking specialised help for a particular problem.

9.12. The social aspects of the disaster environment are not totally comparable to those of the disaster event. In the former, man and his environment are considered in the long-term, in "normality", and as decision-makers. In the latter, man is considered in relation to his immediate predicament, in the very short-term, in behavioural terms only and as a decision-maker under stress. Also, Natural Hazard Research has considerably more applicability to other parts of the world than the sociological disaster event research discussed in Section 8. Indeed, many Natural Hazard Research case studies have emanated from parts of the world other than North America.

REFERENCES

WHITE, G.F. (1973). "Natural Hazards Research." In R.J. Chorley (Ed): Directions in Geography. Methuen, London.

WHITE, G.F. (1974). Natural Hazards: Global, National, Regional. Oxford University Press, New York.

10. THE COSTS OF DISASTER

10.1. The Global Cost of Disaster

An examination of the cost of disaster reveals the level of expenditure in post-disaster situations. The difficulties of costing disaster in any general fashion are obvious; the data is unreliable, average figures are meaningless and firm conclusions negligible. Also, it is difficult to assess the real cost of disaster because actual estimates of losses are always based on a combination of the impact of the physical event and the state of adjustment. It follows that losses are a measure of the relative success of human adjustments to the vagaries of the environment and that losses from natural hazards should be measured with some future adjustment to that hazard in mind.

10.2. The only source of data in a comprehensive form is that of the United States Aid for International Development (USAID). The data analysis which follows is from 1966-1973, the last year of comprehensive data available at the moment.

10.3. Fifty-one 'new' disasters occurred in 1971 in which 522,212 persons were reported killed and 68,089,760 persons were affected. (This figure includes the Bangladesh Civil Strife.) In contrast, twenty-five 'new' disasters occurred in 1973 in which 111,641 persons were killed and 215,240,489 persons were affected. The value of damage is not given but the total value of assistance is detailed. Table 1 details this assistance; the most important fact to note is that in the currently available statistics on relief assistance from 1965 - 1973, the following conclusions are apparent:

a. Total United States Government aid exceeds that of the international community, i.e. the world excluding the United States, in five of the nine years.

b. Total United States Government aid sometimes exceeds total country self-help.

c. Most importantly, total assistance for the nine year period of in-country self-help more than doubled the amount of external assistance provided.

TABLE 1

NINE-YEAR TOTALS REPORTED FOREIGN DISASTER STATISTICS AND EMERGENCY RELIEF COSTS

Year	Total new Disasters	Number Killed	Total number people reported affected	Value of Assistance in Millions of Dollars			
				Total USG Aid	Total by Volags.	Total from the I.C.**	Total in-country self help
1973	25	111,641	215,240,489	301.4	15.5*	158.9*	658.1
1972	30	115,331	37,022,517	314.9	12.0*	582.2*	81.0*
1971	51	522,212	68,069,760	189.0	16.7*	266.6*	744.8*
1970	51	72,915	11,743,040	48.7	12.2*	59.5*	96.6*
1969	36	1,018,534	32,482,216	102.6	12.2*	95.5	131.0*
1968	55	4,103	5,455,602	32.6	7.9*	16.5*	607.1*
1967	62	1,517,547***	14,223,092	81.4	12.2*	173.2*	2,964.7*
1966	48	7,086	4,139,646	25.4	1.6*	9.6*	*
1965	50	47,089	5,504,173	46.3	3.8*	3.6*	*
9 Year Total	408	3,416,458	393,880,535	1,142.3	94.1*	1,365.6*	5,283.3

Key: * Incomplete or not reported.

** I.C. - International Community - not including the US.

*** Note substantial increase in deaths over previously reported totals for year 1967. The reason for this is that at the time the report on the India Famine was written the number of deaths was not available. It has since been estimated there were from 1.5 million to 4 million deaths and the lower figure has been used and added to other deaths previously reported for other disasters.

10.4. The total value of resources diverted to assist disaster-stricken areas was 7884.7 million dollars over the nine-year period. This, however, is not necessarily the total cost of disaster. The mean expenditure over the nine-year period for a disaster hit area was 19.3 million dollars according to these USAID figures, but the concept of average cost of assistance per disaster or even per type of disaster or region is meaningless. It is sufficient to say that 1133.9 million dollars were spent on disaster assistance in 1973; 96 countries of the world had less than this amount of resource capital as GNP during 1973 (World Bank, 1973).

10.5. The central problem remains, however, that at the moment there is insufficient data to account for the actual cost of disasters on a global scale. Any average figure becomes meaningless. For example, the Barbados floods of October 1970 produced an estimated dollar damage of 500,000; the floods of Italy in October 1970 cost 120 million dollars in damage; floods in Malaysia during December 1970 did 37 million dollars worth of damage; and floods in Brazil during April 1971 did 75 million dollars worth of damage (USAID, 1974). Similarly, regional estimates are impossible to calculate. Some surrogate variable, such as loss of life, could be utilised or some composite function of lives lost, injuries received and capital destroyed. Even with such estimates, data should be treated with caution, but it would seem imperative that some statistical index should be evolved. With the current growth of the United Nations Office of the Disaster Relief Co-ordinator (UNDRO), it is to be hoped that such data will be forthcoming.

10.6. Costings are available for the three major world disasters, excluding the Nicaraguan earthquake of 1972. The greatest loss of life occurred in the Bangladesh cyclone - 300,000 - 100,000 more than during the Bangladesh Civil Strife, but dollar damage was low, 86.4 million dollars, because of the underdeveloped agrarian nature of the economy. The Philippines flood, however, 'only' killed 653 people, but did 220 million dollars worth of damage, while the Peru earthquake resulted in 66,794 deaths and destruction costing 530 million dollars. Even if exact costings are not available, the enormity of a disaster event can be appreciated.

10.7. The distribution of costs within a disaster - a Guatemalan example.

On the 4th February, 1976, at 03.10 in the morning an earthquake occurred in Guatemala City which registered 7.5 degrees Richter. Over 1,400 earth movements between 4 - 5 degrees Richter followed the initial quake.

The major earth movement was along the Motagua fault where two tectonic plates meet and in places resulted in a displacement of over $3\frac{1}{2}$ feet. This movement set off a number of secondary faults running North-South. This resulted in serious damage to an area covering 350 by 80 kilometers, stretching from Guatemala City in the south to Salama in the north, Tecpan in the west and El Progresso in the east, affecting 16 of the 22 departments of the province.

This is a well known fault zone that has experienced inumerable earthquakes over the years and as a result those that could afford it have had their buildings constructed according to earthquake norms. The rural and urban poor on the other hand were not able to comply with the costly anti-earthquake specifications. Further, most of the poorest housing is found in the ravines and gorges that criss-cross the city, mainly on a north-south axis. These are well known surface features of fault lines highly susceptible to landslips whenever earth movements occur. Thus the deaths and homelessness of large numbers in Guatemala City reflect clearly the unwillingness of the State to take the simple step of discouraging people from living there, by providing them with land suitable for housing.

In the area affected live 57.5% of the country's population (74% urban and 48% rural), with over 22,000 dead and 75,000 wounded. The initial costs of the earthquake damage are given in Table 2.

10.8. Effects on Production:

a. Industry.

The business organisations announced 5 to 6 days after the earthquake, that the material structure of production was not damaged. They forgot to mention that they were referring to large scale industry that suffered only marginal

TABLE 2

GUATEMALA: INITIAL COST ESTIMATES OF EARTHQUAKE DAMAGE

(In millions of US dollars)

Item	Total Cost	Estimated Foreign Exchange Content (percent)	Foreign Exchange Cost	Domestic Currency Cost
I. Housing	491	22.0	109	382
Metropolitan Area	236	25.0	60	176
Larger Towns	74	15.0	11	63
Smaller Towns	104	10.0	10	94
Miscellaneous 1/	77	35.0	28	49
II. Infrastructure	72	62.0	45	27
Transport	66	62.0	41	25
Power & Telecommunications	4	78.0	3	1
Other	2	32.0	1	1
III. Social Overhead	148	32.0	47	101
Social Service Facilities	98	34.0	33	65
Urban Services	14	41.0	6	8
Government Buildings etc.	36	22.0	8	28
IV. Productive Sector	39	30.0	12	27
Agriculture	8	15.0	1	7
Industry	11	60.0	7	4
Commerce & Services	20	19.0	4	16
Total	750	28.0	213	537

1/ Household goods replacement, rubble removal, etc.

Source: Government estimates.

damage, in relation to current operational costs. Energy was restored within two days and buildings and machines were back in production inside a week. It took a little longer to restore the affected office blocks. Some firms expressed their fears of the probable reduction in demand. Those in the construction industry immediately prepared for increased demands. It must be pointed out that this is a highly concentrated sector with monopolies owning the production of cement, brick, wood for building and the importing of primary materials. The production of asbestos, cement and zinc sheeting is controlled by international consortiums.

In fact, an important sector of the economy was affected - the small industry and especially the artisans. These are found in the areas of the city most damaged. In Zones 3, 5, 7 and 8 of the city, where large numbers of workshops existed, the buildings, an important part of the capital of these enterprises, were heavily damaged or destroyed: also equipment and many workers.

This sector accounts for 56% of the industrial establishments (each employing 5/9 workers) 13.5% of total industrial employment. It is estimated that about 50,000 artisans were so affected.

10.9. b. Agriculture.

The Government and agribusiness responded to the earthquake by stating that there had been no serious damage to agriculture. It is true that the export sector of sugar, cotton and coffee that accounts for 50% of the Gross Product in agriculture was not affected and is controlled by agribusiness. In fact, 180,000 small producers were affected - 65,000 lost their homes and 11,000 were killed. This sector, primarily Indigena, has a very fragile economy based on subsistence production, sale of surplus through local markets, artisan production sold through the same regional markets and finally cash from seasonal employment on the coastal farms. This delicate economy has been hit, the consequences of which are

not too clear. Markets were closed, the wheat harvest was temporarily abandoned, putting all agricultural activity behind, much equipment for artisan production has been destroyed or damaged, cash from migration to the coast will lessen as people give priority to rebuilding. Labour is lost through death. The probability of a lessening of labour available to work on the large plantations has already created concern amongst the government and agri-business sector. It is estimated that it will take one to two seasons for the highland economy to return to normal.

10.10. c. Commerce.

Again, the large urban shops, supermarkets and warehouses lost less than 5 million dollars from earthquake damage and were soon able to be back in business. The people they serve - the middle classes - were not seriously affected by the earthquake and did not reduce their expenditure.

For the small shopkeeper, the reverse was true. They were concentrated in the worst hit areas, their clientel have had to reduce their purchasing because of their serious losses and they, unlike the large enterprises, did not have earthquake insurance.

10.11. d. Communications.

The most serious damage was to the main artery connecting Guatemala City, the Pacific coast and the highlands to the Atlantic ports. This is the main artery for imports and exports - over 80 million dollars worth of damage was done to the road and rail and 15 million dollars worth to Puerto Barrios. Through this route flows 51% of the country's exports - raw materials such as coffee, cotton, timber, sugar, zinc, copper and nickel - two thirds of which is destined for the U.S. market. As part of its aid programme, the U.S. sent in army engineers who have re-opened the road with the use of heavy machinery and bailey bridges seven weeks after the earthquake.

Elsewhere, the roads were completely re-opened within a fortnight by public works.

10.12. e. Health.

15 hospitals and 55 health centres were damaged; it is calculated that the country lost 60% (4,700) of its hospital beds. The private sector did not suffer damage - it was in the public sector that all losses occurred. Medical relief work was co-ordinated by the Ministry of Health and Social Security Institute, over 75,000 cases being dealt with as a result of the earthquake. The private sector at no time offered help to the Ministry of its resources, equipment or installations.

10.13. f. Culture.

28 churches were damaged - a number of important Colonial churches were completely destroyed.

Schools serving 250,000 scholars were rendered unusable. Over 1,000 were lost, but as was pointed out in the Ministry of Planning, the country was missing over 3,000 schools before the earthquake. Again it was in the rural areas and poorer parts of the city where the schools were lost. The city's private system was hardly affected and able to restart on the 15th March.

10.14. g. Summary.

Material damages total about 700 million dollars.
22,800 died and 76,500 were wounded.
Export agriculture was not affected.
Infrastructional projects were not affected.
The fast-growing tourist industry will be back to normal within two months but how long it will take the tourists to return is another question. (Not one tourist was killed or seriously injured in the earthquake.)
Inflationary pressures are expected to intensify. (Deterioration in balance of payments, increased National Debt, already developing speculation)

10.15. h. Conclusion.

1. The catastrophe of the 4 February, 1976, due to the socio-economic structure affected the poor and hardly

at all the rich and middle classes.

2. The poor suffered from the earthquake because:
   a) The anti-earthquake measures applicable were restricted in use to the better off because of cost.
   b) The areas in which the poor lived are those most susceptible to earthquake damage.

3. To summarise the damage:
   a) Middle and large scale industry suffered a temporary paralysis but was back in action within a week; the small amount of damage was covered by insurance. Small industry, particularly artisans experienced serious damage.
   b) Export agriculture was not affected; 180,000 small producers were.
   c) Only the small traders and shopkeepers in the poor areas suffered losses in both capital and turnover.
   d) The mining sector was not affected.

4. It was the poorest sector in each economic activity that suffered, they have the least political influence, and the greatest difficulty in getting credit. The strongest and richest sectors suffered the least, thus they control the reconstruction for which the poor will have to pay and by which the imbalanced power structure will be reinforced. (Wisner, Westgate & O'Keefe, 1976.)

5. The extent of damage to the infrastructure means the government has to play an important role in reconstruction (to the roads, ports, schools, hospitals, etc.) The capacity of the government to respond will affect the extent of social disturbance.

6. The extent to which the disaster has affected the poorest sectors means that reconstruction cannot effectively take place without a positive participation from them.

7. The disaster responses to date have reinforced the passive-receptive attitudes of the poor.

8. The earthquake and its response have re-emphasised the contradictions of Guatemalan society. (Cherrett, I. 1976)

10.16. The lack of price increase in a post-disaster situation - the case of the absent black market

Disaster brings a sudden destruction of wealth. It would seem logical that demand would remain constant or even increase after a disaster while supply would diminish. There is, however, no empirical evidence of price increase following a disaster nor is there evidence to suggest the creation of a black market. This fact presents an anomaly for economic theory to explain.

It could be argued that not only is wealth destroyed in a disaster but also the integrative mechanisms for the distribution of wealth (e.g. markets) cease to function but, again, one would expect a rise in price if this were the case. In fact, evidence indicates that rather than a disorganised black market, orderly queues are apparent.

10.17. Secondly, it could be argued that the emergent altruism observed in post-disaster situations would change the utility functions of a population. This opinion cannot be empirically refuted but, since much of the supply obtains from outside donors, it is questionable whether a change in the utility function of the indigenous population has much to do with price consistency.

10.18. Thirdly, it is doubtful whether consensual agreement following a threat situation leads to co-operative action which keeps prices constant.

Assuming the interdependence of several factors, it would seem logical that utility functions are constant. If this logic holds true, then one may assume that actors seek to maximise their utility functions. In a situation following a disaster, the asset position of donor-recipient changes with the inflow of post-disaster aid. If the donor-recipient have predisaster aid links, then the donor is expected to maximise his utility - such a situation produces price stability in a post-disaster situation.

10.19. Disaster Aid - Some Considerations

If donors are increasing their utility values, what aid process results? Hayter (1971) and Payer (1975) have described the

vested interests that exist in the provision of development aid. In considering the absence of a black market, it was suggested that donors maximised their utility function, i.e. attempted to strengthen their vested interest. This nature of the vested interest will be raised later (vide Section 18) but, at this juncture, the reality of aid, with particular reference to the Sahel, will be considered.

10.20. The review of relief aid to the Sahelian famine makes interesting reading for those with a macabre sense of humour. Sheets and Morris present their analysis of the Sahel famine relief programme which first appeared in 1972 (Sheets and Morris, 1972). Their conclusions are largely based on an analysis of the bureaucratic inefficiencies of international relief aid. They state,

> "The tragedy in the Sahel revealed again what many officials and non-governmental relief agencies have long known from other disasters - that international relief is too important and too complex to leave so largely to a USAID or an FAO ..."

Anyone who has worked in disaster situations would agree that relief activity should be reorganised but, again, anyone who appreciates the political economy of disaster will see that relief aid is merely buttressing the dependency status quo.

10.21. The relief aid to the Sahel famine has generally been seen as one of the largest global relief operations ever launched. El-Khawas, however, in his contribution places this operation in perspective.

> "The United States was the largest donor to the Sahel with a total of $130 million contributed during the 1973-74 crop year. Yet this amount is relatively small in comparison with the $2.2 billion airlifted to Israel during the Yom Kippur War in October 1973. The amount of Sahel assistance also is much smaller in size and scope than the considerable amount of American aid given to the Thieu regime in South Vietnam for a similar period. During fiscal year 1974-5, the UD Congress approved $700 million for South Vietnam only half the total requested by the Nixon administration. President Ford later requested an additional $300 million in assistance for Vietnam."
>
> (El-Khawas, 1976)

El-Khawas argues that Africa rests at the bottom of the aid priorities of the United States. Less than 10 per cent of USAID foreign appropriation goes to Africa and that aid is largely spent on only ten of the forty-two independent African States. More importantly, El-Khawas shows that foreign donors have tended to concentrate on relief measures and have shown little readiness to initiate long term programmes to prevent a future, similar disaster. The response has been to treat the symptoms not the cause of the Sahel famine.

10.22. In an article entitled 'An International Perspective on the African Famines' Wiseberg focuses attention on the 'critical socio-economic and political dimensions of famine' including

a. that major droughts produce starvation only in underdeveloped parts of the world,

b. that underdevelopment itself is perpetuated by the developed, ideologically hegemonous, countries,

c. that local elites in the country suffering famine are slow to respond to the marginalised conditions within their own country. (Wiseberg, 1976)

This analysis grasps the cause of disaster, namely acute poverty, and cites other examples of studies in the political economy of famine (Bhatia, 1967; White and Jacoby, 1946).

Wiseberg described the declining American Food for Peace Program (PL 480).

> "Compared to the 6.1 million tons of wheat the United States gave in food aid in 1970, it provided only 2.5 million tons in 1973, with less than a million tons projected for 1974. In fiscal year 1974, more than 50 per cent of the Food for Peace shipments went to security-related countries such as Vietnam, Cambodia, Laos, Malta, Jordan and Israel."
>
> (Wiseberg, 1976)

The PL 480 food does feed starving people, but it should be remembered that this food programme is primarily designed to assist American farmers by having the US Government buy up agricultural surplus and dispose of it without depressing the world price of grain. Wiseberg indicates that it is not surprising when grain is not abundant and American farmers can obtain higher prices

abroad for their cereal production that PL 480 programme is drastically cut. This analysis would suggest that simple market forces were in operation but the reality of the PL 480 cutback is a reality which is dominated by multinational agribusiness. It is certainly true that the 1972-4 harvests were not excessively abundant but the North American continent which is the cereal basket of the world had been playing the international food market by reducing the amount of land under cultivation. The world export price for wheat diminished noticeably during the 1960s. The price index (based on 100 in 1963) was 94 in 1969 and 90 in 1970. From that point on, the amount of land cultivated with cereal decreased. For example, the amount of land cultivated with wheat in Canada during 1970 was 50 per cent of what was cultivated in 1969. The effect of these restrictions, not only in Canada but in the United States, Australia and Argentina, was reflected in the amount of wheat harvested - a reduction of almost 25 per cent. Until the end of 1974, the United States had been paying $3 billion to American farmers not to plant 50 million acres of cereal crops (O'Keefe and Wisner, 1974; Robbins and Ansari, 1976).

10.23. Sheets and Morris conclude that much of the inefficiency of international relief could be overcome if there was a global watch on disaster-prone areas closely linked with a planning and operations function responsible for disaster relief or prevention. The planning and operation function envisaged in disaster prevention and relief is largely a military capacity. Most disaster research throughout the world is financed by the developed 'countries' military sources, most effective monitoring systems are controlled by military interests and it is difficult to see how effective relief planning on this scale could operate without the use of the military from developed countries. Disasters, however, often provide a focus for political agitation and change for the local people. Global military relief armies could merely reinforce the status quo of poverty which is the ultimate cause of vulnerability to natural hazard.

REFERENCES

BHATIA, B.H. (1967) Famine in India 1866-1965. Asia Publishing House, Bombay.

CHERRETT, I. (1976) Personal correspondence.

EL-KHAWAS, I. (1976) "A Re-Assessment of International Relief Programmes." In Glantz, M. (Ed). The Politics of Natural Disaster: the Case of the Sahel Drought. Praegar Special Studies in International Economics and Development, Praegar, London.

HAYTER, T. (1971) Aid As Imperialism. Penguin, London.

O'KEEFE, P.; WISNER, B. (1974). The World Food Crisis. Current Issues Paper No. 1, University of Bradford,

PAYER, C. (1973) The Debt Trap, Penguin, London.

ROBBINS, C.; ANSARI, J. (1976). The Profits of Doom. War on Want, London.

SHEETS, H.; MORRIS, R. (1972). Disaster in the Desert. Carnegie Endowment for International Peace, New York.

USAID (1974) Internal Mimeograph, Washington D.C.

WHITE, T.H.; JACOBY, A. (1946). Thunder out of China. W. Sloane, New York.

WISEBERG, B. (1976) "An International Perspective on the African Famines." In Glantz, M. (Ed). The Politics of Natural Disaster: the Case of the Sahel Drought. Praegar Special Studies in International Economics and Development, Praegar, London.

WORLD BANK (1973) World Bank Atlas. International Bank for Reconstruction and Development, New York.

11. THE COSTS OF DISASTER PREVENTION

11.1. Introduction

Evidence from a number of empirical investigations suggests that there is a basic difference in hazard events between pervasive and intensive. Drought is the archetype of the pervasive hazard. Earthquake is the archetype of the intensive hazard. Clearly, however, there are many gradations and the establishment of a mutually exclusive dichotomy seems unwarranted.

The differential impact of pervasive and intensive hazards can be illustrated with reference to urban droughts and tornadoes in the United States. Urban drought or a reduction in the natural availability of water for city supplies, is a phenomenon that can affect that half of the population of the United States which draws water from surface systems. These cities together spend about 200 million dollars a year for storage structures (reservoirs and their control works) designed to erase the normal fluctuations of water availability resulting from variations in rainfall.

11.2. A study of the effect of drought (Russell, Arey and Kates, 1970) occasioned by the drought in the north-eastern United States in 1964-67, showed that where there is insufficient rainfall to replenish the reservoirs in a succession of years, the cumulative deficit can lead to evidently severe shortages of water. However, the economic and social losses inflicted upon communities are surprisingly small, not exceeding 5 dollars per person annually. If drought has little impact on urban communities in the United States, it is because society pays a lot in advance to protect itself from such impact. The major social response is one of anticipatory or preparedness expenditures. Reservoirs are designed with considerable over-capacity partly in order to realise scale economies and partly to provide a high margin of safety. The slowness of the onset of drought conditions permits corresponding reductions in water use by voluntary (at first) and then, if necessary, mandatory reductions in water consumption, without major economic or social dislocations resulting. Thus the major impact of the drought hazard is seen in steps taken to substantially reduce its potential effects.

11.3. By contrast, tornadoes are an intesnive hazard which threaten about 40 million people living in the areas of higher tornado incidence in the Midwest, the Great Plains and the Gulf States. The likelihood of an occurrence for a tornado at any single point is extremely small. Although about 600 - 700 tornadoes occur every year, the average path is quite small. There is little incentive, therefore, to invest in protective measures. Their likelihood of being needed in any one place is small, and given the force of tornadoes, protection measures are often not very effective (Baumann and Sims, 1972). Approximately 5 million dollars a year (compared with 200 million dollars for urban drought) is spent to provide and improve warning systems and to construct tornado shelters or storm cellars. Warning time under the best conditions is not more than one hour. Deaths from tornadoes have been reduced in recent years but they are still relatively high, averaging about 120 a year as against zero deaths from drought. Economic damages from tornadoes average about 125 million dollars a year as opposed to only 15 million dollars for urban drought. Damage from the frequent, less severe shortages of precipitation would increase the average substantially.

11.4. The average annual cost per capita of urban drought for those in the area of risk is about 2 dollars; for tornadoes it is about 4 dollars. These costs are very differently distributed, however. Drought, a pervasive hazard, is frequent, low in energy output and slow to develop, and has stimulated a social response of high levels of expenditure on prevention of effects. The ratio of sustained losses to the costs of prevention is approximately 1:13. Tornadoes are comparatively rare events, with high energy outputs, and highly localised with a very rapid onset. These characteristics have served to discourage attempts to prevent effects and a consequent high level of damage and loss of life results. The ratio of losses sustained to the costs of preventive action is approximately 20:1.

11.5. National Estimates of the Costs of Disaster: a Case Study of St. Lucia.

In disaster research, relatively little knowledge is available particularly of the statistical probability of disaster events

and their associated costs. This section outlines a possible method of premium calculation applied to the disaster history of St. Lucia. To produce a more exact determination of the natural hazard premium, both return periods and expected losses from natural hazards must be calculated more precisely. This precision will only occur when further scientific knowledge on the probability of natural hazards is available.

The parameters mentioned, the return periods of natural hazards and the loss expected from each natural hazard, are the two most important considerations in the estimation of a premium to cover losses from natural hazard. The accuracy of these parameters is constrained by several factors. The constraints on measuring returned periods are the limited understanding of the physical mechanism of hazard, the unavailability of data and an insufficient knowledge of risk. It is possible to calculate average return periods but rather meaningless to calculate the probability of a return event because the timescale of observation is not statistically valid, e.g. there are 300 years of scientifically recorded earthquake activity but this 300 year period is not a valid sample of the activity of the current geological era in which it occurs. To avoid this difficulty, it is assumed that the average return period accurately reflects the future return frequency of disaster, i.e. that the average return period is a probability assessment of future natural hazard. The constraints on measuring average costs of a natural hazard are the unreliability of the data, particularly as estimations of damage normally exaggerate the cost of disaster, and the continual development of society which means that continually more infrastructure is vulnerable as development occurs. Costs have to be measured at current prices which, in this case, were determined by the Retail Price Index. (United Kingdom Government, 1975)

11.6. To estimate a premium for the insurance of natural hazard, it is necessary to determine what is going to be insured and what value is placed on the insured stock. In this particular example, we are concerned with the banana industry of St. Lucia. In the St. Lucian economy, bananas account for 77.6 per cent of all agricultural exports and 75.1 per cent of all exports (1971). The

banana exporting business is the backbone of the St. Lucian economy and, with a per capita income level beneath $500 per annum, its importance can be readily understood. The St. Lucian economy demonstrates the difficulties that face the underdeveloped primary producers particularly those involved in monoculture. Table 3 indicates the St. Lucian banana production. It is assumed that a minimum crop of 50,000 tons is necessary if the economy is not to be seriously affected - the visible decrease in production reflects the effects of drought over the last 6 years. The current average price per pound to the grower is 10 cents (E.C. currency). The value of 50,000 tons of bananas at 10 cents (E.C.) per pound is £28 million (£1 = $4 E.C.). With a knowledge of the value of bananas to be insured, it is possible to calculate the premium.

11.7. The annual premium (P) required to cover this risk, apart from loadings for administration, inflation, etc., is calculated on the basis of the average return period and the average cost per disaster impact. This figure is the <u>average loss</u> expected each year. Expressed as a formula it reads:

$$P = \left(\frac{LE}{RP}\right)$$

where P = average loss per annum
LE = loss expected from hazard
RP = return period in years

Research conducted in the Windward Islands during August 1975 allowed the average return period to be calculated based on a time period from 1832 - 1975, (O'Keefe and Conway, 1976). Earthquake, volcano and fire are omitted from these considerations because the influence of earthquake, volcano and fire on banana production is considered slight. If, for example, large scale devastation of banana production were to occur, then the situation would probably result in massive outside relief aid. The purpose of this specific calculation is not to consider every conceivable risk but to assess a minimum premium to allow the continuity of banana production in St. Lucia. Table 4 contains the average return period for disasters directly affecting banana production. Windblow is damage from winds of less than 33 knots;

TABLE 3

ST. LUCIAN BANANA PRODUCTION (ACTUAL TONS)

1970	50,929
1971	45,020
1972	46,998
1973	35,156
1974	44,129
1975	32,000

TABLE 4

AVERAGE RETURN PERIOD PER DISASTER IN YEARS

Type	Intensity	Return Period
Windblow	↓ 33 knots	1.0
Tropical storm	34-63 knots	6.75
Hurricane	64 ↑ knots	16.8
Drought*	↓ 0.2"p.d.	7.0

(* The drought figure is assumed to be unrecorded.)

TABLE 5

AVERAGE DAMAGE VALUE PER EVENT

Type		Value (£)
Windblow		62,500
Tropical storm		500,000
Hurricane		2,000,000
Drought	(a)	1,000,000
	(b)	2,400,000

tropical storms are from 34-63 knots and hurricanes 64 knots or more. For ease in calculation, storm damage (windblow, tropical storm and hurricane) are separated from drought.

11.8. The same fieldwork allowed an estimation of the average damage to banana crops per disaster strike. These figures were obtained from the disaster history of St. Lucia and then corrected to current prices. The two prices for drought damage indicate the complexities of assessing drought damage. These figures are presented in Table 5. The conservative estimate (a) is obtained by comparing each year's forecasted exports with the actual exports produced (Table 1); this method takes into account the effect of the previous year's drought. The estimated exports for 1970-75 were 366,500 tons (approx.) and the actual exports were 254,300 tons (approx.). For simplicity, assume that this total deficit over a six year period is 100,000 tons. At 10 cents (E.C.) per pound the value lost is £5.6 million or almost £1 million per year. The more liberal estimate (b) assumes a maintenance of the level of production before the drought occurred. On this basis, maintenance of the 85,000 tons (approximately equal to the 1969 level) would have been 510,000 tons for the 6 year period. The actual tonnage of 254,300 gives a shortfall of 255,700 tons. Valued at an average of 10 cents (E.C.) per pound, this represents a loss of £14.25 million or almost £2.4 million per annum.

11.9. The annual premium (P) required to cover these risks in St. Lucia, calculated from the equation previously presented, is listed in Table 6. It is possible to express the loss expected per disaster not in pounds sterling (when written LE) but as a percentage of the sum insured V, (when written le) and also to express the premium rate in per mille, p, of the sum insured instead of expressing the premium, P, in pounds sterling. (Munchener Ruckverscherungs Gesellschaft, 1973) In equation form this is:

$$le = \frac{LE}{V} \cdot 100$$

and

$$p = \frac{P}{V} \cdot 1000$$

TABLE 6

CALCULATION OF ANNUAL PREMIUM: RESULTS

Type		Annual Premium (£)
Windblow		62,500
Tropical storm		74,000
Hurricane		119,000
Drought	(a)	143,000
	(b)	342,800

The calculations for the estimation of loss as a percentage of the sum insured are given in Table 7. The calculation of the premium rate per mille is given in Table 8. It is now possible to rewrite the premium calculation to read:

$$P = \left(\frac{le}{RP}\right) . 10$$

This equation means that 'p' is the annual premium rate per mille without loadings for fluctuation for an object which is exposed in the course of RP years to a disaster through which it suffers a loss of 'le'% of its value. The results obtained for the re-written equation are contained in Table 9.

11.10. It is possible to sum the risk of storm hazard, i.e. to cover all storm damage under one policy premium. It is not possible to do the same for drought, for the variation in intensity for drought conditions is not known. The premium equation is amended for the revised storm premium to read:

$$p = 10 . \sum_{i=1}^{i=3} \left(\frac{le}{RP}\right)_i$$

This equation represents the average annual loss expected from storms of varying intensity and would correspond to the risk premium. Table 10 gives the revised premium for storm damage. The equation then reads

$$p = 10 . \left(\frac{0.25}{1} + \frac{2.643}{6.75} + \frac{4.25}{16.8}\right)$$

$$= 10 . (0.25 + 0.39 + 0.25)$$

$$= 8.9 \text{ }^{o}/oo$$

11.11. The results of this premium calculation expressed as costs against the total value of the banana crop (£28 million) are contained in Table 11. These are basic estimates which do not contain any loadings for fluctuation in either intensity or impact. Until better data is obtained, this will be impossible. Commercial insurance companies are likely to overestimate the premium to safeguard against fluctuations. There are no loadings for administration, commission and profit. It is difficult to visualise any company who would underwrite the risk for less than £1 million per annum or more than 3.5% of the annual crop value.

TABLE 7

ESTIMATION OF LOSS AS A PERCENTAGE OF SUM INSURED

Type		%
Windblow		0.22
Tropical Storm		1.79
Hurricane		7.14
Drought	(a)	3.57
	(b)	8.57

TABLE 8

PREMIUM RATE EXPRESSED PER MILLE

Type		°/oo
Windblow		2.232
Tropical storm		2.643
Hurricane		4.25
Drought	(a)	5.107
	(b)	12.243

TABLE 9

REVISED PREMIUM CALCULATION

Type		Premium °/oo
Windblow		2.232
Tropical storm		2.643
Hurricane		4.25
Drought	(a)	5.107
	(b)	12.243

TABLE 10

REVISED PREMIUM FOR STORM DAMAGE

Intensity	Type	1e(%)	RP(Years)
↓ 33 knots	Windblow	0.25	1
34-63 knots	Tropical storm	2.643	6.75
↑ 64 knots	Hurricane	4.25	16.8

TABLE 11

ANNUAL COST OF INSURANCE

Type		Value
Windblow		62,500
Tropical storm		74,000
Hurricane		119,000
Total Storm Coverage		255,500
Drought	(a)	143,000
	(b)	342,800
Total hazard coverage (inc. drought (a))		398,500
Total hazard coverage (inc. drought (b))		598,300

11.12. The Comparative Costs of Insurance and Preventive Measures - A Case Study of the Bahamas

In winter 1974 the Disaster Research Unit undertook a field mission to the Commonwealth of the Bahamas. The D.R.U. was analysing particularly the probability of hurricane strikes on the island group. What impact were these events going to have upon the life and economy of the Bahamas? Having in mind the possibility of a recurrence of hurricane with the force and impact of the 1929 event, with a sea surge of 12'0" (3.6 m) up to Shirley Street and winds of 150 mph (240 kph), one can estimate the cost of damage at current prices. If one delimits an area of coastal Nassau from Paradise Island Bridge to the Sheraton Colonial Hotel bounded to the north by Shirley Street, we have an area of approximately one square mile (0.9 square miles) (1.6 km^2).

It has been estimated that damage would be $50 million for property alone if the area were totally destroyed; this loss of $50 million is 11.6 per cent of GNP at 1971 prices. It would be more realistic to consider partial losses at, say, 50 per cent ($25 million) or 25 per cent ($12 and a half million). Even a 10 per cent loss ($5 million) which would occur with hurricanes like Betsy (1965) would produce a loss of $5 million or more than one per cent of the GNP.

If the losses within one square mile (1.6 km^2) seem at first sight to be unrealistic, then compare the losses with those experienced by less developed countries from hurricanes since 1970. Estimated dollar damage in the Bangladesh cyclone was a low $86.4 million because of the underdeveloped nature of the economy, but losses in human terms high; 300,000 people - 100,000 more than during the civil strife. Hurricane 'Edith' which struck Nicaragua in 1971 did relatively little damage causing less than $500,000 destruction. This, of course, should be contrasted with Hurricane 'Fifi' in Honduras, 1974, where estimated losses in an underdeveloped agrarian economy was $154 million. The most pertinent example to the Commonwealth of the Bahamas is the recent hurricanes suffered by the Gilbert and Ellice Islands, 1972, when damages were estimated to exceed $22½ million.

11.13. It should be borne in mind that the estimates of damage to one square mile (1.6 km^2) of Nassau, the capital city, are for real estate property only with an impact of total destruction. Much of this central business district will be covered by insurance so the loss is not eventually borne by individuals. However, these figures do not include vehicles, goods in buildings, crops, loss of trade and loss of business. Similarly no attempt has been made to estimate the loss of life. It is worth stressing that with the increasing population of Nassau more people are vulnerable to a disaster upon New Providence and therefore, the impact of that disaster would be greater. Similar calculations could be made for any other island.

11.14. These estimates of losses do not, of course, depend only on a recurrence of a 1929 strength hurricane, the probability of which is much less than a number of less ferocious tropical storms and hurricanes which over a longer period of time, could cause the same or a greater amount of damage. If one takes the probability of hurricane occurrence and the estimated cost of hurricane 'Betsy' ($700,000) for the Northwest quadrant of the Bahamas then there is an annual probability of losses exceeding £400,000. Dollar damage from tropical storms and hurricanes has a probability of exceeding $0.5 million per annum.

Figures are in any case hypothetical due to the absence of hurricane occurrence of equal significance to 1929 and the absence of records over a longer period of 100 years. The most detailed account of a hurricane in the Bahamas is that written by Governor Rawson of the hurricane in 1866; no other such detail is available. A graphical analysis of all hurricane and tropical storm occurrence over the past 100 years would indicate that if the cyclical trends and probabilities remain constant, hurricane strikes will increase. The greater concentration of population in the area of greatest hazard means that the disaster vulnerability of the population will increase also.

11.15. Against probable recurring losses of $500,000 per annum from tropical storm and hurricane the cost of precautions is negligible. Assuming a growth rate of 3 per cent, i.e. $12,900,000 on a GNP of $430 million, then the probable recurring

losses lower the value of this growth rate by 3.9 per cent ($500,000). This figure is much higher than any comparable recurring insurance figure and does not compare with any of the outright capital costs for infra-structure improvement which do not recur.

11.16. The cost of precautions requiring capital outlay discussed is negligible. Possibly the most significant series of precautions are those already contained in the Bahamas Building Code and these have been costed in showing only a 5 per cent additional building cost for incorporating all precautions in medium cost family house construction or, say, $500 on a $10,000 house. (Lewis, 1975)

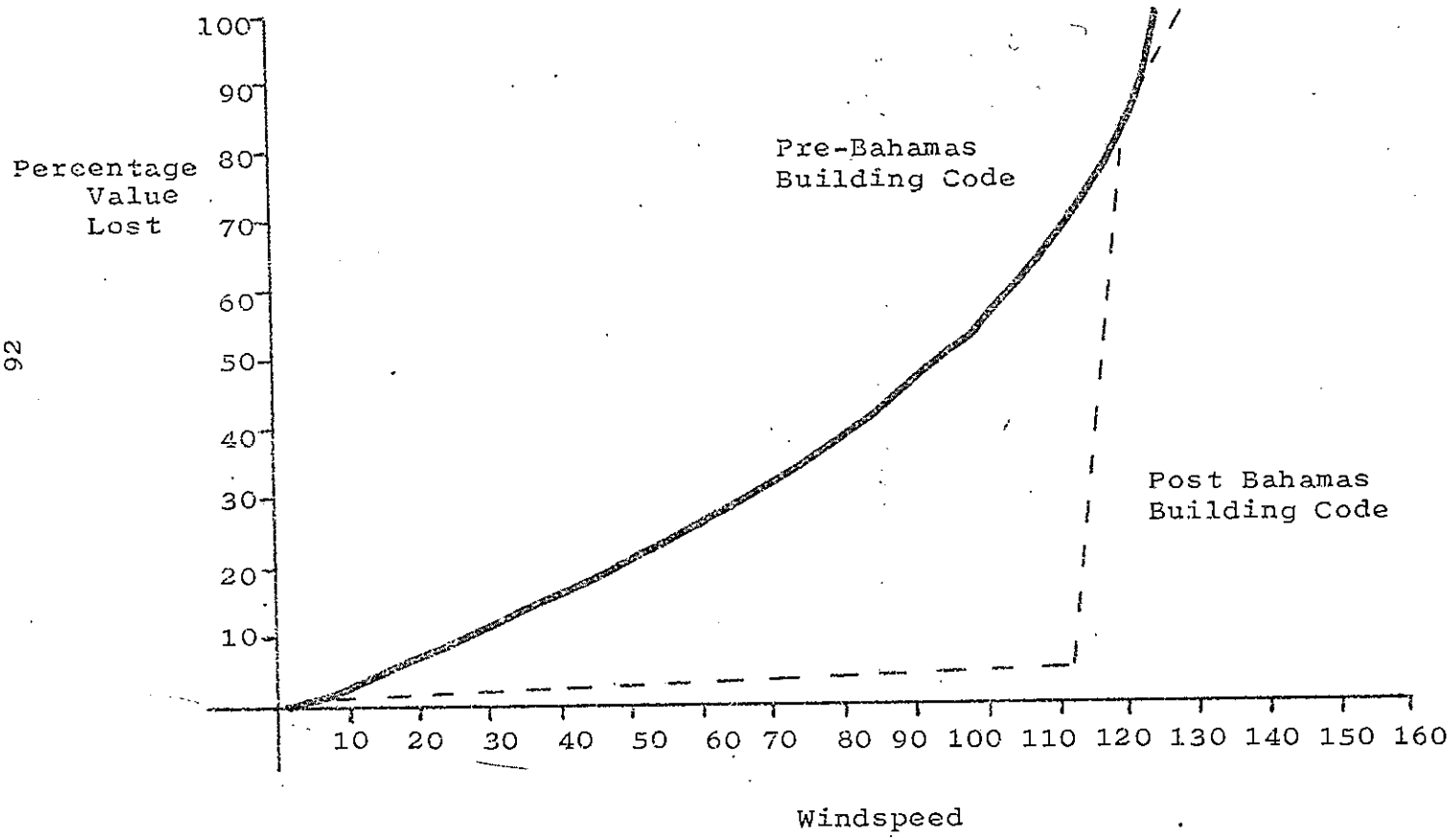
Despite the difficulties of providing building inspectors to ensure hurricane precautions are adequately implemented, the Government of the Commonwealth of the Bahamas should attempt to strictly enforce the Bahamas Building Code with additions as proposed. Diagram 8 shows a model of the impact of the enforcement of the Building Code on percentage value of housing cost. The Code copes adequately with wind - speeds up to 120 mph (192 kph). Parallel examples from earthquake regulations in the United States would suggest that this model is accurate.

11.17. Other precautions which have a similar non-recurring capital cost are worth implementing. For example, water over-flow channels to the sea which do not break the water disk are worthy of implementation. They greatly ease the relief of flooded areas and save much land from potential damage. The cost of such civil engineering is negligible and the work could be carried out by the Ministry of Works. The cost effectiveness of such measures is not easily measurable but one only need emphasise how long it takes for soil that has been covered in sea water to regain its potential to realise the importance of these preventive measures. (Lewis, 1975)

11.18. Reference to the discussion on hurricane probability shows that of the three 5^{o} squares covering the Bahama Islands the Northwest square which includes the Biminis, Grand Bahama, Great and Little Abaco, Eleuthera and New Providence, has the highest probability.

DIAGRAM 8

HYPOTHETICAL IMPACT OF BAHAMAS BUILDING CODE ON HURRICANE DAMAGE IN BAHAMAS



of the three for hurricane occurrence by a significantly large margin. The islands of this area contain also 90 per cent of domestic, commercial and industrial development that has taken place in recent years and it is also the area of most commercial fishing. By comparison, the area with the lowest probability of hurricane occurrence, the Southeast square containing San Salvador, Acklin, Crooked, Mayaguana and Inagua, is the area containing the least developed islands. The higher the level of development the higher the concentration of population with attendant servicing and infrastructure activity, the greater becomes the probability of higher losses. The highest risk area is the area of highest hurricane probability. Losses could be seen as being directly proportional to the level of development but because the more developed areas have a higher probability of hurricane impact it would seem that losses would be more than proportional to the level of development. On the other hand the minimal losses suffered by subsistence farmers or fishermen could mean the real difference between life and possible death.

11.19. It is worth considering the impact of a disaster situation on the resources of the Commonwealth of the Bahamas. If aid in disaster situations to the Bahamas is likely to be low because the perception of the Bahamas is that of the 'Playground of the Western World' which can adequately cope with its own disaster, external relief for disaster situations is likely to be minimal unless the Bahamas suffers a holocaust. In fact, the USAID Computer File on Disaster Aid indicates that response to the $700,000 damage of Hurricane "Betsy" was only $8,376, a ratio of 84:1. This ratio of aid to damage is likely to be indicative of the general response to a disaster situation in the Bahamas. If the disasters which occur are small but frequent it will necessarily mean that the cost of losses must be borne by the Government itself.

11.20. The Government will have to provide resources for rehabilitation and reconstruction as well as the initial costs of relief. Previous disasters have indicated that reconstruction often takes the form of land redistribution. The land allocation at Matthew Town and Dundas Town near Marsh Harbour, Abaco after the 1926

hurricane is an example of this; limited or no financial help was available except for the land reallocation. A similar reallocation of land could take place after a future disaster. Crown lands are the most available for this area but unfortunately most of the remaining available Crown land is swampy, unsuitable land in island interiors often unsuitable for relocation of population. Land bought for resettlement at current market prices would necessarily be inflated and at excessive cost to rehabilitation procedures.

11.21. A sensible level of investment in pre-disaster planning, given that one can accept an insurance rate of 0.02% per annum for any building, is equivalent to 5% for any building per 25 years; a generation. This figure generally seems to be the accepted level for additional security or insurance in the Bahamas. A similar percentage should be applied to probable government expenditure. If the probable annual losses are taken as $500,000 then government should be expected to be willing to invest 5% of this total in immediate pre-disaster planning, i.e. $20,000 per annum.

11.22. Project Appraisal of Preventive Measures: A Case Study of Flood Control

Preventive planning must be seen within the broader analysis of regional planning. However, within the practice of preventive planning, individual projects must be appraised. The Project Planning Centre at the University of Bradford specialises in such appraisal. The example that follows is simplified. Further discussion of techniques of appraisal are available in Gittinger (1972) and James and Lee (1971). A worked example of importance can be found in United Nations (1970).

11.23. To quantify flood threat one must determine the frequency of occurrence of flood peaks of various magnitudes. If a long record of streamflow is available, it is possible to relate flood magnitude to frequency. The maximum flows recorded each year are ranked in descending order. Each annual flood is assigned a frequency using the following formula:

$$f = \frac{m}{n + 1}$$

f - frequency of annual flood

m - ranked position

n - total number of years recorded

This allows estimates to be made for the cost of structural measures, land treatment, land use adjustment and flood insurance.

For the purposes of planning, a reasonable estimate of the total cost of flood-proofing all structures in a flood plain may be obtained from the formula

$$C_p = C_d C_2 \quad CRF_p \quad + \quad M_p \quad M_s h A,$$

assuming that costs increase linearly with depth of flooding, where

C_p The average annual cost of flood proofing determined from the equation.

C_d A factor to account for contingencies and the cost of designing flood-proofing measures and administering a flood-proofing programme. A reasonable estimate is 1.30.

C_2 The initial cost in dollars of flood-proofing per foot of flood depth per dollar of market value of the flood-proofed structure. An analysis of flood-proofing costs for Bristol, Tennessee and Virginia, produced a value of 0.035. (James, 1964)

CRF_p A capital-recovery factor based on the appropriate discount rate and flood-proofing-measure life.

M_p The annual maintenance cost of flood-proofing measures including the operation cost during floods, expressed as a fraction of total installation cost.

M_s The market value of all structures to be flood proofed, in dollars per acre. It may be estimated from assessment records.

h The average depth of flooding in feet.

A The area flooded, in acres.

Worked examples of this approach are to be found in James & Lee (1971).

11.24. Preventive Measures - the importance of the time value of money

In preventive planning, the experienced or perceived value of the cost of a project depends on the time at which money becomes available for the project. Future sums are less valuable than the same amount of money now. The limiting case of this is called pure time preference. Generating and saving surplus value means refraining from present consumption. If a society is to be motivated to save, some incentive, such as the payment of interest on savings, is needed.

11.25. Wearne (1975) argued that a scale was necessary to determine project urgency in preventive planning depending on the value of saving time. He suggested three classifications namely zero, commercial and absolute urgency.

> "Zero urgency: the condition when little or no cash return is expected from completion of a project, as is usual in expenditure on public works. Urgency, therefore, has no effective financial value. A faster speed of completion may be socially desirable, but in practice the pressure on administrators tends to be that projects have to be planned to be built for the lowest initial capital cost. Time is, therefore, not money.
>
> Commercial urgency: the condition when the investor expects a cash return from the completed project. Urgency, therefore, has a commercial value. Time is money in such a project. The speed and quality of work should, therefore, be equated against cost, in the planning and in the control of the project.
>
> Absolute urgency: the condition when speed overrides all other influences on decisions. Any attempt to optimise the use of resources is irrelevant. Time is priceless. This is the condition of rescue, etc. following a disaster. It may be only temporary. Costs are recorded for accounting rather than control."

REFERENCES

BAUMANN, D.D.; SIMS, J.H. (1972). "The Tornado Threat: Coping Styles of the North and South." Science, Vol. 176, pp. 1386-1392.

GITTINGER, J.P. (1972). Economic Analysis of Agricultural Projects. The Economic Development Institute, International Bank for Reconstruction and Development, The Johns Hopkins University Press, London.

JAMES, L.D. (1964). A Time-Dependent Planning Process for Combining Structural Measures, Land Use and Flood Proofing to Minimise the Economic Cost of Floods. Institute in Engineering Economic Systems, Stanford University, Stanford, California.

JAMES, L.D.; LEE, R.R. (1971). Economics of Water Resources Planning. McGraw-Hill Series in Water Resources and Environmental Engineering, McGraw-Hill Book Company, New York.

LEWIS, J. (1975) A Study in Predisaster Planning. Disaster Research Unit Occasional Paper No. 10, University of Bradford.

MUNCHENER RUCKVERSCHERUNGS GESELLSCHAFT (1973). Earthquakes. Munich.

O'KEEFE, P.; CONWAY. C. (1976). A Survey of Natural Hazards in the Windward Islands. Disaster Research Unit Occasional Paper No. 14, University of Bradford (forthcoming).

RUSSELL, C.S.; AREY, D.G.; KATES, R.W. (1970). Drought and Water Supply: Implications of the Massachusetts Experiences for Municipal Planning. The Johns Hopkins University Press, Baltimore.

UNITED KINGDOM GOVERNMENT (1975). Monthly Digest of Statistics. No. 357, September, H.M.S.O., London.

UNITED NATIONS (1970) Report on Indicative Basin Plan: Lower Mekong. New York.

WEARNE, S.H. (1975) "Managing an Emergency." New Scientist, April 10.

PART 5: CASE STUDIES OF DISASTER

12. Case Studies I: Three Recent Earthquakes.

13. Case Studies II: Hurricane Fifi, 1974.

14. Case Studies III: Drought - a Case Study of Africa.

12. CASE STUDIES I: THREE RECENT EARTHQUAKES

12.1. Guatemala: Impact of the Earthquake of February 4, 1976

Shortly after three in the morning of February 4, a massive earthquake ripped through the highlands of Guatemala, leaving in its wake at least 22,000 dead, nearly 75,000 injured and over 1 million of the nation's six million inhabitants without shelter. The Department of Chimaltenango was hit the hardest - nearly 100 per cent of the homes were destroyed, and in some of its towns, more than one person in ten was killed. Fourteen towns were totally destroyed, and less than 30 per cent of all buildings remained standing in another 17 towns. Most of the damage occurred in the highland areas north and west of Guatemala City and the strip along the Montagua River valley running eastwards from the highlands to the Atlantic coast. The quake, which measured 7.5 on the Richter Scale (compared to 6.3 for the 1972 earthquake in Managua, Nicaragua), spread ruin across about 3,500 sq. miles of the most densely-populated part of the country. Two days later a second major quake, of somewhat lesser intensity, again sent fear through the population and destroyed additional structures already weakened by the first quake. Within the first 20 days following the quake, over 1,000 aftershocks had been recorded.

12.2. Preliminary estimates indicate that by far the heaviest damage occurred to housing, with substantial damage also to the main highway from Guatemala City to the northeast, to the Caribbean port of Puerto Barrios, and to hospitals, health posts, school buildings and water supply systems. The directly productive sectors of the economy suffered relatively minor damage. Total reconstruction costs are estimated by the Government at US$750.0 million, of which about US$210.0 million is likely to be in foreign exchange. The Government hopes to be able to obtain about US$270.0 million from external lending agencies over the next four years which would cover foreign exchange costs and provide some local cost financing.

12.3. The effects of the Guatemalan earthquake are discussed under the costs of disaster (vide Section 10). Perhaps the most telling comment about the disaster is illustrated below:

> "Some 1,200 people died and 90,000 were made homeless in Guatemala City, almost exclusively in the slum areas of the city. In this well-known fault zone the houses of the rich have been built to costly anti-earthquake specifications. Most of the poorest housing, on the other hand, is in the ravines or gorges which are highly susceptible to landslides whenever earth movements occur.
>
> The city received proportionately little aid largely because it is governed by the most radical opposition tolerated in Guatemala, the Frente Unido de la Revolucion, a social democratic coalitition. Its leader, Manuel Colom Argueta, was shot and wounded by unknown gunmen on 29 March, the latest victim of a wave of terror attacks that has claimed 40 lives since the earthquake. One city official, Rolando Andrade Pena, was shot down two weeks after the earthquake after suggesting that homeless people should be encouraged to rebuild on unoccupied private land."
>
> (Latin America, 9 April 1976)

12.4. Nicaragua: Impact of the Earthquake of December 2nd, 1972

The earthquake in Managua, the capital city of Nicaragua, on December 23rd, 1972, damaged some 27 square kilometres of the city's total area of 33 square kilometres. Approximately 14 square kilometres of the central area was totally destroyed. An estimated 6,000 to 8,000 persons were killed and about 20,000 people received substantial injuries. The most extensive physical losses were in housing where about 45 per cent of the total housing units were destroyed. By contrast, large scale industry and infrastructure outside the central district suffered little damage.

12.5. The most interesting perspective on the Managuan earthquake can be gained from looking at the primacy of the capital city in terms of the rest of the country. 25 per cent of the Nicaraguan population lived in Managua at the time of the earthquake. Prior to the earthquake, urban migration into Managua resulted in

the population growing from 170,000 in 1963 to a total of 430,000 in 1972, an increase over a decade of almost 253 per cent. Such a population pressure produced a housing crisis - one result of this rapid urbanisation was that there was an estimated housing deficit of 80,000 units prior to the earthquake (Davis, 1975). The economic predominance of Managua is equally striking; product per capita in 1972 for Nicaragua was US$507, but the product per capita in Managua was US$925.

12.6. The process of marginalisation was not so obvious in Nicaragua as it was in Honduras (vide section 13). The control of land pushed peasants not up the mountainsides but to seek alternative sources of livelihood ... a classic case of rural-urban migration began during the late 1950s. The situation of Managua and the political climate encouraged foreign industrial investment, although the site of the city was hazardous because it was located on the Pacific seismic belt. The low wages offered by the industrial entrepreneurs forced peasants, who had rural households and ties to land even if they were actually landless, to begin to sever their rural linkages because the cost of supporting two households, one in the rural areas and one in the urban areas, was too great. Without the security of a food production system behind them, the peasants were vulnerable to the economic condition in which they found themselves. They were isolated within an underdeveloped economy controlled by foreign interests; a fall in demand for the industrial products of that economy resulted in a classic market adjustment, the growth of unemployment. This vulnerability to market adjustments of unemployment restricted demands for minimum wage levels. The lack of a minimum wage meant that disposable personal income was not sufficient to cover adjustment to the earthquake hazard. Few buildings were built to the specified requirements and little life or material was insured. The peasants of Nicaragua were marginalised in an urban area, located in a seismic zone, which had a long earthquake history. One of the revealing results of the disaster was that all rural-urban ties had not been ruptured; the extended family system coped with 95 per cent of all refugees, over 200,000 people (Davis, 1975).

12.7. The Chinese Earthquakes of July 1976

The series of earthquakes which hit the Chinese Province of East Hupei, particularly around the city of Tangshan with over one million inhabitants, offers much insight into the Chinese response to natural hazards.

The major shocks, registering 8.2 on the Richter scale, resulted in the deaths of many thousands of people and the destruction of much infrastructure. Although accurate accounts of the damage will not be available for some time, the earthquake was greater than those recently experienced in Peru (1971), Nicaragua (1972) and Guatemala (1976).

12.8. Over the last year, Chinese earthquake research has caught public imagination since the prediction of an earthquake in Liaoing Province in February 1975. The Chinese researchers had successfully synthesised amateur and professional evidence to forecast the Liaoning earthquake and warn the population at risk. When the earthquake occurred, people were not in their houses, domestic animals had been moved out of their stables, trucks and cars were not in their garages and despite the fact that most of the buildings collapsed, losses of human and animal lives were greatly reduced. For example in the Ringjiagon Brigade of Haicheng, consisting of more than 3,000 persons, only one child was injured. This is obviously because the accurate prediction of the earthquake was used to implement successful precautionary measures.

12.9. Western experts have been reluctant to accept the lessons to be learned from the Chinese experience. Discussion among Western scientists has primarily centred on whether the Chinese methodology for earthquake prediction can be used to predict the occurrence of all types of earthquake. The Chinese methodology included new methods for measuring movements of the earth's crust, recordings of the chemical composition and level of water in village wells, observations of animal behaviour and the recording of a localised foreshock sequence. Although Liaoning region was traditionally identified as being non-seismic, the evidence was strong enough to suggest that the fore-shocks were an indication

that a much larger earthquake would occur. Armed with this evidence, the cadres organised the evacuation of the population.

The type of earthquake experienced in Liaoning was unusual because most major earthquakes are not normally indicated by precursory foreshocks and even if these foreshocks occur, there is seldom the wealth of observation available to analyse and predict the actual earthquake strike. Western experts have continually emphasised this point, concentrating their analysis on the predictability of the individual earthquake occurrence rather than on the delimitation of zones of risk and so have missed the most important lesson of the Chinese experience. Chinese disaster planning concentrates not on the ability to predict a particular event but on the identification of the masses at risk to the natural hazard.

12.10. Chinese engineers have, since the revolution, studied theories of earthquake-resistant structure, formulated earthquake-resistant design codes for industrial and civil buildings, measured the dynamic properties of various structures and performed dynamic model tests and analyses on these structures. This has led to the rebuilding of villages by local people according to these seismic regulations and the strengthening of existing buildings in some selected cities. More importantly it has delimited Hupei Province as a region of major seismic risk when the commonly held view is that North West China, with the large earthquake in the 1920's in Kansei and the famous sixteenth century Shensi earthquake, is the most vulnerable area.

Mr. G. Whitlam, former Prime Minister of Australia, indicated the success of these measures. He said:

> "We saw debris piled in the streets and some of the older buildings had been completely destroyed but overall the damage did not seem too bad".

12.11. Most importantly the People's Army and the cadres had been successfully trained in the implementation of contingency planning. There have been no reports of panic but continual evidence that the warnings of further shocks following the major quake of

Wednesday, 28th July, have resulted in people moving out of buildings into clear areas. This is particularly important because of the further damage likely to occur to already weakened structures during aftershocks. To date over one hundred and ten aftershocks have been recorded and officials are carefully monitoring the possible movement of the epicentre in case Peking, with a population of over six million, should be threatened.

The attention paid to these warnings is in marked contrast to the attentions paid to the twenty-four hour flash flood warning at Thompsons Canyon in Colorado on Sunday, 1st August where although the local sheriff had sent deputies to warn the population that flooding was imminent many people did not heed these warnings.

12.12. The refusal of the Chinese government to accept international relief aid must be clearly understood against the background of their self-help and self-reliance programme. Following the Revolution the Chinese masses have gone all out, in a People's War, to counteract the vagaries of the environment. With revolutionary fervour and acting according to the late Chairman Mao's instructions, the population set about transforming China in the spirit of "the old man who moved mountains". With the implementation of flood control and irrigation the North China Plain, of which the Tangshan region is the Northern extremity, has ceased to be an area which continually suffers from the extremes of flood and drought. The earthquake has probably destroyed some of this infrastructure and it is to be expected that when the Chinese rebuild, the preventive structures against flood and drought will also include measures to combat earthquakes.

12.13. The Marxist approach to disasters embodied in Chinese policy seems to be an eminently sensible way to approach the problem of disaster. The ideology is that disasters are not "Acts of God", and are not "natural" so policies can and should be devised to minimise the risk of the vulnerable population before, during and after a disaster. The Chinese approach still requires improvements and refinements but so far they lead the world in

disaster planning. Not for them the bandages of relief aid, but rather a detailed analysis of natural hazards which allows them to combat the cause rather than treat the symptoms of disaster.

REFERENCE

DAVIS, I. (1975) "Disaster Housing: a Cast Study of Managua". Architectural Design, Vol. XLV, No. 1, pp. 42-47.

13. CASE STUDIES II: HURRICANE FIFI, 1974

13.1. Honduras is in the middle of the Central American Isthmus which links North and South America. It has a long narrow coastline on the Caribbean and a narrow southern outlet to the Pacific. Its neighbours are Guatemala to the west, San Salvador to the south-west and Nicaragua to the south-east. Mountainous areas and high plateaux divide the northern coastal region from the narrow southern area. The coastal areas have more extreme temperatures and a heavier rainfall than the high inland areas. The rainy season is from May to November, a season that coincides with the hurricane season.

13.2. In October, 1963, the Liberal President, Dr. Ramon Villeda Morales, was deposed after a coup led by the armed forces. Colonel Lopez became Head of State and the Constitution was suspended. In June, 1965, a new Constitution was promulgated and Colonel Lopez became Constitutional President for six years. Presidential elections took place in March, 1971, and Ramon Ernesto Cruz Ucles, the National Party candidate, was elected. Popular discontent over the austerity measures taken by the Cruz Government and peasant unrest over delayed land reform hastened the fall of the Government by a bloodless coup led by Colonel Lopez in December, 1972. The political life centres around Tegucigalpa, the Capital city, and the rural areas are not really integrated into the political machinery.

13.3. Honduras is principally an agricultural country. It is the most rural, peasant based society in Spanish America, with 2.8 million inhabitants, two million of whom live in the rural areas as Campesinos, peasant farmers. It is an isolated mountainous country and the poorest in the Western Hemisphere, bar Haiti. The per capita income was $250 in 1972. The major exports are bananas (40 per cent), cattle, sugar and timber - between them these products account for 80 per cent of Honduran exports. Coffee, tobacco, coconuts, cotton, maize and beans are also grown. The most valuable mineral is silver, and there is some gold, copper, titanium, zirconium, iron and antimony. There has been some

attempt to diversify the economy but industry is still on a small scale. Honduras joined the Central American Common Market at its inception in 1960. It remains the poorest country despite substantial growth during the 1960's. Trade with San Salvador was broken off after the 'Football War' of 1969 and serious disagreement on policy in the CACM led Honduras to suspend its trading pact with all the CACM countries in December, 1970. A 15-year development plan is currently being drawn up which, apart from provisions for agrarian reform, will give prominance to the development of forest resources.

13.4. The situation of the two million Campesinos who make up 70 per cent of the population is perilous. Over two-thirds are illiterate; more than 70 per cent of the children suffer from protein-calorie malnutrition; 95 per cent of the dwellings have no latrines or drinking water. The estimated annual income for a rural family is $150 or $25 per person per year. Sixty-three per cent of the farmers farm only 5.9 per cent of the land. Over one-third of the rural population does not possess land and works as labourers. In fact, the heart of Honduras' poverty lies in its land tenure system. The areas of least agricultural potential, Tegucigalpa, Choluteca and Santa Rosa, contain 46 per cent of the agricultural population. Only 17 per cent of the total land area of 112,000 square kilometres is considered viable for arable cultivation; another 16 per cent is considered to be viable pasture. The major part of the land is occupied by large farms in which the Banana Companies are included. Over 72 per cent of the land is farmed by only 3 per cent of the population yet they only grow 13 per cent of the beans, 10 per cent of the maize and 10 per cent of the rice that forms the basic food stocks of the nation. Because of the concentration on export crops the country faced a food import bill of $11.8 million for cereals, fruits and vegetables in 1970. In fact, 67.6 per cent of the farms are barely subsistent being less than six hectares. The standard of living of the Campesino in Honduras is very much the same as elsewhere in Central America. What the country lacks is a developed modern sector which, because of the historic role of the Banana Companies, is only weaker in Haiti in the Western Hemisphere.

13.5. Disaster Vulnerability

The conditions of poverty and powerlessness in which the majority of the peasants exist can be seen as the root cause of their vulnerability to disaster. If one looks at the disaster history of Honduras between 1968-73, one can appreciate this vulnerability. Eight disasters were recorded requiring total relief aid of over $1.5 million. Excluding accidents and civil strife, the Honduran population experienced, within a five-year period, two severe droughts, one flood, one hurricane and two epidemics (Table 12). The population can be seen to be highly vulnerable.

13.6. The Hurricane Fifi

Tropical storm Fifi formed near the southern coast of Jamaica on the 16th September; as it branched west on the 17th September it assumed the characteristics of a hurricane with a wind velocity in excess of 120 kilometres per hour. According to weather reports, which were confirmed by satellite photographs, it approached Cape Gracias a Dios on the 18th September, having built up winds of over 200 kilometres per hour across a front extending for approximately 450 kilometres. During the remainder of the 18th and 19th September it maintained a course parallel and adjacent to the Atlantic coast of Honduras, passing over the Islas de la Bahia and coming as close as 80 kilometres to La Ceiba. It then turned inland near Puerto Barrios, Guatemala, on the 19th September, moved into Belize and continued to Mexico where it lost force and intensity but also caused considerable damage.

13.7. In Honduras, Hurricane Fifi registered winds of up to 250 km/hour and rainfall of 400 millimetres in a period of 24 hours. The rainfall figures should be compared with the annual rainfall measuring between 2,000 and2,200 millimetres in years when the rainfall is normal. The most serious damage was caused by flooding which affected both the north and south. The south has a population of 230,000 of whom 200,000 are Campesinos. This is a very dry area with fertile alluvial flats producing sugar, cotton and cattle; behind in the valleys and hills the Campesinos suffered heavily, either from the earlier drought which halved

TABLE 12

Honduras: Disaster History - 1968-73

Drought	2
Civil Strife	1
Epidemics	2
Accidents	1
Flood	1
Hurricanes	1
	8

Source: USAID, 1974.

the maize crop or from the flooding following Hurricane Fifi. The North Yoro Cortes Atlantida and Colon has 850,000 people, of whom 500,000 are Campesinos. The fertile land is occupied by the large landowners amongst whom two Banana Companies occupy 250,000 hectares; most peasants do not have access to fertile land in the area. Different damage estimates for Fifi emerged, but its impact on balance of payments, national income and government revenues was severe. More importantly, the people most unable to bear losses, the rural peasantry, were hardest hit.

13.8. Assessment of Damage

The population affected by the hurricane slightly exceeded half a million people, 20.3 per cent of the country's population. The number of victims was estimated at 120,000 and an estimated 6,000 people died. Food and hygiene were problems immediately after the hurricane. Water contamination produced dysentry and typhoid (United Nations, 1975).

13.9. The areas affected by the hurricane produced 57 per cent of the total agricultural income of the country. Rural activity is export orientated, namely banana cultivation and cattle ranching. The land is generally low-lying and is regularly inundated by flood. First estimates indicated that most serious damage was inflicted on banana production, affecting not only the plantations but also the physical installations such as storage centres, canals and transport infrastructure. The reduction in the banana crop means that Honduras lost an estimated $90 million in foreign exchange in 1975. The country had suffered two consecutive years of poor harvests due to drought. The floods destroyed 134,000 hectares of maize and rice; an estimated loss of 22,000 tons worth $8.4 million approximately. The subsequent POSTRERA (winter harvest) was badly affected by drought. It was the Campesinos who suffered the greatest losses from the POSTRERA as only the highly capitalised farms had the resources to afford irrigation. It was not until the following September that the Campesinos had a successful harvest. Meanwhile they survived on maize, salt and charity - the adults that is! The child mortality rose very

high. The general hospital in Choluteca (the largest town in the south) was inundated with abandoned children, generally young girls who are the first to go without when there is not enough food for the family. An estimated 100 per cent of the livestock in the areas were lost, mainly from dairy herds kept stalled who could not escape and reach high ground. The total cattle production of Honduras was reduced by 6 per cent.

13.10. The recoverability of the banana production is complicated by recent Honduran attempts to increase the country's share of the profits from the industry. The companies had been cutting back production and diversifying into palm, pineapple and above all cattle. Much of the high cost infrastructure was damaged or destroyed. Four thousand five hundred men (or approximately one-third of the labour force) were laid off a month later. The companies do not appear to be interested in attaining pre-disaster production levels. The losses of food crops and animals amongst the peasantry was never accurately estimated.

13.11. Damage to the industrial sector was slight because little large-scale manufacturing exists. Damage to fixed assets and stocks was not serious in most plants, so unemployment in industry was temporary. Total damage did not exceed $8 million. Damage to infrastructure was estimated at $38 million. At least 3,000 dwellings were destroyed and some 13,000 damaged. Surveys of damage were carried out by the Planning Council (PC) in September and the United States (ROCAP) in October. PC estimates are higher because there is a tendency for initial estimates to exaggerate the effect of disasters. Table 13 contains these estimates.

Neither of these estimates contains an analysis of the economic impact of the hurricane on peasant farmers nor a social analysis. A similar report by the United Nations can be criticised for the same reason. All assume that the casual agent of the disaster was the physical agent, but the question is WHY so much damage occurred. Past hurricanes in Honduras have not been so catastrophic. In decreasing order of size, those of 1954, 1935 and 1969 were the most serious and caused damage ranging between

TABLE 13

Honduras Planning Council: Damage Assessment

Losses in production and physical damage	$350 - 450 million
Loss in real GDP in 1975	12 per cent
Loss in banana plantations and exports (1975)	50 - 75 per cent
Loss in 1974 corn production*	35 per cent
Decline in total exports (75 compared with 74)	13 - 25 per cent
Balance of payment deficit 1975	$82 - 101 million
Loss in Central Government revenues in 1975	21 - 26 per cent ($32 - 39 million)

* This does not include 1975 loss through drought.

$10 - $16 million. Fifi caused between $350 - 450 million damage and severe loss of life. The disparity between the recorded effects of the hurricanes cannot be simply understood in terms of the physical agent, but must be understood against the background of the increasing vulnerability of the population to extreme hazards. The increased vulnerability of the population leads one to consider the possibilities for precautionary planning. The probability of a hurricane hitting Honduras in any year is 26 per cent, i.e. almost 1 in 4. Assuming a damage cost of $16 million based on the other recorded hurricanes, less than 3 per cent of the cost of Fifi, this means that there is a probable annual agricultural loss to the Honduran economy of $4 million. If one considers specifically the northern area directly in the path of the hurricanes and the area which also accounts for greater agricultural production, then it means that probable annual recurring losses are between $1 - 2 million, because this area accounts for more than 50 per cent of total agricultural production. It is impossible to divide this cost of vulnerability between the export orientated banana and cattle production units which would often be covered by commercial insurance and the subsistence production of the farmers which has no such insurance. The storm gave an added push to inflation which was rampant in Honduras during 1974. Food prices rose 17.5 per cent with such products as flour, beef, coffee, cooking oil and pasteurised milk increasing by more than 30 per cent.

13.12. Aid to the stricken population followed clear political lines. For example, when the earthquake struck Nicaragua in 1972, US Government aid poured into the country. Within two weeks 800 American personnel (85% were military) were in Nicaragua and $8 million was spent on supplies, transport and salaries. USAID made a short-term loan grant of $20.4 million and outright grants of $8.7 for food, housing, hospitals, roads and schools. This massive supply of aid contrasts sharply with the reduced level of aid which was given by the United States to the victims of Hurricane Fifi. The US presence in Honduras following Hurricane Fifi was only 53 military personnel; the supply of relief was less than $0.5 million, including 7,000 blankets and tents.

13.13. The loss of life in both disasters was similar. Material damage to the national economy of Honduras was worse than the material damage to the national economy of Nicaragua. The principal reason is that General Anastasio Somoza was a keen supporter of Nixon while President Lopez Arellano of Honduras, on the other hand, was seen to be taking a nationalistic posture threatening to US business interests.

13.14. Nicaragua is strategically important offering the most promising alternative connection, between the Pacific and Atlantic, to the Panama Canal. The Somoza dictatorship (longest lasting in the hemisphere) had centralised power with Managua as the Administrative Centre. It was here that the earthquake struck. In Honduras the administrative structure was not affected, it was the rural population that was hit. Above all, Somoza has opened Nicaragua to US investment and maintained close ties with the US military and Administration. It was from Nicaragua that the Bay of Pigs invasion set out. It was from Nicaragua that Hughes and the CIA successfully lifted a Russian submarine off the Ocean floor. The military regime in Honduras on the other hand has set out a policy of land reform, nationalisation of the timber industry and increasing pressure on the banana companies for government participation. These moves have been viewed with some alarm in the States: the guarantees of Somoza are much more satisfying to US capital.

13.15. Voluntary aid agencies frequently provide shelter and food for victims of a disaster. They commonly declare that they are indifferent to local politics and are simply filling a humanitarian need, but when it is given in an uncritical way, aid invariably buttresses the status quo. However, they operate in an area of conflicting ideologies and their aid serves to strengthen one side or the other. In the Honduran case, most aid was controlled by bodies which had powerful interests in preserving the status quo. The status quo of under-development is indicated by Table 14. Aid flows through the power structure,

GOVERNMENT ⟶ ARMY ⟶ LOCAL HIERARCHY (Priest, Trader, Rancher) ⟶ PEASANT

TABLE 14

Honduras: Percentage Industry Controlled by Foreigners

Mining	100
Banana	100
Timber	20
Banking	70
Fishing	70

which used it to reinforce power and interests, e.g. the Army took over control in some areas, all decision-making centralised under their control. Therefore civilian initiative was prevented; nothing could happen without approval of the Senior Officer in the region. For example, in one area, all refugees had to take mass and confession before the priest would allow distribution of relief supplies.

13.16. The military government declared in the New Year's Day message, 1976, that they will remain in control of Honduras at least until 1979. The military government is more progressive than the large landowners who were against any land re-organisation following Hurricane Fifi. The military, however, had and have their own interests to pursue. The man who was President of Honduras during Hurricane Fifi, Colonel Lopez Arehano, took bribes from United Brands, the large American banana exporters, to avoid the incipient cartelization which was implied by the formation of the Banana Exporters Association. The President of the United Banana Corporation, Eli Black, killed himself when the account of the bribery came to light. Colonel Lopez was ousted from power but his successor, General Melgar, is following a similar nationalist policy. The peasant farmers continue to suffer.

13.17. The climatic pattern as described earlier has not changed, therefore weather changes cannot be blamed. The reason for the damage is described by a Honduran Forestry Engineer, Jorge Arevalo:

> "The destruction of the forests and the protective cover of the soil are factors which exaggerate floods and precipitate a chain of disasters in our country.
>
> As there has been frequently little or no understanding of the relation between forests and national prosperity, we will describe how the woodland affects the flooding. The Campesinos, in resorting to forest lands for lack of agricultural lands, are destroying the forest by "slash and burn". We see, therefore, the gist of the problem that we are suffering. When the forests are well conserved, they constitute a complete and efficient protection for the soil. The combination of plants and other organic materials that are decomposing acts under the surface to improve the porosity and increase the capacity for absorption of the soil. When heavy rain falls, part of the rainwater is retained in the foliage of the trees

and shrubs. The dense vegetation acts to considerably reduce the effects of the rain. A part of the rainfall is absorbed by the humus and mold of the forest soil, which acts as a giant sponge. The rest of the rainfall gradually penetrates to the earth and when the soil is saturated, runs along the surface. This surface stream is slowed up by the action of all the vegetation. Therefore, our forest resources perform a decisive role in the hydrological system, retaining rain water in the foliage and in the soil, and increasing the capacity of absorption. In this way, the woodland prevents the dangers and losses caused by floods.

In the change to an area cleared of vegetation, the rain water falls tumultuously down the hillsides. The penetration of rain water is reduced and the surface stream is much greater. In the absence of dense foliage, part of the rainfall cannot be retained or reduced. Finally, without the brake put on the surface stream by vegetation, the water flows in a muddy, highly erosive, torrent which fills the streams until they overflow their banks. In this way, floods become more frequent because the surface water is immensely greater when the earth is clear of vegetation and has little penetration.

Honduras has suffered, is suffering and will suffer more floods if we don't stop the custom of destroying the woodland and the protective cover of the earth."

13.18. The rich fertile valleys have been extensively developed because of the investment of the American banana companies. Heavy forest was cleared, disease was controlled and roads and railways were constructed. This development obviously attracted labour. Problems have developed since 1956 when the banana companies began changing from labour intensive to capital intensive production. No land was available on the valley bottoms because, if it was not owned by the banana companies, it was used for large scale ranching. The peasants were thus forced to grub for food on poor hill slopes where they were extremely vulnerable to flooding. The Campesinos organised their own fight for land rights for, without land, they cannot grow food.

The most important reason for the destruction was the deafforestation which has taken place since 1965. The river valleys

on the north coast have been increasingly cleared of forest for the banana plantations of the multi-national corporations, United Brands and Standard Fruit; both US owned. As a result of this economic development the Campesinos moved to cheaper land on the hills where they cleared forest to grow maize. This deafforestation has led to severe erosion; the loose soil silted the rivers which flooded more frequently. Man-made factors coincided with an extreme natural event to cause destruction.

13.19. The form of economic development experienced in Honduras produces underdevelopment. Underdevelopment is a process that is found particularly in the poorer countries of the world. It is a process in which societies and people suffer from change imposed and controlled from outside the community, in the interests of the outsiders. The conditions of underdevelopment make a population such as the Honduran population more vulnerable to extreme natural events such as hurricanes.

13.20. The effects of Hurricane Fifi contrast sharply with those of the tropical storm that struck Darwin, Australia, on the 24th December, 1974. Cyclone Tracy had a similar windspeed to Hurricane Fifi, between 230 and 250 km/hr, but the loss of life in disaster impact was much less than that of Hurricane Fifi, 49 and 8,000 persons respectively. Both areas are in major tropical storm zones, and both possess adequate warning facilities; both areas received similar extensive damage and early eye-witness reports from the two areas estimated that 80 per cent of the impact zones were severely disrupted. Why, with such parallel conditions, was the impact so more serious in Honduras than Australia? The answer lies in the degree of vulnerability of the two societies, in the degree of marginalisation. (Australian Natural Disasters Organisation, 1975)

REFERENCE

Australian Natural Disasters Organisation (1975). Darwin Disaster: Cyclone Tracy. Australian Government Publishing Service, Canberra.

USAID (1974) Disaster File Computer Printout. Washington D.C.

14. CASE STUDIES III: DROUGHT - A CASE STUDY OF AFRICA

14.1. Following a series of disastrous years of drought in Africa, this section aims to present a synopsis of the current situation. To attempt incisive generalisation encourages ambiguity and inaccuracy but on the other hand the current plethora of publications begs an overview.

14.2. The Physical Reality

Most discussion of the African drought focuses upon the region known as the Sahel. In fact this region is extremely difficult to delimit and it has been suggested that it would be better to consider the drought-affected areas in Africa as being regions with less than 700 millimetres annual rainfall. This formulation of the problem in terms of rainfall data would allow an accurate study of drought as a climatic phenomenon and an assessment of the relationship between the natural hazard drought and the famine experienced in the Sahel (O'Keefe, 1974a).

Such a regionalisation would also allow the inclusion of areas in Ethiopia, Kenya and Tanzania where, although the ecology might differ, the process remains fundamentally the same (Berry et al., 1972). Few would now deny that there has been climatic variation on a global scale (Lamb, 1974). One authority has analysed climatic variations for Africa (Winstanley, 1973a; 1973b) demonstrating that, since 1960, the summer monsoon rainfall of the Sahel zone shows a high negative correlation with the winter-spring rainfall of the Mediterranean. During the 1960s the circumpolar vortex expanded and the meridional circulation in the tropics contracted, giving heavy winter-spring rainfall over the Mediterranean and the Middle East, and low monsoon rainfall in the Sahel zone. The change since 1960 is interpreted as a continuation of trends first apparent in the 1920s. Winstanley argues that the monsoon rainfall is at a low point of an irregular fluctuation superimposed on a longer downward trend. The present drought extending from Mauritania to India is a result of the cumulative effects of a decade of below average rainfall with less and less rain each year. He

estimates that, because of the low mean annual rainfall and the strong north-south precipitation gradient of the Sahel, a southward shift of the climatic zones through one degree of latitude over 100 years means a decrease in rainfall of 40-50%; furthermore he estimates that there has been a southward shift of the isohyet range by approximately 9 km per annum. On a microcosmic level Bradley examined the implications of the 1973 rains at Samaru, Nigeria, and argued that the low early season rainfall would have a detrimental effect on the annual total and, therefore, on agricultural production (Bradley, 1973). Early season deficit would produce a poor harvest because for most crops good growth is essential during the first month after germination.

14.3. It is worth stressing that, because of the shortage of climatic data, no watertight case can be presented to calculate the significance or severity of the drought. While Lamb and Winstanley argue that increasing dryness is the long term prospect for the Sahel, others would suggest the possible existence of long periodic cycles. The important point to stress is that in the Sahel the human response to low, and highly variable, rainfall has been nomadic pastoralism and dry farming - both of which reflect a functionally adapted way of life. That the population has been unable to cope with the present shortage of rainfall indicates the severity of the drought and the lack of alternative available responses.

14.4. Parallel to the arguments concerning climatic variation are the myths that surround the environmental processes of <u>desertification</u> and <u>deafforestation</u>. It is argued that these concepts tend to blur rather than clarify the discussion of environmental degradation. At this juncture it is worth emphasising two points:

a. That the only area of real downgrading desertification is the intermediate region between the area where the grasses are predominantly annuals and the area where they are perennials (500-700 mm rainfall). There seems little reason to presume a southerly drift of a frontier of sand.

b. That deafforestation often means the lack of bush savanna but bush savanna has less potential utility in terms of protein generation than comparable grassland (O'Keefe, 1975).

14.5. In summarising current knowledge of the environment it appears that three things need to be emphasised. First, it seems impractical to delimit the drought zone according to vegetational phenomena - after all drought is concerned with the amount of rainfall not received. Any area receiving less than 700 mm of rainfall should be regarded as drought-prone. Secondly, it should be emphasised that although drought has been severe in the past few years, most authorities would expect that this is only the beginning of long-term drought prospects for Africa; this has ominous implications for future development. Thirdly, the area which will suffer most ecological degradation seems to be an area between the 500 and 700 mm isohyets, an area which supports both pastoral and arable economies but which is often considered to be beyond the scope of relief activities.

14.6. A Brief Description of the Drought-Famine Process

It is self-evident that the form of peasant resource management in dry areas is functionally adapted to the environment. Any functional adaptation requires ongoing change as the range of the experience-response system expands; change implies the necessary political power to enforce further adaptation and it is the absence of executive power that has made peasant farmers so vulnerable during the current drought. If one assumes that these peasant landuse systems were once successful and efficient, then one needs to reconsider their recent history to understand why they should be so vulnerable in the current crisis.

14.7. Adaptation can be viewed within the framework of game theory. It is assumed that the limitations of environmental potential and social organisation allow for an optimum strategy to be followed at a specific time. Strategy, however, is quite distinct from the players and both strategy and players are distinct from

the rules within which strategy is evolved by generations of players. If one reviews the current crisis against this theoretical framework, the following points come to light.

a. In 27 of the 39 years, from 1920 to 1958, rainfall in the semi-arid areas of Africa was above the long period average; this change would necessarily encourage the evolution of a different environmental strategy by the peasant farmer.

b. No alternative environmental strategy was evolved because of the impress of colonialism. Colonialism had far-reaching effects but these may be summarised in game theory terms as follows:

   i. The composition of the players changed, possibly as death and disease control were introduced without concomitant birth control, certainly insofar as colonialism accelerated the process of, and brought new forms to, rural stratification - thus creating classes of antagonistic players: landless, small, middle, rich peasant, etc. This has sharpened the contradiction between some strata of the peasantry as a result, e.g. pressure to increase cash crop acreage forced sedentary peasant farmers to encroach on grazing land previously used by pastoralists. Strictly speaking the 'game' became less a game of man-against-nature and more a game of man-against-man-against-nature. Furthermore, land pressure (e.g. in the Kenyan Highlands) has forced increasing numbers of very poor peasants down into the semi-arid plains - thus providing yet more 'new' players and exacerbating competition among players in the dry zone.

   ii. The strategy, previously a functional adaptation, was rendered inappropriate by colonial legislation which in some parts emphasised statutory and individual land tenure against traditional patterns. Alternative pastures and virgin land were reduced; the land frontier began to close.

   iii. The rules changed as the economy was assimilated into an era of market force manipulation. Consequently, the resource base itself was eroded.

> Deterioration of the resource base was the direct and indirect result of syphoning off surplus value from the rural areas - a process which spans both colonial and neo-colonial periods (Suret-Canale, 1971; Amin 1973; Brett, 1974; Meillassoux, 1974; Leys, 1975; O'Keefe & Wisner, 1975).

Despite changes in the composition of players and rules, to a significant degree the strategies of landuse, herd management, etc. employed by peasants in arid regions - especially those employed by the poorest peasants in these areas - have remained unchanged. In order to understand why this is so one must analyse the way in which colonial and neo-colonial modes of production have added constraints to the objective and subjective frameworks within which the peasant makes decisions. This analysis requires, in turn, a closer look at the application of game theory to small-scale agriculture.

14.8. Gaming models have been used for some time by students of agricultural decision-making in cases where it is assumed that 'payoffs' from a given set of agricultural decisions are not simply given by some input-output function, but are also affected by a given 'state of nature' (Gould, 1963; 1965). Various assumptions are made about possible states of nature, their frequency distributions, and the state of the farmer's knowledge of these distributions. It is further assumed that the farmer's response to a given state of nature is chosen by him from an array of possible actions of which he is aware through personal or cultural experience. Changes in the farmer's objective conditions throughout the colonial and neo-colonial periods - especially the rise of the capitalist mode of production - have worked to constrain this array of possible actions or range of choices. Constraints have been applied in the following ways:

i. Direct capital penetration into the more arid parts of many African countries meant direct expropriation of the land resource and an absolute decrease in the land base of the livelihood systems of poor peasants in these areas. For example, the introduction of coffee to the Mt. Kenya highlands in the 1950s created a 'coffee-bourgeoisie' in the highlands, who invested widely in cotton farms on the

drier lower slopes of the mountain in the 1960s and found additional investment outlets even further out into the dry plains when they obtained control of more than 800 km^2 of land which was then 'enclosed' and named Meru Game Park. The effect of highland capital's penetration via investment in cotton and the game park was to cut by at least one-third the land available to poor farmers in the lowlands who had combined dry-farming with transhumance herding in what had previously been 'common' land. Such examples abound in Africa, and such a decrease in the livelihood base of poor peasants usually results from the establishment of 'modern' ranching by agri-business and large-scale irrigation schemes.

ii. Where direct capital penetration has not yet taken place the orientation of the national economy towards the needs of the capitalist mode of production generally means that the poor farmers of dry areas have severely limited access to new strategies which could enlarge their range of choice. It is well known that such inputs as credit, extension, marketing - not to mention infrastructure - are maldistributed in Africa according to colonial patterns favouring so-called 'high potential' areas. These patterns have generally been perpetuated by the independent governments.

iii. Where the programmes of independent African governments have attempted to enlarge the peasant's range of choice, these programmes have never tried to deal with the whole problem of regional underdevelopment but have focused on a small number of discrete superimpositions on the livelihood systems of the neglected area, e.g. a new seed variety, some boreholes, a road. These partial solutions, precisely because they are partial, often conflict with the pattern of survival behaviour evolved in the neglected region. The net effect is a further decrease in the poor peasant's range of choice.

14.9. The subjective framework of peasant decision-making has been attacked by lack of respect for traditional science and technology. This lack of respect - often bordering on denigration - is found throughout the civil service, educational systems and national

bureaucracy. It rejects 'people's science' wherever it appears, be it traditional flood-retreat agriculture, folk medicine, or house-building. These attitudes - born in the colonial period, but perpetuated by continuing transfer of technology from the world's metropolitan centres and by an educational system designed to produce manpower for the capitalist sector - are major obstacles to the emergence of hybrid technology which would draw from both traditional and modern sources, thus enlarging the peasant's range of choice.

14.10. The combined result of these various sorts of constraint on peasant decision-making is at best stagnation of the peasant range of choice - failure to enlarge the area of possible action which is a sine qua non of any new peasant strategy. At its worst it has meant an actual shrinking of the range of peasant choice, often brought about by the atrophy of various cultural adaptations based on kinship, such as mutual aid in land clearance and harvesting, or cattle trusteeship. As constraints on strategy build up it becomes more likely that, at some point, stress which previously might have been dealt with becomes, in the new situation, too much for the peasant livelihood system to bear, as has happened in the Sahel and Ethiopia. Even where catastrophe is not the result, increased vulnerability to stress often produces a highly simplified - one might even say 'pathological' - type of peasant decision-making. The phenomenon of decision-pathology is, in fact, a greater challenge to long-run development planning than the overt economic dislocation seen in the Sahel. The examples discussed below demonstrate the magnitude of this challenge.

14.11. Failure is common in all agricultural activity whether one judges by the rates of bankruptcy in the USA or the frequency of hunger in Africa. Thus no matter what one 'plays' against the opponent, nature, there is a good chance that one will 'lose' something. Even granting that the gaming approach helps one anticipate the order of magnitude of probable losses (useful if one is a grain marketing board, questionable if one is a small farmer), it is clear that the main focus of interest naturally moves on beyond

the immediate payoff. Given such and such a payoff, what does the farmer do? He still has to keep his family fed and otherwise provided for. Therefore the critical questions lie between 'rounds' in the game with nature. By joining a series of gaming decisions, one produces a rudimentary 'learning model'. However, each 'round' involves the same type of decision: the farmer makes some judgement about the probability of a state of nature; chooses inputs according to some algorithm which avoids risk and seeks utility to some degree or another; and receives an output, the 'payoff', which will somehow modify both the farmer's knowledge of probable states of nature and the choice of algorithm. One can hypothesize a period 'in-between rounds' when a decision of another type is taken. This second type of decision simplifies the situation, seeks certainty by consideration of a small number of 'sure bets' which cultural adaptation has pre-selected to be the most likely to provide a livelihood once 'losses' have exceeded some culturally and environmentally specific threshold.

The closer to a positive quantity the payoff is, the more likely that the next decision will be sensitive to the next state of nature. The closer to the threshold loss the payoff is, the more likely that the next decision will not be sensitive to the next state of nature. Herein lies a partial explanation of the fact that poor peasant strategy has often remained constant while players and rules have changed. Progressive deterioration of the peasant resource base, decrease of reserves, increasing constraints - everything, in short, which contributes to increased vulnerability to environmental stress - causes the peasant to rely more frequently on such over-simplified decisions. The additional irony is that once colonial and neo-colonial patterns force the peasant into such modes of decision-making, social scientists in the service of colonial or neo-colonial interests lay the blame on the peasant himself for being 'irrational'.

14.12. Dodoma (Tanzania) April, 1969: rain has been poor, grain supplies are quite low, some threshold has been passed and the threat to the family is so great that an unprecedented sale of cows has taken place which peaks in December with 3000 cows sold in

Dodoma district. Since 1966 the monthly sale of cows had fluctuated around 600. The 1969 sale was the result of thousands of very serious decisions on the part of peasants. To sell one's cows is to cut into core reserves. Indeed an all time low in total cattle sales in mid-1970 would suggest that the breeding nucleus of some herds was affected. This liquidation of reserves represents a different type of decision from the decision to shift one's cultivation into an available lowland swamp, to plant extra cassava, or to pray. These latter are adjustments to soil moisture extremes and associated losses within the range bounded by some normal positive payoffs and the threshold negative payoff.

14.13. The decision to migrate and the decision to sell cows as opposed to other livestock are both generally decisions which are less sensitive to the series of successive states of nature. The members of this set of emergency adjustments are few. They are resorted to only when the level of reserves of a farm family (including livestock, grain, availability of credit and gifts from more fortunate kin, savings, and capital goods) is very low with respect to relatively fixed minimum family needs and relatively high possible additional losses. One has witnessed in the Sahel the extremes to which the necessary combination of increased vulnerability and increased pathology of decision-making can lead. What are the dimensions of that extremity?

One hardly needs to emphasise the lack and inaccuracy of demographic data in this particular situation. It is sufficient to state that if one accepts a catastrophe as a situation in which more than 100 people die and/or 1,000 are injured and/or $1,000,000 worth of damage is sustained, then this disaster is parallel to recent disasters in Bangladesh in terms of magnitude of death, disability and destruction (UN Protein Advisory Group, 1974). Six years of drought have brought the sub-Saharan areas of the Sahel, parts of Ethiopia, and Somalia to nothing short of catastrophe. More than 25 million people have been affected and initial estimates for West Africa suggest that more than 100,000 people have died (Sheets and Morris, 1974). Although these figures have been queried this seems the most realistic estimate.

Estimates of cattle losses are also high; it is thought that Mauretania has lost 1.6 million cattle from a total of 2.1 million in the last two years. Cattle losses are placed around 50% in Senegal, 50-80% in Mali, 50-100% in Upper Volta, 80% in Niger and 90% in Chad. FAO estimates the 1973 cattle loss at 3.5 billion head valued at £400 million. This suggests (according to Oxfam, February 1974) a loss of 25% in the Sahel herds. Crop losses have varied between 50-70% (± 20%).

14.14. General statistics tend to be misleading, so other data sources are necessary. The best indications of the population status can be gathered from the nutritional surveys completed during the last two years (Seaman et al., 1973). Several pessimistic conclusions emerge from these surveys. First, that although the anthropometric and clinical evidence presented indicates that the population is on a low nutritional plane, the general situation is not unusual for rural Africans in similar environments. Secondly, the poor harvests of 1972, 1973 and 1974 have produced a serious economic situation in which nomad pastoralists have been more severely affected than sedentary farmers, although the latter have also suffered; long term drought prospects would prove disastrous. Thirdly, it is not possible to state whether or not the people who have received free distributions of cereals have actually depended upon them. Fourthly, it is accepted that death seldom results from malnutrition per se but because a malnourished population is susceptible to endemic and epidemic diseases. In this context it is worth noting a major increase in deaths from measles in West Africa. Fifthly, and most importantly, the continued erosion of food stores stock-piled against the possibility of long-term drought, indicates that a more permanent solution than relief aid must be found. With current estimates of malnutrition suggesting that 10% of the sedentary and 50% of the nomadic population is undernourished there is an immediate need for long-term planning.

Such a stress situation encourages wholesale migration and to some extent increases the difficulties of relief distribution and rehabilitation. Traditionally two migratory patterns were discernible:

i. A rural-urban movement for wage labour.

ii. A seasonal movement of semi-nomadic population utilising traditional routes in search of water and pasturage for their animals.

None of the traditional alternatives, which are spatially finite in a subsistence community experiencing stress, are available. It is useless to increase the labour input, useless to search for fertile unoccupied land, difficult to establish external linkages to provide secondary sources of income, pointless to emigrate to equally barren areas and futile to implement population control programmes which do not have immediate benefit (O'Keefe, 1974a). As a result of the stress situation and the absence of alternative strategies major migratory variations have occurred. Namely:

i. Migrants have deviated from traditional itineraries: nomads are arriving in urban areas and some have been arriving in areas further south than normal, thus causing political friction.

ii. Increased numbers of people are migrating. Entire families have been seen on routes usually followed only by male herders and their animals.

iii. Reasons for migrating have changed. No longer are migrants searching for pasturage but rather for government-distributed food.

iv. The normal seasonal migration is not being balanced by the usually predictable return. Many nomads will remain within the urban area (Sheets and Morris, 1974).

Such a situation indicates that the drought has turned to famine even if, at the moment, it is impossible to quantify the exact extent of social and economic dislocation.

14.15. Reaction to the drought and growing famine was extremely slow. It took five years for the plight of the people in the Sahara to become newsworthy - so newsworthy that three colour magazines in UK have devoted space to the topic. Many articles have emphasised that modern techniques have been insufficiently mobilised to give warning of the approaching famine. The FAO/WFP (Food and Agriculture Organisation/World Food Programme) Early

Warning System gave the first intimation of critical crop failure and exceptionally poor harvests only in September 1972; it was not until the end of February 1973, after the Economic Commission for Africa Conference of Ministers that an FAO/WFP Inter-Departmental Working Group on the Problems of the Sahelian Zone was established. If the world press was tardy in appreciation and reporting on the drought, the response of the international organisations was equally slow even though they had the necessary structure to ameliorate the effects of drought.

What is more worrying than the slowness with which relief was made available is the conservatism of present plans for rehabilitation and reconstruction in the area. Since aid for rehabilitation and reconstruction is only a special case of aid in general, there is always the danger that such programmes will simply reconstruct the status quo ante (Baird et al., 1975). Large scale river basin development and agri-business ranching clearly contain that danger, especially when the logic behind them follows some variation of Lonrho's questionable formula: Arab capital plus European technology plus African labour (see Comite Information Sahel, 1974, 157-170). The reconstruction of the status quo can only mean further increase in the vulnerability of the poorest strata of the peasantry in Africa's dry areas. The alternative is programmatic rehabilitation and reconstruction of the area built on releasing the productive energies of the inhabitants of the dry zone. Such programmes demand new modes of production, and they in turn demand new social relations. This is an essentially political activity of the kind that has been underway for some time in northern Mozambique (Wisner, 1975). In addition such programmes would be built on clear recognititon of the following facts:

i. The problem of drought is basically a problem of poverty, of continuing regional economic maldistribution and underdevelopment within countries, leading to increasing vulnerability of the poor in these regions.

ii. Any large scale reconstruction initiative (including agri-business investment) carries with it the danger of displacing or, at the minimum, proletarianising the poor

peasant (both sedentary and nomad) into increased vulnerability to drought.

iii. Peasant perception and utilisation of local resources can be (and usually is in the absence of the constraints listed earlier) very sensitive to states of nature. Hybridisation of folk and modern technology would thus seem a strong foundation for development in the dry zone. However, new organisations of production are called for, especially small-scale cooperatives amongst peasant producers.

REFERENCES

AMIN, S. (1973) Neo-Colonialism in West Africa, Penguin, London.

BAIRD, A.; O'KEEFE, P.; WESTGATE, K.; WISNER, B. (1975). Toward an Explanation and Reduction of Disaster Proneness, Disaster Research Unit Occasional Paper No. 11, University of Bradford.

BERRY, L. et al (1972). Human Adjustment to Agricultural Drought in Tanzania: Pilot Investigations. Natural Hazard Research Working Paper 19, University of Colorado, Institute of Behavioural Science, Boulder.

BRADLEY, P. (1973) 'The delayed start of the 1973 rains at Samaru, Nigeria', Savanna, Vol. 2, pp. 79-81.

BRETT, E. (1974) Colonialism and Underdevelopment in East Africa: the Politics of Economic Change 1919-39. Heinemann, London.

COMITE INFORMATION SAHEL (1974). Qui se Nourrit de la Famine en Afrique? Maspero, Paris.

GOULD, P. (1963) 'Man against his environment: a game theoretic approach', Annals of the Association of American Geographers, Vol. 53, pp. 290-297.

GOULD, P. (1965) 'Wheat farming on Kilimanjaro', in General Systems Year Book.

LAMB, H.H. (1974) 'Last year's weather', Geographical Magazine, Vol 46, p. 445.

LEYS, C. (1975) Underdevelopment in Kenya: the Political Economy of Neo-Colonialism 1964-1971, Heinemann, London.

MEILLASSOUX, C. (1974). 'Development or Exploitation: is the Sahel Famine Good Business?', Review of African Political Economy, Vol. 1, pp. 27-33.

O'KEEFE, P. (1974a) The Ecological Background to the Sahel Drought. Disaster Research Unit, University of Bradford, mimeo.

O'KEEFE, P. (1974b) 'Gakarara - a Study in the Development of Underdevelopment.' Ph.D. thesis, University of London.

O'KEEFE, P. (1975) African Drought - a Review. Disaster Research Unit Occasional Paper no. 8, University of Bradford.

O'KEEFE, P; WISNER, B. (1975). 'Underdevelopment in East Africa: a Kenyan Case Study' African Environment/ Environment Africain, I.3, International African Institute, Forthcoming.

SEAMAN, J. et al. (1973). 'An inquiry into the drought situation in Upper Volta', The Lancet, No. 2, pp. 774-778.

SHEETS, H.; MORRIS, R. (1974). Disaster in the Desert. Carnegie Endowment for International Peace, Washington D.C.

SURET-CANALE, J. (1971). French Colonialism in Tropical Africa 1900 - 1945. Universe Press, New York.

UN PROTEIN ADVISORY GROUP (1974). Recommendations: August 1974. United Nations, Geneva, mimeo.

WINSTANLEY, D. (1973a). 'Recent Rainfall Trends in Africa, the Middle East and India'. Nature Vol. 243, p. 464.

WINSTANLEY, D. (1973b). 'Rainfall Patterns and General Atmospheric Circulation', Nature Vol. 245, p. 190

WISNER, B. (1975) 'Famine Relief and People's War in Africa', Review of African Political Economy, No. 3, forthcoming.

PART 6: THE RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT.

15. Sources and Analysis of Data on World Disaster Occurrence.

16. The Data Interpreted: the Relationship Between Disasters and Development.

15. SOURCES AND ANALYSIS OF DATA ON WORLD DISASTER OCCURRENCE

15.1. There are five major sources of data on world disaster occurrence.

a. International Agencies.

b. National Governments.

c. Non-governmental Organisations.

d. Academic Research Institutions.

e. Private Insurance Companies (vide 1.2.)

15.2. International Agencies

The principal agencies involved are those of the United Nations, the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the United Nations Economic and Social Council, and the United Nations Office of the Disaster Relief Co-ordinator (UNDRO).

15.3. UNESCO provide an annual summary of information on natural disasters but they make a distinction between a disaster event and its destructive power. All events listed are referred to as disasters although few of them affected a population. Those that did are referred to as destructive phenomena. Thus, in 1969, UNESCO's summary lists 759 "disasters" (by far the greatest annual number encountered in this survey), but only 12 of these were considered destructive (i.e. affecting a population). Table 15 lists these "disasters" by type and region. It is important to note that the UNESCO data only covers the hazard phenomena of earthquake, tsunami, storm surge and volcano. The UNESCO data, thus, has three important shortcomings:

i. It is concerned with scientific recordings of extreme physical phenomena rather than disaster events.

ii. The range of phenomena covered is not the full range of those associated with disaster events.

iii. The annual summary is only available from 1966.

15.4. The United Nations Economic and Social Council have produced data on world disaster occurrence for the years 1961-1970 based on the number of occasions on which the League of Red Cross Societies had issued a major appeal. The data more clearly reflects the nature of disaster, Asia being the predominant region and flood the

TABLE 15

UNESCO: DISASTERS BY TYPE AND REGION, 1969.

a. Number of Disasters by Type

Earthquake	722
Tsunami	5
Storm Surge	7
Volcano	25
TOTAL	759

b. Number of Disasters by Region.

Pacific	467
Atlantic	68
Mediterranean	67
Continental Africa, Indian Ocean, Australia	63
Asiatic Ranges	61
Continental Europe	17
Antarctica	1
Other	15
TOTAL	759

Source UNESCO, 1971.

predominant type (Table 16). Three criticisms can be levelled at this data source:

i. It is derived from secondary material and thus hides the anomalies inherent in the declaration of a disaster by the League of Red Cross Societies.

ii. The data does not cover a long enough period.

iii. The data contains no data on losses to population or physical infrastructure.

15.5. UNDRO produced a document which attempted to analyse disaster occurrence between the years 1919 and 1971 focusing on disasters in which assistance was necessary and provided by the international community. The 52 years covered by the data is a long enough period for shorter periods within the 52 years to be analysed separately. Thus over the total period, Asia experiences most disasters with Europe and the Americas second and third respectively (Table 17). If, however, a twenty-one year period is considered (1951-71) or a four year period (1968-71), the disaster experience of Europe and the Americas significantly decreases (Tables 18 and 19). A disaster type ranking for the years 1968-71 reveals a similar hierarchy to the United Nations Economic and Social Council data (Table 20).

15.6. UNDRO have produced some of the most accurate data available, more detailed than that of any source. Yet there are several drawbacks

a. The data analysis is only tentative although the terms of reference are clearly stated.

b. The data does not contain calculations of loss of either population or physical infrastructure, although it does contain a brief analysis of institutional preparedness for disaster.

15.7. National Organisations

The largest single data source at this moment is the United States Aid for International Development Programme (USAID). They publish case reports on each disaster in which they are involved, producing each year, since 1960, an annual summary of Foreign Disaster Emergency Relief. The data not only gives a description of the

TABLE 16

UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL: NATURAL DISASTERS OCCASIONING A MAJOR APPEAL ON THE PART OF THE LEAGUE OF RED CROSS SOCIETIES, BY TYPE AND REGION, 1961 - 1970.

a. Number of Disasters by Type.

Hurricane	18
Flood	58
Earthquake	19
Volcanic Eruption	3
Drought/Famine	8
Epidemic	6
TOTAL	112

b. Number of Disasters by Region.

Asia	46
Africa	22
Middle East	20
Europe	13
Americas	11
TOTAL	112

Source: United Nations Economic and Social Council, 1971.

TABLE 17

UNDRO: DISASTERS RANKED ACCORDING TO REGION, 1919 - 1971.

Asia	89	
Europe	49	
Americas	42	
Middle East	38	
Africa	33	
TOTAL	251	Mean = 4.8 disasters per annum.

Source: Stanissis, 1972.

TABLE 18

UNDRO: DISASTERS RANKED ACCORDING TO REGION, 1951 - 1971.

Asia	77	
Middle East	38	
Americas	35	
Europe	35	
Africa	29	
TOTAL	214	Mean = 10.0 disasters per annum.

Source: Stanissis, 1972.

TABLE 19

UNDRO: DISASTERS RANKED ACCORDING TO REGION, 1968 - 1971.

Asia	24	
Middle East	10	
Africa	9	
Americas	6	
Europe	3	
TOTAL	52	Mean = 13 disasters per annum.

Source: Stanissis, 1972.

TABLE 20

UNDRO: NUMBER OF DISASTERS BY TYPE, 1968 - 1971.

Flood	27
Earthquake	8
Hurricanes	7
Drought	5
Epidemics	2
Famine	2
Volcanic eruptions	1
TOTAL	52

Source: Stanissis, 1972.

disaster strike but also information on numbers killed, estimated victims, total U.S.A. assistance, reported assistance from other countries and reported assistance from within the host country. The number of disasters by region differs from other sources with the predominance of Latin America (Table 21). This is the major criticism of the data source - it is heavily biased towards American influence overseas.

15.8. USAID also produce a disaster file computer printout but for some reason this data does not correlate with that from the formal annual report - there is no internal consistency. The printout recordings for 1968 - 1971 showing a similarity to the annual report data with regard to the ranking of disaster by region whereas the ranking of disaster by region compares favourably with the data from United Nations sources (Table 22). Two criticisms can be levelled at USAID data sources:

a. The material is heavily biased towards American influence overseas.

b. It does not record disasters which occur in the United States.

15.9. Academic Sources of Information

Academic data sources can be considered to be primarily twofold - the Smithsonian Institution, Centre for Short-lived Phenomena, and the Natural Hazard Research Group (vide 2.10.).

15.10. The Smithsonian Institution, Centre for Short-lived Phenomena, as its name suggests, ignore such disaster types as drought or famine. Basically it is a continual monitoring system of the environment and short-lived phenomena refers to a great variety of environmental events among which are included short-run disaster events. Table 23 indicates disaster phenomena recorded by the Smithsonian Institution for the period from 1968 - 1971. Three criticisms can be levelled at this data source:

a. The basis for data collection is predominantly recordings of phenomena occurring in the United States and related countries.

b. Little data is available on the impact of the phenomena.

c. The data excludes longer-term disaster phenomena.

TABLE 21

USAID: NUMBER OF DISASTERS BY REGION, 1968 - 1971.

Asia*	68
Latin America	64
Africa	55
Europe	7
TOTAL	194

* Includes Middle East

Source: USAID, 1972.

TABLE 22

USAID: DISASTER OCCURRENCE BY REGION AND TYPE, 1968 - 1971.

a. Disasters by Region.

Americas	41
Asia	32
Africa	19
Europe	7
Middle East	5
TOTAL	104

b. Disasters by Type.

Floods	41
Hurricanes	24
Earthquakes	19
Drought/Famine	18
Volcanic eruptions	2
TOTAL	104

Source: USAID, 1974.

TABLE 23

SMITHSONIAN INSTITUTION, CENTRE FOR SHORT-LIVED PHENOMENA: DISASTER PHENOMENA, 1968 - 1971.

Volcanic eruptions	71
Major earthquakes	86
Major floods, etc.	11
TOTAL	168

Source: Smithsonian Institution, Centre for Short-lived Phenomena, 1971.

15.11. The Natural Hazard Research Group is the best academic data source. For studies of global trends in disasters, the Group have produced data covering the years from 1947 to 1973. A methodology was created to maintain consistency. Disasters are defined as situations which satisfy at least one of the following operational conditions, viz.

a. at least $1,000,000 damage, or
b. at least 100 dead, or
c. at least 100 injured.

Disasters are categorised as being large area or small area. Large area disasters are defined as exceeding one 10^{o} latitude by longitude square on a world map while a small area disaster would cover less than one 10^{o} square. The data was compiled from various encyclopaedic and journalistic sources including the New York Times Index, Encyclopaedia Britannica Yearbook, Collier's Encyclopaedia Yearbook, The American People's Encyclopaedia Yearbook and Keesing's Contemporary Archives.

15.12. Table 24 contains a list of large area disasters from 1968 - 1971 and although predominance of hurricanes, floods and earthquakes among disaster types does not diverge greatly from the predominance in other sources discussed, regional allocation does differ, primarily because of the emphasis inherent in the source material. Basically, Natural Hazard Research data is comprehensive but again there is no cost accounting of disaster impact.

15.13. Non-governmental Organisations

The main data source here is the material published by the Catholic Relief Services which includes the number of disasters in which the Catholic Relief Services, the League of Red Cross Societies, the Lutheran World Federation, the World Council of Churches, or Oxfam provided assistance. (In major disasters the inclusion of Oxfam indicates the inclusion of the British Red Cross, the Save the Children Fund, Christian Aid and War on Want because all five charities are co-ordinated through the British Disasters Emergency Committee.)

TABLE 24

NATURAL HAZARD RESEARCH GROUP: NUMBER OF LARGE AREA DISASTERS BY TYPE AND REGION, 1968 - 1971.

a. Large Area Disasters by Type

Earthquake	3
Flood	9
Hurricane, typhoon, cyclone	10
Tornado	3
Heatwave	1
Rainstorm	3
Snowstorm	1
TOTAL	30

b. Large Area Disasters by Region

United States	11
Asia	12
Latin America	4
Africa	1
Europe	1
Australia	1
TOTAL	30

Source: Dworkin, 1974.

15.14. Table 25 contains figures on disaster occurrence by type and region over a three-year run. The data is estimated to be fairly accurate because non-governmental organisations tend to have more "grassroot" contact and involvement. Disasters by region stress the predominance of Asia while the ranking of disaster types reflects closely other data sources discussed. The two major criticisms of this data source are

a. Each non-governmental organisation contributing to the data is governed by its own terms of reference concerning the provision of emergency assistance.

b. There are no estimates of damage suffered or costs of relief, rehabilitation and reconstruction except for the individual disbursements of each Charity.

15.15. Commercial Organisations

The commercial organisations who provide data on disaster occurrence are reinsurance companies. The data available is inadequate but is the only global summary of reinsurance material available at present in the absence of an examination of total local, regional and national insurance returns for individual countries. Table 26 shows disasters by region and type for 1968 to 1971. The figures bear little relation to those discussed earlier and show that investment in financial insurance is a western adjustment to hazard. As a data source on disaster occurrence, its use is minimal.

15.16. Several conclusions can be drawn from this brief survey of data sources:

a. There is no common or universal scale of disaster measurement and consequently little compatability between the data.

b. There is no accounting for disaster losses except in individual appraisals of a specific disaster situation.

c. Most data contains a bias which results from its specific viewpoint on disaster.

d. The best available data is from UNDRO and the Natural Hazard Research Group. USAID provide most information but the internal and external consistency of the data is much in question.

TABLE 25

NON-GOVERNMENTAL ORGANISATIONS: NUMBER OF DISASTERS BY TYPE AND REGION, 1970 - 1972.

a. Disasters by Type

Flood	51
Drought	34
Hurricane	15
Earthquake	7
Volcanic eruption	3
TOTAL	110

b. Disasters by Region

Asia	45
Latin America	31
Africa	31
Europe	3
TOTAL	110

Source: Catholic Relief Services, 1974.

TABLE 26

INSURANCE COMPANIES: DISASTERS BY TYPE AND REGION BASED ON REINSURANCE DATA, 1968 - 1971.

a. Disasters by Type

Cyclone	7
Flood	1
Storm/Hail	4
Earthquake	2
TOTAL	14

b. Disasters by Region

United States	9
Central America	1
Europe	4
TOTAL	14

Source: Swiss Reinsurance Company Review, 1973.

REFERENCES

CATHOLIC RELIEF SERVICES (1974) Narrowing the Gap. New York.

DWORKIN, J. (1974) Global Trends in Natural Disasters 1947 - 73. Natural Hazard Research, Working Paper No. 26, University of Colorado, Department of Behavioural Science, Boulder.

SMITHSONIAN INSTITUTION, CENTER FOR SHORT-LIVED PHENOMENA (1971) Annual Report 1970 Cambridge, Massachusetts.

STANISSIS, P.C. (1972) Disaster Analysis United Nations, Office of the Disaster Relief Co-ordinator, Geneva.

SWISS REINSURANCE COMPANY (1973) "Natural Disasters and Major Losses, 1968 - 1972". Quarterly Review, First Quarter, pp. 7 - 11.

UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL (1971) Assistance in Cases of Natural Disaster: Comprehensive Report of the Secretary-General. 51st Session, Agenda Item 15, Document E/4994, New York.

UNESCO (1971) Annual Summary of Information on Natural Disasters, 1969. Paris.

USAID (1972) Foreign Disaster Emergency Relief: 11th Report, 1972. Washington, D.C.

USAID (1974) Disaster File Computer Printout. Washington, D.C.

16. THE DATA INTERPRETED: THE RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT

16.1. The sources of data on disaster occurrence have been described in the previous section. In spite of the data's unreliability, several tendencies can be observed.

The most important tendency is an increase in the occurrence of disasters over the last 50 years. Diagram 9 shows this increase from 1947-73 of large-scale disasters, that is, those disasters covering more than a ten-degree square on a world map and where damage exceeds $1 million. This tendency is paralleled by an increasing loss of life per disaster. The greatest loss of life per disaster is observed in under-developed countries, and there are general indications that the vulnerability of these countries in particular is increasing. Such conclusions clearly require further explanation.

16.2. Disaster marks the interface between an extreme physical phenomenon and a vulnerable human population. It is of paramount importance to recognise both of these elements. Without people there is no disaster. The two elements are basic to an explanation of an increase in the occurrence of disasters. No major geological or climatological changes over the last 50 years adequately explain the rise. There is little argument about geological change, but there has been much mystifying argument about climatic change, especially following the prolonged drought over the African and Asian continents. But no firm conclusion can be drawn about changing climatic conditions from available evidence. Randall Baker at the Development Studies School of the University of East Anglia recently reviewed all the evidence of climatic change in Africa, and offered the Scottish judgment of "case not proven". Even if some long-term change was observable it would not explain the increase in disaster occurrence observed in the data.

If it is accepted that there has been no major geological and climatological change in recent years, then it can be assumed that the probability of the extreme physical occurrence is constant. If the probability is constant, then logically the explanation of the increasing numbers of disasters must be sought

DIAGRAM 9:

GLOBAL DISASTERS 1947-1973: FIVE YEAR MOVING AVERAGE

Source: Dworkin 1974.

in an explanation of the growing vulnerability of the population to extreme physical events. Ongoing research suggests that some radical rethinking on the nature of "natural" disasters is necessary.

16.3. It is known that the frequency of natural disasters is increasing especially in underdeveloped countries. Indeed, the increased vulnerability of people to extreme physical events can be seen as intimately connected with the continuing process of underdevelopment recorded throughout the world. As population continues to expand, and as resources continue to be controlled by a minority, the real standard of living drops for much of the world's population. This population is increasingly vulnerable to environmental variation as the process continues. Paul Richards of the Environmental Unit in the International African Institute recently emphasised this in his introduction to African Environment: Problems and Perspectives: "...just as natural processes such as lack of rainfall affect social structures", he argued, "so social processes such as economic 'development' can affect natural systems, 'causing' famine and soil erosion for example" (Richards, 1975). He went on:

> "In a continent where internationalities of dependency, massive international labour migration and multinational companies prevail and in a world where growth does not necessarily mean development, and development does not necessarily bring enrichment or an increase in personal happinesss, the ultimate cause of environmental problems may well be traceable to the structural imbalances between rich and poor countries and we would be right to replace the term natural with the more appropriate term social or political disaster".
>
> (Richards, 1975)

These suggestions would strike the Guatemalan peasant as commonsense. The recent earthquake there is no longer identified as a natural event - the local inhabitants who survived are referring to the event as a "classquake". It is a view which reflects their broad experience.

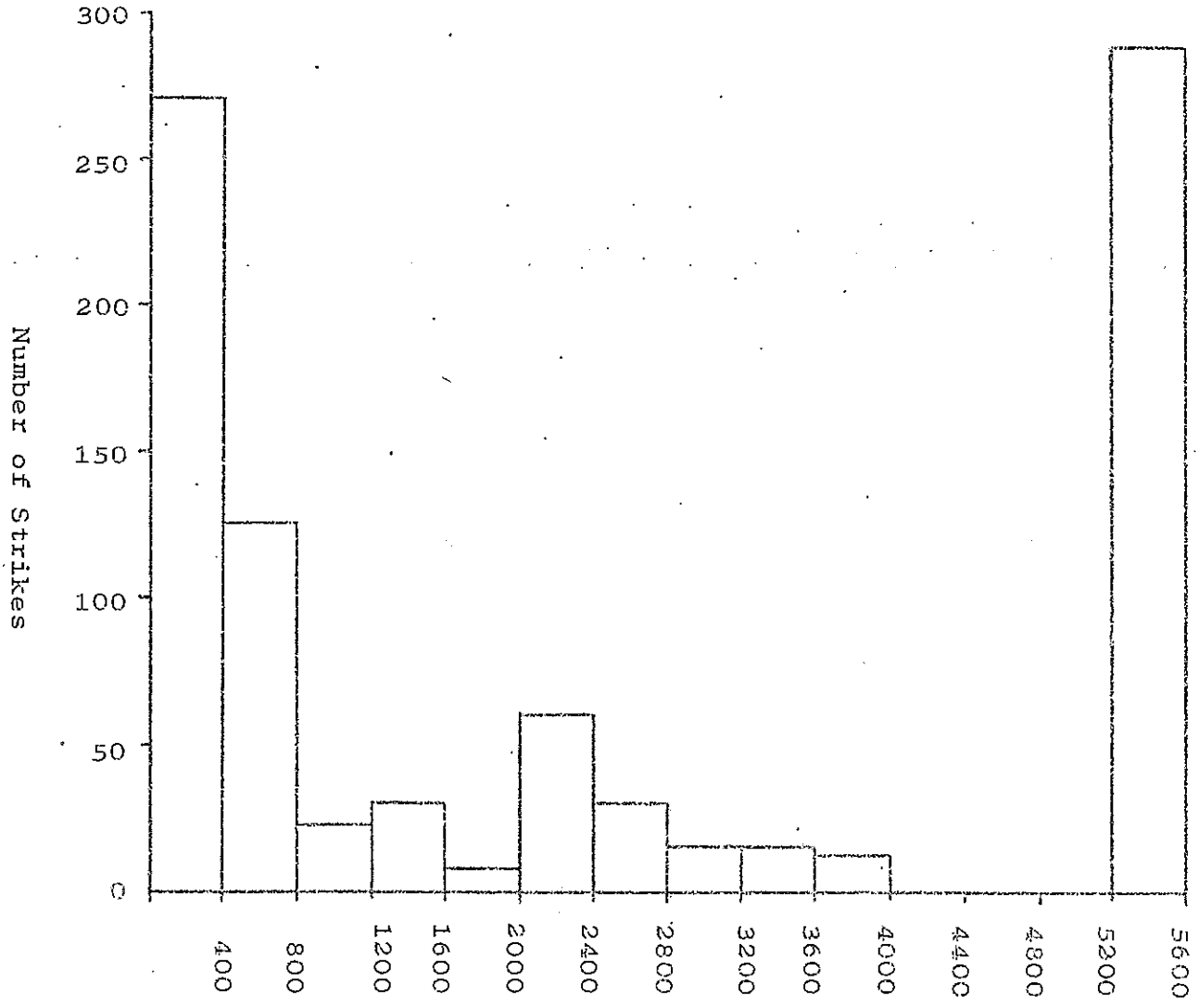
16.4. Towards an Explanation of Disaster Proneness

Why is there such a marked increase in disaster occurrence? Disaster marks the interface between an extreme physical phenomena and a vulnerable human settlement. These two elements are basic to an understanding of an increase in natural disaster. No major geological change or no major climatological change has occurred over the last 50 years that would adequately explain this phenomena. There is little argument about geological change; the forces from which earthquakes, volcanoes and tsunamis arise have been remarkably consistent over the quarternary era. There has been much mystifying argument about climatic change which would have a strong bearing on the occurrence of hurricane, flood and drought. Following the prolonged drought over the African and Asian continents, many theories have been raised attempting to see the drought in terms of global changes in the earth's climatic belt. It now seems that, from the available evidence, no firm conclusions can be made about the nature of recent climatological change. In fact, evidence actually indicates that physical factors were not of great importance in the so-called drought; recent work indicates that the Sahel famine in particular was the result of socio-economic factors rather than climatological ones.

16.5. If the explanation of the increase in the number of disasters cannot be found by considering the physical milieu, then, given the definition of disaster outlined above, it is of paramount importance to consider the social milieu in which disasters occur. An analysis of the events recorded in Diagram 9 indicates that the disasters are increasing especially in the underdeveloped countries. Diagram 10 contains this analysis. The vulnerability of the people to extreme natural events seems to be increasing. Indeed, this increasing vulnerability of people to extreme physical conditions can be seen to be intimately connected with the continuing process of underdevelopment that has been recorded throughout the world. As population continues to expand and as the resource base continues to be controlled by a minority, the real standard of living drops for much of the world's population. The population is thus increasingly vulnerable to extreme natural hazards.

DIAGRAM 10

NUMBER OF DISASTER STRIKES BY PER CAPITA INCOME OF DISASTER STRIKE AREA



This process has been identified as one of marginalisation. The concept of marginality was originally used to denote the plight of migrants who left rural areas to find employment opportunities in towns. The concept initially referred to the lack of adequate housing facilities that these groups faced but it was soon used to denote a general lack of facilities for these migrant workers. It was then realised that the processes of migration to cities were induced by a more serious lack of opportunities in the rural areas. The cause of this low level of participation was supposed to lie in the lack of internal integration within a society. This view of marginality led to the conclusion that if marginals were helped to organise then help could be provided to them so that they could adjust and adapt better to the requirements of society.

Radically opposed to this interpretation of marginality and the consequent policies, another interpretation of marginality emerged. This interpretation emphasised that the population that was called marginal and was supposed not to be integrated within society was actually fully integrated into society. The condition of marginality results not from the action of the marginal group itself but from the relationship that the group has with other classes and interest groups in society.

16.6. Poverty and Disaster

In 1970, 225,000 were killed by cyclone and flooding in Bangladesh, and another 600,000 were made homeless. An earthquake flattened Mánagua, capital of Nicaragua, in 1972, killing at least 6,000, injuring 20,000, and destroying nearly half of the sprawling town's housing. The recent toll in Guatemala was even greater. At least 8,000 Hondurans died in 1974 due to Hurricane Fifi, and throughout the early 1970s, south Asia and the African savanna lands baked. Drought is thought to have contributed to the death by starvation and/or measles of about 100,000 inhabitants of the six Sahelian countries. In 1973 alone, 25 major disasters killed 110,000 people, disrupted the lives of 215 million more, and cost more than £500 million. The Chinese have not released casualty figures for the earthquake at Tangshan in July of this year, but the earthquake in the Southern Philippines in August killed 1,742 people, with

a further 2,000 missing.

16.7. Faced by disaster and suffering on such a scale world leaders and their experts have had conferences, made on-the-spot inspections, and talked a lot about causes. Since the tragic struggle seems to be the poor versus nature, experts have taken the role of umpire. Some judge that it is mostly the poor themselves who are to blame, by reproducing themselves too frequently; by choosing to live in hazardous places like the Bangladeshi coastal islets or steep Honduran hillsides; by thoughtlessly unbalancing local ecology in their attempts to farm. Other umpires blame nature; for long-term climatic shifts resulting in "desertification;" for a short-term series of exceptionally wet years in the 1960s that encouraged peasants and nomads to push their luck in lands usually too dry to support them.

16.8. The physical and social hazard defences of the rich countries have become more effective, but at the same time the poorest people in the poor countries, have become increasingly vulnerable to disaster. If the umpires are wrong, how does one explain the increase in the hazards of life in the poor countries? There is no evidence that major physical changes in the atmosphere or crust of the earth were responsible. Instead, it is argued that under present conditions the poor are bound to become more vulnerable to natural hazards. This viewpoint is supported by a group based in France and West Africa, called Comite Information Sahel. And for over 20 years established development economists like Ragnar Nurkse and Gunnar Myrdal have demonstrated the "vicious circles" which make poor become poorer and rich, richer. Certainly the poorer people get, the less reserves they have to tide them over droughts; the flimsier their shanty housing, the more vulnerable it is to winds, and storms, and earthquakes; the poorer their nutritional status, the lower their resistance to the extra stress of disaster and the outbreaks of disease that often follow.

16.9. As landlessness and unemployment spiral upwards in Asia, Latin America, and in less densely populated Africa, families find their

choice severely narrowed. When foreign firms bought up hundreds of thousands of acres of valley bottom land in Honduras, the rural poor had no choice other than to move up the neighbouring steep slopes to find land to farm. Similarly, in the last 60 years, land hunger has crowded the flood-prone coastal lands of Bangladesh with small farmers and even poorer migrant labourers, where population was previously sparce. The emphasis on groundnuts and cotton placed by Senegal, Upper Volta, and the other Sahelian countries has forced small farmers to extend their farms into drier and drier land, which has pushed the nomadic herders further toward their own margins.

As their choice narrows, the poor find it increasingly difficult to use standard ways of safeguarding their families. For instance traditional herd movements for times of drought have been destroyed by international and national restrictions on mobility. The loss of male labour to the "modern sector" has left women incapable of farming enough to feed the family and keep a large supply of grain in store for bad times. Data from Kenya and the Sahelian countries show that the wage paid to the absent male in such circumstances is seldom enough to cover the lost production at home. Vulnerability to disastrous famine therefore increases.

16.10. Some experts argue that this situation is only temporary. They believe that in the course of general modernisation in such poor countries, "modern hazard adjustments" such as irrigation, mass movement of livestock by rail, even agricultural insurance, will take its place. Such optimism is very hard to swallow.

16.11. The poor respond to potential and actual disaster in ways that often appear to be irrational. They overstock the land with livestock, especially goats. They clear vegetation on steep Honduran hillsides in order to farm, removing the same vegetation that holds the soil in place. They stream back to the chars of the Bay of Bengal only weeks after wind and water has swept away all signs of human life. They have not the capital or organisational resources to provide modern adjustments. The latter do exist for a tiny minority in the poor countries: the few thousand rich

Kenyan farmers with access to agricultural insurance against drought; the few thousand wealthy Nicaraguans and Guatemalans who are able to afford earthquake-proofed homes.

The rich countries and rich elites within poor countries do not conspire to starve the poor, to shift them into dangerous places like Nazis shifting Jews to death camps. But it is believed that the international division of labour among rich and poor countries and market forces within the poor, underdeveloped capitalist economies of the Third World cause the poorest of the poor to live in the most dangerous places. This is a matter of complex social allocation: both of the social surplus product (national income) and of locations within the space-economy. The issues of income distribution are entangled with issues of "spatial social justice."

16.12. The frequency and impact of disasters has naturally had a great deal of press coverage in the last few years. But older written sources such as the Bible, Koran and Chinese sources, give us a record that is not significantly improved by the existence today of a world-wide communications technology. Some computerised, up-to-the-minute sources, such as US-AID's disaster file computer print-out, probably omit more disasters because of the politics of aid than did older, less space-aged reporting and recording systems. For instance, the US-AID print-out reports 41 disasters in the Americas in 1968-1971 and only 19 in Africa.

Population growth alone is said to be sufficient to "explain" increased vulnerability to disaster. But of course this does not explain anything. At most population increase is only one of many variables which link poverty to disaster proneness. Over-population is a symptom, not a cause. Studies from all continents show that people only limit their family size when they are assured of certain levels of material well-being. The more uncertain a couple's life, the more likely they are to want a large family to support them. If, in the long run, such an increase in population intensifies an already serious situation of continually growing vulnerability, it is tragic. But is it logical to attribute the whole problem to population growth?

Growing population might well be a symptom of absolute poverty and family insecurity, but it is also a sign of lengthening life

expectancy, even among the poor! Is longer life not incompatible with increasing disaster vulnerability? A longer life, like most health benefits of "modernisation" such as freedom from tuberculosis or smallpox, has been concentrated in the richer 60 per cent of Third World people. The recent World Bank and United Nations trumpeting about programmes focused on "the poorest of the poor" is an institutional response to this unfortunate fact. Average life span in underdeveloped countries has increased dramatically, but only because it was so short to start with: 32 years before the last war, to 49 years by the end of the 1960s. But whose lives have lengthened? The World Bank reports a very high correlation between income and life expectancy. Those who suffer highest vulnerability to disaster, generally do not live longer than they did a generation or two ago; for that matter they still die of easily preventable diseases like TB and smallpox. Groups such as Chicano farm workers and American Indians have life expectancies at least 20 years shorter than the American average.

16.13. As more evidence piles up, it is clear that one must radically rethink the causal relationships involving people and nature.

It is time the popular belief in the "randomness" of disaster - the so-called "act of God" enshrined in the law of contract and the popular mind is questioned. The Lisbon earthquake of 1755 was supposed to have contributed to the rejection of Divine Providence by intellectuals of the period known as the Enlightment. They saw this as an example of sudden, uncontrollable, horrible forces unleashed "at random." The concept of vulnerability to disaster brings order out of such apparent chaos. However the "natural" disasters confronting the enlightened today will not bring them back to an acceptance of Providence, but to a conviction that the influence of the global market reaches everywhere - into the most isolated African, Asian, Oceanic, and Latin American homes.

In this way the present revolution in thinking about disaster is related to a far wider revolution of thought about underdevelopment. What had previously been seen as a state out of which the poor country had to emerge is now widely seen as a continual process of impoverishment based on a world economy which perpetuates technological dependency and unequal exchange. A similar view is

taken about the active underdevelopment of poorer classes by richer ones within poor countries, as well as between rich countries and poor.

16.14. When this is applied to the internal conditions of a poor country, the very poorest people are often said to be "marginalised". The "marginals" are those who have been either forced off the land or onto very poor or insufficient land, and who cannot find a permanent job. This is a growing class, especially in Latin America and Africa. Those concerned serve the modern industrial groups in underdeveloped countries as cheap casual labour, or by producing cheap food for industrial workers. They also have little political power and a poor standard of living. Often they are a cultural or ethnic minority within the poor country: the nomads in the Sahel or the Mayan Indians of Guatemala. Finally, they often live in the most dangerous and unhealthy places. It is no accident that San Juan (Puerto Rico) slums are frequently inundated by high tide; that Rio's infamous favelas climb slopes of alpine difficulty; that the poorest urban squatters in much of Asia live on hazardous floodplains; that those people crowded into Recife in north east Brazil live in, and on, the mud of the tidal estuary, living off the crabs that also inhabit the mud. The poor are often clearly aware of their own vulnerability. Why else would the devastated slums dwellers of Guatemala City refer to the earthquake as a "class-quake"?

Often the man-made hazards of "modernising" the environment add to the large and growing risks already described: natural gas and oil leaks off the coast of Nigeria; wastes from Pakistan's developing chemical industry in the groundwater; the problem of rubber-waste disposal in Malaysia.

16.15. The increasing vulnerability to environmental hazards among the world's poor is at least as big a problem as the clearly recognised and studied food crisis and should have been a bigger issue in Vancouver at the UN conference on Human Settlements. Indeed these two great threats to human development very much overlap. Absolute poverty is the core of both. There is a high correlation among

disaster proneness, chronic malnutrition, famine potential, and low income. Poverty is as much due to gross maldistribution of national income within poor countries, as a product of unequal exchange between poor and rich countries.

REFERENCES:

DWORKIN, J. (1974) Global Trends in Natural Disasters 1947-73. Natural Hazard Research, Working Paper No. 26, University of Colorado, Department of Behavioural Science, Boulder.

RICHARDS, P. (Ed.) (1975). African Environment: Problems and Perspectives. International African Institute, London.

PART 7: DISASTER TECHNOLOGY

17. Traditional Approaches to Disaster Technology.

18. An Integrated Approach to Disaster Technology.

17. TRADITIONAL APPROACHES TO DISASTER TECHNOLOGY

17.1. Several important issues arise in any discussion of disaster technology. The classical division between types of disaster technology is in the acceptance of a functional difference between the technology required for pre- and post-disaster situations. Predisaster technology includes the use of building regulations, flood plain zoning etc. for preventive measures and early warning systems and storage facilities for preparedness measures. Post-disaster technology includes requirements for relief, rehabilitation and reconstruction.

17.2. Predisaster technology applied to preventive measures has been dealt with adequately in the Economics section (vide 11.16). This technology includes all of the technological requirements for adequate development planning.

17.3. The question of early warning systems and the relationship of these systems to the development of communications is a more tortuous problem. At the present moment there is sufficient technical expertise available to adequately forecast most natural hazards before a population is endangered. The use of this complex electronic technology is, however, normally orientated towards military rather than civilian purposes. Disaster warning systems are usually considered in total isolation from the disaster process itself and failure of these warning systems can only be seen against the background of non-integration within the population's activities as a whole.

17.4. Storage facilities, which are considered as separate isolated planning units, similarly fail because they are not integrated into the everyday economic activity of the population. For example Swift (1975) has indicated that the introduction of water holes in pastoral areas of Africa to alleviate problems of drought has increased the problem. This is because no adequate mechanism existed for providing fodder as well as water. The great increase in the number of herds around well sites led to the deterioration of the ecosystem because pressure on pasture increased, destroying grasses, particularly the perennials and

soil erosion consequently began.

17.5. The technology included in relief, rehabilitation and reconstruction is of a more dubious nature. If adequate rehabilitation and reconstruction are to take place, then the technology which is used in the everyday economic activities of the population must be utilised. However, over the last decade the large amounts of money available for relief work following a disaster have led to the growth of a specific technology, i.e. a relief orientated technology. One of the outstanding examples of the application of such a technology is in the field of relief housing (Davis et al 1977). Specific shelter technology has been provided in most disaster situations since the 1960s. The relevance of this shelter can now be seriously questioned. By the time the emergency technology has arrived, the local population has frequently already begun to rehabilitate themselves, i.e. there is no requirement for shelter. The imposition of shelter from outside agencies encourages the growth of shanty areas and consequently leaves the population more vulnerable after a disaster than it was before.

The severe limitations of any form of specific relief technology must mean that in future the funding of research into such technologies should be seriously questioned.

17.6. A conclusion of this section must necessarily be that the technological solutions that are offered in disaster situations are largely irrelevant, if not actually wasteful because they are not integrated into the socio-economic conditions of everyday life.

REFERENCES

DAVIS, I. et al (1977). "UNDRO Consultancy Report on Housing Conditions in Disaster Situations." (forthcoming)

SWIFT, J. (1975) Personal Correspondence.

18. AN INTEGRATED APPROACH TO DISASTER TECHNOLOGY

18.1. Disaster technology, to be of any value whatsoever, must have the following characteristics:-

a. It must be integrated within the overall developmental context.

b. If it is integrated within the overall developmental context, it must be integrated in a practical and not a theoretical way (vide section 20).

c. Disaster technology must not, therefore, assume that there is a need for a specific technology until conditions of vulnerability are understood.

d. This can only be achieved when a consideration of the factors involved in the appropriate technology are location-specific.

e. The criteria for the introduction of disaster technology must be established with the full knowledge of the effects upon and consent of the local population. Any imposition of external technologies produces a dependency relationship and enhances conditions of vulnerability.

18.2. If these conditions outlined in 18.1. are met, then it is felt that the technologies employed in disaster situations will be more cost effective not only in terms of reducing death and destruction but also in enhancing the opportunities for development. For the actual implementation of such technologies see 11.25.

PART 8: DISASTER RESEARCH APPLIED - THE PLANNING FRAMEWORK

19. Disasters and Planning.

20. Preventive Planning for Disasters - a Long Term Strategy.

19. DISASTERS AND PLANNING

19.1. The preceding sections of this booklet have concentrated on developing a conceptual framework within which the reality of disaster can be comprehended and with practical approaches to specific problems. It is now time to piece the puzzle together and to concentrate on the requirements for practical attempts to counteract the ugly manifestations of the interaction between extreme physical phenomena and vulnerable human groups. With the right tools (among which much of this booklet can be counted) something, perhaps, can be achieved. The rising cost of disaster can be alleviated, mitigated and perhaps prevented by an appropriate, level-headed and organised approach for each disaster-prone location. This section and the one following will attempt to look at planning for the mitigation of disaster occurrence. This section will concentrate on developing a philosophy of planning and a framework within which successful precautionary planning can take place. Section 21 will outline a possible long-term strategy for the alleviation of disaster in developing countries.

19.2. The Framework for Precautionary Planning

Planning is a policy implementation which sets its objectives in the form of targets to be reached in a determined time. Targets established by the plan must be feasible in terms of available resources if any success is to be achieved. Planning can be attempted at various levels from the international, through the national and regional, to the local level. The type of planning considered here is precautionary planning.

19.3. Previous orientations towards some kind of disaster planning have concentrated on administrative and logistical considerations, sociological considerations, or regional planning considerations.

a. The Administrative/Logistical Approach: This approach concentrates on the disaster event, its impact and the alleviation of its immediate effects. It is orientated towards practicality immediately before and after a disaster event and consists of the delimitation and organisation of necessary activities. There is always a need for such a plan of action, but it does not treat disaster as a dynamic process.

b. The Sociological Approach: This approach is based on the Disaster Research Centre's sociological studies of disaster events (vide 8.8 ff). It is concerned with the co-ordination of community activity based on an understanding of the community's expected behaviour and response to particular disaster events. As such, it again ignores the disaster process, the dynamic quality of the disaster environment. Also, it has little relevance to many developing countries who lack the organisational facets assumed by this approach.

c. The Regional Planning Approach: This approach can be credited to the Swedish architect Krimgold (1974). Krimgold does emphasise the need to apply disaster planning to longer-term considerations but does not see the disaster process as a continuum. He argues that predisaster planning is a more important consideration than relief aid after a disaster event where the latter should be seen as part of this planning. Krimgold sees predisaster planning as including longer-term mitigative and preventive measures and views it as a significant part of development planning to be utilised in those countries with highly vulnerable populations. This approach comes closest to effective precautionary planning but one problem will always be the integration of the various activities involved. Effective planning cannot be exercised on a multidisciplinary base.

19.4. To overcome this it is necessary to create an interdisciplinary base. The Disaster Research Unit attempted to develop such a base. It argued that local resource utilisation is an important part of any attempt at planning within an underdeveloped country. Indigenous resources were defined as everything present within a particular locality and included infrastructural and administrative elements.

19.5. Precautionary planning (originally conceived of as predisaster planning) was seen by the Disaster Research Unit as:

> "...a comprehensive precautionary strategy ranging from administrative contingency planning, strengthening of buildings and revision of building codes,

> flood plain control and land use zoning to the technology of warning systems and psychology of response to them. These precautions will be prepared for a known vulnerability and analysed risk. Furthermore, the economic impact of natural disaster events can be explored (and their role in a condition of low development examined) in an assessment of losses from past disasters and a forecast of probable future losses".
>
> (Lewis, 1975).

Basically, precautionary planning is a policy implementation over time which sets its objectives in the form of targets for mitigating the effects of disaster by a comprehensive co-ordination of indigenous resources and infrastructure.

19.6. With the apparent increase in the number of disaster occurrences in the developing countries, it is important that precautionary planning recognises the association of a high degree of disaster vulnerability with under-development. Precautionary planning, thus, should quite properly find its place within development planning to act as an insurance of the development process. In this way, precautionary planning can aid the reduction of overall vulnerability rather than concentrate on short-term relief measures after disaster events which tend to be palliatives and could even exacerbate vulnerability as a whole.

19.7. Initially, precautionary planning identifies three stages:

a. Policy
b. Strategic planning
c. Detailed planning.

Firstly, it is necessary to make governments and other institutions aware of the possibilities of precautionary planning. Secondly, when this awareness is current, then it is possible to produce a strategic plan. Thirdly, the detailed plan follows with its core as the co-ordination and utilisation of indigenous resources. The knowledge necessary for this precautionary planning process is of an interdisciplinary nature and includes detailed analyses to discover the disaster context (vide 1.16) and the disaster environment (vide 1.16.). After the written plan it is imperative that the plan be implemented and not exist purely as an academic exercise. The implementation will quite obviously take place within

short-term, medium-term and long-term phases with the short-term phase constantly under review and the implementation of the long-term coincidental with the implementation of the short- and medium-term phases.

19.8. Planning is an activity in the present for the future. Precautionary planning, like development planning, is essentially a long-range planning activity to reduce the disaster vulnerability of a population. The aim is similar to that of development planning, i.e. increasing human welfare in the form of an ability to absorb disaster effects. Medium-term measures (such as land-use zoning) are also necessary to reduce vulnerability, as are short-term measures to provide immediate relief after a disaster event.

19.9. The time phases of precautionary planning can be represented as:

Prevention

Precautions for mitigation - physical precautions within building and planning/land-use zoning.

Precautions for warning - social precautions - warnings and associated advice.

DISASTER

Emergency - during and immediately after the disaster event.

Rehabilitation - emergency housing and provision of food and water.

Reconstruction - rebuilding and reconnection of utilities and services.

This scheme accepts the fact that disaster is likely to occur given that total prevention, which presupposes control of natural phenomena, is unlikely in the near future. The reconstruction phase is carried out whether there has been a disaster event or not and can generally be referred to as development. However, this phase should not ignore the probable damaging effects of disaster events. The essence of precautionary planning is thus to be found in physical and social precautions, emergency measures and rehabilitation.

The latter two phases depend entirely on what happens during a disaster event and can be covered in short-term precautionary planning only by contingency planning - the identification and preparation of a range of aids to decision-making during and immediately after a disaster event. Long-term precautionary planning will be incorporated into the rehabilitation phase.

19.10. In the overall context of the country of occurrence, a disaster event may be national, regional or local in the extent or severity of its impact. Variations in severity and/or impact imply certain needs for a population. These needs can be a combination of

a. Immediate bodily needs
b. Social organisational needs, and
c. Physical infrastructural needs

dependent on the degree of disruption.

19.11. The preceding paragraphs can be summarised as follows:

a. The disaster phases for planning activity:

1. Prevention	DISASTER	4. Emergency
2. Precautions: physical		5. Rehabilitation
3. Precautions: social		6. Reconstruction

b. The phases distilled for immediate purposes into:

1. Precautions: physical and social

2. Emergency
3. Rehabilitation

} Contingency planning

c. Disaster events may be national, regional or local and may affect a population's immediate bodily needs, social organisation, and/or physical infrastructure.

d. Precautions may be expanded into:

1. Short-term - social - warnings
2. Medium-term - physical - land-use zoning and construction
3. Long-term - development

e. In the actual precautionary planning process, the disaster phases become irrelevant as predisaster planning is seen as

a continuing activity concentrating on contingency planning and precautions within development.

19.12. If the need for planning is accepted, then the need for precautionary planning is obvious. The approach to precautionary planning must be to incorporate it within a development planning framework. Such an incorporation would mean that development planners could conceive the risk involved in development programmes, but more importantly that precautionary planning could avoid the pitfalls experienced by development planning. Examples of precautionary planning strategies that might be utilised in developing countries, together with a brief survey of the problems of planning in these countries, will be found in the section following.

REFERENCES

KRIMGOLD, F. (1974) Predisaster Planning: The Role of International Aid for Predisaster Planning in Developing Countries. Avdelningen för Arkitektur, Kth Stockholm Skrift.

LEWIS, J. (1975) Proposals for a Working Method of Indigenous Resource Co-ordination as Part of a Predisaster Plan. University of Bradford, Disaster Research Unit, Occasional Paper No. 3.

20. PREVENTIVE PLANNING FOR DISASTERS - A LONG TERM STRATEGY?

20.1. Certain sections in this book have stressed that according to available figures, the poorer countries are suffering from increasing disaster. Within these countries it is that large proportion of the population existing on the margins - the marginalised - who are most vulnerable to future disaster events. Such a viewpoint of disaster should encourage precautionary planning to mitigate the effect of future disaster. The concentration of such planning should be on the vulnerability of a population to future disaster. This emphasis on precautionary planning does not obliterate the necessary valuable action in an immediate post-disaster scenario. In the long run, however, precautionary planning will be more beneficial than relief work; it is important to consider and alleviate the causes and not merely the symptoms of disaster. The design of a successful precautionary plan can only be achieved if the orientation of the plan is focused on the population's vulnerability. Successful precautionary planning depends upon the identification of cultural attitudes towards the use of indigenous resources at local and regional levels and the incorporation of disaster mitigation strategies into development planning. In fact, precautionary planning should be seen as the insurance chapter in any development plan, delimiting the boundaries within which development can occur.

20.2. The average cost of a disaster strike, a rather meaningless concept when the range of impact is so great, is about 20 million dollars. It is sufficient to say that more than 1133.9 million dollars was spent on disaster assistance in 1973; 96 countries of the world had less than this amount of resource capital as GNP in 1973. The time is ripe for some form of precautionary planning which considers vulnerability of the population as the real cause of disaster; a vulnerability that is induced by socio-economic conditions that can be modified by man is not just an "Act of God". Precautionary planning must commence by the removal of the concepts of naturalness from natural disasters. (O'Keefe et al, 1976.)

20.3. The Problems of Planning

Before assessing the necessary requirements for a successful approach to precautionary planning for disaster, it is necessary to discuss briefly some of the problems encountered by development planning in underdeveloped countries. The reason for this is not merely that disaster planning is closely associated with development planning but that it is an integral part of the latter if only because both planning approaches should have as their aim the decrease of socio-economic vulnerability.

20.4. Planning is a relatively recent development in its wholesale application to national economies. As large areas of the world gained their independence, "development" became an important priority. The early attempts by the U.S.S.R. revealed the viability of the planned economy and since 1952, when India introduced its first five-year plan, virtually every underdeveloped country has seen fit to adopt planning techniques as the best method of securing development. However, a growing cynicism has emerged regarding the efficacy of planning as it is seen that although plan has succeeded plan in rapid succession, none of them have been implemented to any effect. The reasons for this cynicism do not necessarily lie in the plan itself or in the commitment to planning but rather in the attitudes prevailing in a country which supersede and often eliminate the intentions of the plan. Three reasons emerge:

a. The plan is normally prepared by experts from developed countries with no indigenous roots.

b. Planners have, in the main, been economists who thus tend to produce documents whose contents are narrow-minded and take little account of the social or political conditions that prevail.

c. In assessing the economic context, planners are applying themselves, in the main, to an economic system which emanates from the developed world which answers questions posed by the ruling elite in an underdeveloped country who tend to retain the vestiges of previous colonial rule. The questions posed by the mass of the rural population tend not to be answered by reference to such an economic and value system

because their approach to resources and environment is likely to be very different although they are seen as part of the political and economic system operated by the ruling elites of these underdeveloped countries.

20.5. Planners must not underestimate the capacity of any society to meet problems and to successfully cope with them. This is particularly so with reference to underdeveloped countries. The indigenous capacity to solve problems is immediately violated when planners are brought in from outside without a knowledge of the true nature of the economic, social and political framework within which their work will have to take effect.

20.6. It is important to recognise that development planning implies the purposeful direction of human activities. Underdeveloped countries may be said to have generalised characteristics which set them apart from the developed world. Yet the latter, through former colonial linkages, tends to operate in the underdeveloped countries in a way which assumes the predominance of the developed framework. This leads to planning practices which may be alien to indigenous needs.

20.7. Development planning is essentially the promotion of political power. However, in order to be of maximum use, the political sector requires to have as its objectives, practical and tangible concepts and goals which are seen to have value by the indigenous population. Nebulous concepts such as "growth" have little meaning to a rural subsistence population whereas a project aiming at increasing output based on the constraints within which the population operates would probably have significant meaning.

20.8. Development planning has tended to utilise models developed for the more sophisticated societies of the western world. In poor, dependent, monocultural underdeveloped societies, many of these concepts have little meaning. Planning should concentrate on what is appropriate to a particular country in terms of its coming to an understanding of its own environment. Many models gained from the West are inappropriate to meaningful development.

With these important points in mind, let us now look at some of the principles necessary for effective precautionary planning for disaster in underdeveloped countries.

20.9. The Necessary Principles for Effective Disaster Planning

Major disasters kill many people and leave thousands homeless every year. The immediate requirements of a disaster-stricken population are obvious - they require food, shelter and clothing. Requests from the stricken country for these requirements are taken up by international organisations and governments who generally supply the items required. Consequently, the suffering of the people can be relieved. Is it correct to assume, however, that, by channelling available resources into relief after disaster, the disaster problem has been solved for a population? Does this relief affect their vulnerability to future disaster occurrence?

20.10. Shelter and food are two basic requirements of a disaster-stricken population. Calls for shelter are answered by the provision of tents or pseudo-tents. It is usual to find that these temporary housing measures become permanent; tented villages still exist some months, or even years, after the disaster has occurred (Davis, 1975). Similarly, massive supplies of relief food discourage local farmers from cultivating land and encourage dependency on external food supplies. Such distortions of the existing socio-economic conditions can obviously increase the vulnerability of a population to further disaster.

20.11. To avoid increasing vulnerability, disaster relief policy must be reorientated towards the mitigation of future disaster occurrence to give developing countries a greater self-reliance in coping with disaster. This is not to say that immediate relief requirements are not vital. What is required is an understanding that as well as catering for the immediate needs of a disaster-stricken population government should consider the need for a continuing programme of disaster mitigation measures to be integrated into development plans, which will tend not only to decrease the population's vulnerability to disaster occurrence,

but also act as an insurance of the development plans themselves. Disasters interrupt development programmes to a great degree and appropriate mitigative measures can decrease the possible losses.

20.12. An Approach to Disaster Mitigation

Any disaster mitigation policy for developing countries must have at its core the promotion of self-reliance as far as possible. Such a policy should bear in mind five vital points:

a. Disasters are not just isolated events but are recurring phenomena; for example, Managua was damaged by earthquakes in 1885, 1931, 1968 and 1972. An earthquake can therefore be expected at some time in the future. This fact tends to be reflected in the lives of the population to a greater or lesser degree, depending on the frequency of occurrence. The population, consciously or unconsciously, respond in their everyday lives by action or attitude, to the future earthquake threat. Disaster is, thus, a continuing process. Just as this fact is often reflected in local attitudes, so equally it should be reflected in disaster aid.

b. Efforts at the provision of adequate defences against disaster should concentrate on the promotion of self-reliance. This implies the utilisation of local resources and technologies. Selective foreign technology, methods and ideas should only be utilised where they are appropriate to the culture and resource utilisation of the local population.

c. In developing countries it is essential that attempts at disaster mitigation be incorporated into development planning as an insurance of development. It has already been stated that disaster should be seen as a continuing process. Development planning is also a continuing process and disaster mitigation strategies quite properly should find their place within this development strategy and not be considered as an isolated exercise.

d. Vulnerability is not a static concept. Populations have different levels of vulnerability depending upon their biophysical conditions and socio-economic status. Evidence shows that the locations of prime importance for sustained mitigative activity should be those areas where the populations' vulnerability to disaster is greatest because its

socio-economic status is low. This concentration on socio-economic status is a more important consideration than the intensity of the disaster agent.

e. Disaster must always be seen against a backcloth of normal everyday activity. Conditions of risk can only be understood by examining the economic ecology of resource management within any vulnerable situation.

20.13. These five points should act as guidelines for a successful disaster mitigation strategy. The following examples give an indication of some elements of this strategy.

i. The survey and analysis of local adjustments to the particular hazard or hazards involved. Adjustment refers to the response made by an individual or community in the face of potential disaster which aims to counteract the occurrence of actual disaster; for example, the movement of cattle from low land to higher land in anticipation of an annual spring flood. These local adjustment processes should be encouraged wherever possible and only mixed with foreign methods or technologies where the latter can aid in securing the appropriate strategies for that particular population (Wisner et al, 1976)

ii. A survey and analysis of local attitudes to potential disaster. These attitudes, such as fear, resignation, etc. can have a great bearing on information and education programmes. Ignorance of these attitudes can lead to wrong decisions being taken and harmful strategies being adopted (Westgate, 1975).

iii. A survey and analysis of the effect of potential disaster on local economies. In most cases, the industrial sectors of the economy will have some degree of protection even in developing countries. It is essential that attention be focused on the damage potential to the rural population who, in the majority of developing countries are the largest single sector of the population and whose economic contribution is often the largest single factor in national production. With an orientation towards this rural population, not only will overall vulnerability to disaster decrease, but real development will be stimulated (O'Keefe, 1975).

20.14. These examples show some areas where aid can contribute to successful disaster mitigation instead of a short-term relief programme which treats the immediate symptoms and not the causes of true disaster and only temporarily alleviates the situation. The immediate requirements of a stricken population in the first instance, can be adequately accommodated by self-help, which is usually underestimated, and by voluntary agencies whose appeal for public support requires immediate and visible results. Government aid should orientate itself to the identification of disaster potential and the mitigation of future disaster occurrence by the promotion of appropriate measures. In all cases, a successful disaster mitigation programme must result in self-reliance wherever possible, within a comprehension of local cultural attitudes and traits, must be seen as a part of development planning and not as an isolated and separate process, and must consider 'disaster' as an ongoing phenomenon and not as a series of isolated events.

REFERENCES

DAVIS, I. (1975) "Skopje Rebuilt: Reconstruction Following the 1963 Earthquake." Architectural Design, November, pp. 660-663.

O'KEEFE, P. (1975) Gakarara: a Study in the Development of Underdevelopment. Occasional Paper No. 6, Disaster Research Unit, University of Bradford.

O'KEEFE, P.; WESTGATE, K.; WISNER, B. (1976). "Taking the Naturalness out of Natural Disasters." Nature, Vol 260, April 15, pp. 366-367.

WESTGATE, K. (1975) "The Human Response to Disaster." Unpublished M.Sc. Thesis, Postgraduate School of Planning, University of Bradford.

WISNER, B.; O'KEEFE, P.; WESTGATE, K. (1976). "Global Systems and Local Disasters: the Untapped Power of People's Science." Disaster, Vol. 1, No. 1. (forthcoming)

APPENDIX I

DESCRIPTIONS OF THE LISBON EARTHQUAKE OF 1755 FROM MR. BRADDOCK, AN ENGLISH RESIDENT OF THE CITY.

"....the whole house began to shake from the very foundation, which I at first imputed to the rattling of several coaches in the main street, but on hearkening more attentively, I was soon undeceived, as I found it was owing to a strange, frightful kind of noise underground resembling the hollow distant rumbling of thunder..... but in a moment I was raised from my dreams being instantly stunned with a most horrid crash as if every edifice in the city had tumbled down at once. The house I was in shook with such violence that the upper stones immediately fell.... it was with no small difficulty I kept my feet and expected nothing less than to be soon crushed to death..... the sky in a moment became so gloomy that I could now distinguish no particular object, owing no doubt to the prodigious clouds of dust and lime raised from so violent a concussion..... I found myself choked for near ten minutes."

At the riverbank Mr. Braddock located a "...prodigious concourse of people of both sexes and of all ranks and conditions among whom I observed some of the principal canons of the Patriarchal Church, in their purple robes..... several priests who had run from their altars in their sacredotal vestments in the midst of their celebrating mass; ladies half dressed and some without shoes. All were on their knees at prayers, with the terrors of death in their countenances."

Mr. Braddock goes on to describe the effects of a seismic sea-wave which swept up the river Tagus following a second tremor: "In the midst of our devotions the second great shock came, little less violent than the first, and completed the ruin of those buildings which had already been much shattered..... Turning my eyes towards the river which in that place is more than four miles broad, I could perceive it heaving and swelling in a most unaccountable manner. In an instant there appeared at some small distance a large body of water, rising as it were like a mountain. It came on roaring and foaming and rushed towards the shore, with such impetuosity that we all immediately ran for our lives as fast as possible. Many were actually swept away, the rest up to their waists in water at a good distance from the banks."

"I could hardly take a step without treading on the dead or dying... some had their backs or thighs broken, others vast stones on their breasts, some lay in the rubbish and crying out in vain to the passengers for succour. A gentleman told me that going into town a few days after the earthquake he saw several bodies lying in the streets some horribly mangled as he supposed by dogs."

Source: NIDDRIE, D.C. (1961). When the Earth Shook. Hollis and Carter, London.

APPENDIX II

FOLKSONGS OF INDUSTRIAL DISASTER

1. Johnny Seddon

As I went out in summertime all for to take the air,
I saw a handsome maiden down by the river clear,
She wept and she lamented, and bitterly she cried,
Saying: "My curse upon the cruel mine where Johnny Seddon died."

My lad he was a collier lad and wrought beneath the ground.
For modest mild behaviour his equal can't be found.
His teeth as white as ivory, his cheek a rosy red,
But alas, my handsome collier lad lies numbered with the dead.

Last night as I lay on my bed I fell into a dream.
I dreamed a voice came unto me and called me by my name,
Saying, "Jeannie, lovely Jeannie, for me you need not mourn,
But the cruel stones do crush my bones and I'll never more return."

Early the very next morning my dream was clarified.
The neighbours all came running in. "Johnny Seddon's dead" they cried.
"As he was at his work last night, the roof upon him fell."
The grief and sorrow of my heart no mortal tongue can tell.

Come all you pretty fair maids, I hope you'll lend an ear,
For the grief and sorrow of my heart is more than I can bear.
For once I loved a collier lad, and he loved me also,
But by a fatal accident, he in his grave lies low.

2. From: "The Blantyne explosion"

"The explosion was heard; all the women and children
With pale anxious faces they haste to the mine.
When the truth was made known, the hills rang with their mourning.
Three hundred and ten young miners were slain."

3. From: "The Donibristle Moss Moran Disaster"

They lost their lives, God help them. Ah yes, it was a fact.
Someone put in a stopping, and they never did get back.
Was that not another blunder? My God, it was a sin.
To put a stopping where they did, it closed our heroes in.

We never shall forget them, though they have lost their lives,
So let us pay attention to their children and their wives.
It simply is our duty now, and let us all beware;
Their fathers died a noble death and left them in our care.

4. From: "The Gresford Colliery Disaster"

A fortnight before the explosion,
To the shotfirer Tomlinson cried:
"If you fire that shot we'll all be blown to hell",
And no one can say that he lied.

The fireman's reports they are missing,
The records of forty-two days;
The colliery manager had them destroyed
to cover his criminal ways.

Down there in the dark they are lying.
They died for nine shillings a day.
They have worked out their shift, and now they must lie
In the darkness until Judgement Day.

The Lord Mayor of London's collecting
To help both our children and wives.
The owners have sent some white lilies
To pay for the poor colliers' lives.

5. "The Trimdon Grange Explosion"

Oh, let's not think of tomorrow lest we disappointed be.
Our joys may turn to sorrow as we all may daily see.
Today we may be strong and healthy, but soon there comes a change,
As we may see from the explosion that has been at Trimdon Grange.

Men and boys left home that morning for to earn their daily bread,
Nor thought before the evening they'd be numbered with the dead.
Let's think of Mrs. Burnett, once had sons but now has none -
By the Trimdon Grange explosion, Joseph, George and James are gone.

February has left behind what will never be forgot;
Weeping widows, helpless children may be found in many
a cot.
They ask if father's left them, and the mother hangs her
head,
With a weeping widow's feelings tells the child its
father's dead.

God protect the lonely widow and raise each drooping head;
Be a father to the orphans, never let them cry for bread.
Death will pay us all a visit, they have only gone before.
We'll meet the Trimdon victims where explosions are no
more.

6. "Rap her te bank"

Rap her te bank, me canny lad!
Wind her away, keep tornen.
The backshift men are gannen yern.
Aa'll be back in the mornen.

Me feyther used to caal the tom
When the lang shift wes ower.
Aal the way ootbye ye'll heor him cry:
D'ye knaa it's eftor fower?

Rap her te bank, me canny lad!
Wind her away, keep tornen!
The backshift men are gannen yern.
Aa'll be back in the mornen.

And when that aaful day arrived,
The last shift for me feyther;
A faal of stones and brokken bones,
But still above the clatter, he cried:

Rap her te bank, me canny lad!
Wind her reet slow - that's clivvor!
This poor aad lad is tekken bad.
Aa'll be back heor nivvor.

Source: LLOYD, A.L. (1975). Folksongs in England. Paladin.

APPENDIX III

INDICES USED IN THE DESCRIPTION OF EARTHQUAKES

Source: Boulder, Colorado Earthquake Research Society

Earthquakes	-	violent vibrations that shake the earth.
Foreshocks	-	from minor fault movement that precedes a major shock, can be a considerable length of time in advance, epicenter may be somewhat removed from that of major displacement, no recognizable pattern.
Major Shock	-	the one that results in greatest displacement along a fault - may not be able to identify until after series of shocks have run their course.
After Shocks	-	follow major shock, strength varies with size of main shock, number will increase as magnitude of shock increases.
Tectonic Earthquakes	-	shocks caused by sudden rupture or rock slips and elastic recoil along deep faults.
Volcanic Earthquakes	-	shocks resulting from volcanic activity - violent subterranean explosion.
Faults	-	a fracture or fracture zone along which there has been displacement of the two sides relative to one another parallel to the fracture. The displacement may be a few inches or many miles. They may or may not be visible from the surface.
Focus	-	point of origin of an earthquake within a fault where it begins to slip.
Deep Focus	-	at depths as great as 400 miles.
Intermediate Focus	-	at depths from 27 to 150 miles.
Shallow Focus	-	at depths less than 27 miles.
Epicenter	-	a point on the earth's surface directly above the focus of an earthquake - not necessarily along the fault line (such as when fault plane does not run perpendicular to the surface).

Earth's Crust - outer shell of the earth - extends to a depth of 25 miles (rather brittle).*

*Above depths and compositions from "Elements of Geology" by James H. Zumberge.

Earth's Mantle - section of earth beneath the crust extending about 1800 miles deep (basically rock which is plastic and flows under pressure).*

Earth's Core - outer section of central core of earth around 1360 miles deep; inner section around 815 miles deep (believed to consist of iron and nickel).*

*Above depths and compositions from "Elements of Geology" by James H. Zumberge.

Richter Magnitude Scale - system for measuring energy released by an earthquake developed by Dr. C.F. Richter. "The magnitude of any shock is taken as the logarithm of the maximum trace amplitude, expressed in microns (thousandths of a millimeter) with which the standard short-period torsion seismometer would register that shock at an epicentral distance of 100 kilometers (62 miles)." The scale begins at "0" with no specific upper limit. "0" does not necessarily mean no earthquake but is one whose strength at greatest amplitude will register no more than one micron (about .04 thousandths of an inch) at a seismograph station 100 kilometers from the epicenter.

Modified Mercalli Intensity Scale - a system to indicate the degree of damage caused by earthquakes. It is indicated by a Roman Numeral.

Rossi-Forel Scale - another scale to measure damage intensity - generally superceded by the Mercalli scale.

Tsunami (soo-nom-ee) - seismic sea waves, the destructive oceanic offspring of earthquakes and volcanic eruptions (erroneously referred to as "tidal waves"); two main categories are storm waves and seismic waves.

Storm Waves - catastrophic wind - generated waves accompanying wind systems such as hurricanes and typhoons.

Seismic Wave - produced by earthquakes and displacement of submarine blocks of the earth's crust.

Uniform Building Code	-	adopted by International Conference of Building Officials (establishes standards for soil engineering, foundation design and construction design) which is recommended for adoption by municipal and state governmental agencies.
National Building Code	-	adopted by National Board of Fire Underwriters, stresses fire control and life safety.
Seismograph	-	a vibration measurement instrument; consists of a seismometer, a recorder and a timer.
Seismometer	-	the transducer that converts mechanical motion of the ground to a signal of some type.
Seismogram	-	the written record of a seismograph; it gives particle velocity.
Seismoscope	-	simple instrument for measuring motion in a single component.
Strong Motion Seismograph	-	an instrument for measuring motion in three simultaneous components.
Seismology	-	study of shakes or earthquakes; also study of wave motion.
Frequency	-	number of cycles per second.
Period	-	time for one complete cycle.
Wave Velocity	-	rate at which disturbance propagates through the medium.
Particle Velocity	-	the rate at which the constituent particles of the medium oscillate above their equilibrium position when excited by wave energy.
Transcient Type Wave-		characteristic of mediums response to a sudden pulse-like excitation (such as a blast).
Periodic Type Wave	-	repetitive in nature, recurring in exactly the same form at fixed time increments (the simplest type is called harmonic or sinusoidal), such as pile driving or delay element blasting.
Random Type Wave	-	amplitude of vibration is predictable only on a probabilistic basis, such as seismic background noise (called microseisms).

Standing Wave - result when superpose 2 harmonic waves of same amplitude, frequency and propagation velocity but travelling in opposite direc tions.

Types of Elastic Waves - body waves and surface waves.

Fundamental types of Deformation of an elastic body are:

Compression and shear
Compression alters volume but not shape
Shear alters shape but not volume
These deformations are transmitted as body waves.

Compression Waves - the "P" wave, primary, or first to arrive, has highest velocity.

Shear Wave - the "S" wave, secondary, arrives after the P wave.

P Wave - is in line of direction of wave, does not show up in transverse component.

Transverse Component gives arrival of S wave.

Surface Waves are of two fundamental types: Rayleigh and Love waves.

Rayleigh Waves - velocity about 0.9 that of S wave, come in after the S wave, particle motion on the surface is elliptical (up and forward, down and backward).

Love Waves - velocity approaches that of shear waves, velocity is greater than Rayleigh waves, particle motion is in horizontal transverse only.

Zones - used to describe areas of probable earthquake damage and also to describe construction requirements for such areas.

Zone 1 = No damage

Zone 2 = Minor damage

Zone 3 = Moderate damage

Zone 4 = Heavy damage

Source: MUKERJEE, T. (1971). Economic Analysis of Natural Hazards: a Preliminary study of Adjustments to Earthquakes and their Costs. Natural Hazard Research Working Paper No. 17, University of Colorado, Institute of Behavioural Science, Boulder.

APPENDIX IV

a. DEFINITIONS OF TERMS USED IN THE DESCRIPTION OF TROPICAL STORM ACTIVITY

Cyclones - any atmospheric system in which atmospheric pressure diminishes progressively to a minimum value at the centre and toward which the winds blow spirally inward from all sides, resulting in a lifting of air and eventually in clouds and precipitation. Cyclones are the Lows of weather maps. Circulation in a cyclone is counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere. The name does not suggest any degree of intensity and is applied to moderate as well as intense storms. Cyclones are divided into tropical and extratropical groups, depending upon characteristics of the surrounding air masses. The hurricane is a tropical cyclone, and is the most ideal vortex in the atmosphere.

Anticyclone - an area of high pressure from the centre of which air spirals out in all directions, implying sinking air and good weather. Cold anticyclones are those which move rapidly south or southeastward out of the polar regions and are comparatively shallow or short-lived. Warm anticyclones like the Azores-Bermuda High are deep systems extending high into the upper atmosphere and are often stationary or quasi-stationary over the oceans. Their influence on atmospheric processes is profound; the Azores-Bermuda anticyclone's oscillations produce changes in continental United States weather and affect the tracks of hurricanes.

Convection - vertical motion produced by thermal or mechanical instability in the atmospheric column. Free convection is that produced by differences in density of layers within a fluid system, as when dense cold air overlies less dense warm air and overturning of the layers occurs. Forced convection is more mechanical than thermal, as when inflowing air at low levels forces air upward. The circulation in a tropical cyclone is a combination of free and forced convection.

Coriolis force - the apparent force imparted by the earth's rotation that deflects moving objects to the right in the Northern Hemisphere, and to the left in the Southern Hemisphere. The coriolis force is proportional to the speed of motion and increases with distance from the Equator.

Inversion - in meteorology, a departure from the usual decrease or increase with altitude of the value of an atmospheric property, and, also, the layer through which this departure occurs. As used here, inversion refers to a departure from the normal cooling of air with increasing height at low and intermediate altitudes; from the base of the inversion, air grows warmer with increasing altitude until the inversion is passed, after which the air cools normally with increasing height.

Eddy - a circulation within a fluid mass that has a certain integrity and life history of its own.

Trough - in meteorology, an elongated area of relatively low atmospheric pressure, commonly used to distinguish this from the closed circulation of a cyclone; a large trough may include one or more Lows, an upper-air trough may be associated with a lower level Low, and a Low may have one or more distinct troughs radiating from it.

Ridge - the opposite of a trough, an elongated area of relatively high atmospheric pressure, commonly used to distinguish this from the closed circulation of an anticyclone; a ridge may include a High, an upper-air ridge may be associated with a surface High, and a High may have one or more distinct ridges radiating from its centre.

Tropics - the region between the Equator and Tropic of Cancer in the Northern Hemisphere and the Tropic of Capricorn in the Southern Hemisphere. The two Tropics are respectively the northernmost and southernmost positions to receive the perpendicular rays of the sun during the year. Their latitudes ($23^{\circ}27'$ north and south) correspond to the inclination of the earth on its axis.

Tropical cyclones - the general term for cyclones that originate over the tropical oceans, from tropical disturbance to hurricane or typhoon.

b. TROPICAL CYCLONE CLASSIFICATION

Tropical Cyclone	-	is the general term for all cyclonic circulations originating over tropical waters, classified by form and intensity as follows:
Tropical disturbance	-	rotary circulation slight or absent at surface but sometimes better developed aloft, no closed isobars (lines of equal atmospheric pressure) and no strong winds, a common phenomenon in the tropics.
Tropical depression	-	one or more closed isobars and some rotary circulation at surface, highest wind speed 39 miles per hour (34 knots).
Tropical storm	-	closed isobars, distinct rotary circulation, highest wind speed 39-73 miles per hour (34-63 knots).
Hurricane	-	closed isobars, strong and very pronounced rotary circulation, wind speed of 74 miles per hour (64 knots) or more.

Source: U.S. Department of Commerce, National Oceanic and Atmospheric Administration (1971). Hurricane - the Greatest Storm on Earth. Washington D.C.