I S S N 0386 – 5878
Technical Memorandum of PWRI
No. 3985

Technical Report on Global Trends of Water-related Disasters

October 2005

Secretariat for Preparatory Activities of
UNESCO-PWRI Centre

Public Works Research Institute (PWRI)

Technical Report on Global Trends of Water-related Disasters

Tarek Merabtene
and
Junichi Yoshitani

Synopsis:

The aim behind this research is to develop our understanding of the relations between water-related disasters and their impacts on society, so as to improve policies for hazards mitigation. This technical report presents the results of our assessment and analysis of water-related disasters during the past four decades (1960 to 2004) in particular as reported in the OFDA/CRED Emergency Disaster Database (EMDAT), University of Louvain, Belgium. The results presented in graphics and tabular forms for each type of water-related disasters allow the reader to evaluate the current state of the global and regional trends. The outcome of the report puts emphasis on numbers of emerging issues and challenges for the concrete evaluation of social and economic vulnerabilities to water-related disasters. The findings introduced in this study were presented in front of the UN Expert Group on Risk Management led by WMO and ISDR for consideration during the production of the 2nd Edition of the World Water Development Report (WWDR) managed by the Secretariat of the UN-World Water Assessment Programme (UN-WWAP) hosted by UNESCO.

Keywords: OFDA/CRED EMDAT, trend of disaster, water-related disaster, flood, windstorm, landslide, drought, famine, epidemic water-related, technologic water-related disaster.

Table of Contents

Foreword ..... **vi**

Acknowledgments ..... **viii**

Preface ..... **x**

List of Tables and Figures ..... **xiv**

List of Figures xiv

List of Tables xvi

Chapter 1: Background and Objectives **1**

1.1. Introduction 1

1.2. Methodology 3

Chapter 2: The Global Disasters Database EMDAT **7**

2.1. General criteria 7

2.1.1. EMDAT Sources of Data 7

2.1.2. Events Entry Criteria 8

2.2. EMDAT typology of disasters and structure of the database 9

2.3. EMDAT data quality and limitations 13

Chapter 3: Global assessment of human disasters **15**

3.1. Trends in natural disasters 15

3.2. Assessment of the social impact of natural disasters 22

3.2.1. Trend of the number of dead people 22

3.2.2. Trend of the number affected people 28

Chapter 4: Trends Analysis of water-related disaster **31**

4.1. Trends of water-related disasters 31

4.2. Regional assessment of social impacts of water-related disasters 46

Temporal trend analysis based on each decade 46

Temporal trend analysis based on each 5-year period 52

4.2.1. Regional trends of killed people by type of water-related disasters 57

4.2.2. Regional trends of affected people by water-related disasters 66

Chapter 5. Technical aspects and challenges ahead **79**

Appendix **89**

Annex 1: National, Regional and International disaster databases 95

Annex 2: EMDAT Water-related Disaster Glossary 97

Annex 3: Processed Five-year data series of EMDAT data 1960-2004 100

Annex 4: Largest Disastrous Events: EMDAT data from 1900 to 2004 117

A: Top 100 disastrous events in terms of killed people 117

B: Top 100 disastrous events in terms of affected people 119

References **123**

Foreword

Water-related disasters afflict our societies in different forms and have continuously taken an enormous toll on our socio-economic development. The increasing trend of negative socio-economic impact worldwide affirms that there is a shortage of effective disaster preparedness and mitigation methods. This global shortage is due not only to the fact that risk reduction is not yet properly implemented as an integral part of water resource management, but also to the social, economical and political factors that force people to live in risky areas. To achieve our goals for sustainable development there are emerging needs to develop novel concepts and management strategies to tackle the multifaceted complex issues hampering our progress in water-related disaster mitigation.

The development of strategic processes for water hazards mitigation requires a solid base of concrete assessment and understanding of the risk levels that our societies are facing. A holistic risk management approach is essential to build sound and sustainable policies for mitigation of water-related disasters. A critical step forward in this direction is to develop and sustain a reliable water-related disaster database to assess the vulnerability of people and property to each type of water-related disasters and propose tailored adaptive actions to secure sustainable development.

Under our current preparatory activities for the establishment of the International Centre for Water Hazard and Risk Management under the auspices of UNESCO (ICHARM), research on flood risks and policy analysis has been initiated by the Secretariat of ICHARM. This research is also part of our active collaboration to the United Nations World Water Assessment Programme (WWAP) hosted by the UNESCO headquarters in Paris. In addition to the Japan Case Study prepared for the second World Water Development Report and coordinated by the Ministry of Land, Infrastructure and Transport (MLIT), our institute is taking active participation to support the UN-Expert Group on Risk led by the World Meteorological Organization (WMO) and the United Nation International Strategy for Disaster Reduction (UN-ISDR).

This technical report presents the first results of the investigation conducted by the authors to analyze the global and regional trends of water-related disasters and their social impacts during the past decades based on OFDA/CRED disaster database developed at the University of Louvain, Belgium. I welcome readers from all over the world to evaluate through the results presented in this report the emerging needs for further research, information sharing and capacity building in the field of water hazard and risk management. Today, the world is convinced that the need for a strong platform of cooperation to share science, knowledge bases and expertise, is more valuable than ever before. I invite you all to join Japan collaborative leadership in this direction through your support and contribution to the mission of the international center to ensure a safer world and build more resilient nations against water-related disasters.

Dr. Tadahiko Sakamoto

Chief Executive
Public Works Research Institute (PWRI)

Acknowledgments

The authors acknowledge the valuable advice of the anonymous reviewers. We also acknowledge the comprehensive and high quality work of the people of the Centre for Research on Epidemiology of Disasters (OFDA/CRED) of the University of Louvain, Belgium, for creating and maintaining the Emergency Disasters Database (EMDAT) and for their initiative to make it open to public and accessible free of charge via their web site (http://www.em-dat.net).

We would like to thank all individuals and organizations working in the field of natural disasters and risk management, namely the United Nations Educational, Scientific and Cultural Organization (UNESCO), the World Meteorological Organization (WMO), the UN International Strategy for Disaster Reduction (UN-ISDR), the United Nations Environment Programme (UNEP), the United Nation Development Programme (UNDP), The Asian Disaster Reduction Center (ADRC), the Social Studies Network for Disaster Prevention in Latin America (LA RED), and ReliefWeb, to site only few along many other national and regional centers, for their initiatives to make their work and publications publicly available in a digital format and accessible via the Internet.

Preface

Of all natural disasters, water-related disasters (i.e., floods, droughts and epidemic water related at the top of the list) are prevailing in number and their overwhelming consequences for the society and the environment cannot be overemphasized. The disaster database EMDAT reported that the number of people killed by flood and windstorms during the period from 1960 to 2004 was as high as one million people or about 20,000 people every year in average. The number of affected people by these two disasters during the same period was as high as 300 million people or about 7 million people every year in average. Dr. Jonas Bogardi, Director of UNU Institute for Environment and Human Security (UNU-EHS) warns that unless preventative efforts are stepped up worldwide, the number of people worldwide vulnerable to a devastating flood is expected to mushroom to 2 billion by 2050 due to climate change, deforestation, rising sea levels and population growth in flood-prone lands. (The newsletter of United Nations University and its international network of research and training centres/programmes, Issue32: July - August 2004).

Mitigation, alleviation, and reduction of water hazards are terminologies used alternatively to express a common focal objective that can be addressed as: to minimize the negative impacts of disastrous events on people and property in a way that ensures a stable society and sustainable progress. Many countries have developed at varying levels their respective capacities for disasters risk reduction and have put forward numerous preventive and mitigations actions. Nevertheless, the complex dynamics of water hazards determinants, both natural (such as climate variability) and human-made (such as population explosion in hazardous area), have increased the vulnerability of people and property to the wide diversity of water related disasters. In other words, the perennial toll on human lives and property challenges the effectiveness and sustainability of adopted policies for water-related disaster reduction and calls to search for innovative and holistic strategies for water-related disasters mitigation and risk management. To this end building a common platform to share knowledge and expertise among nations has become more crucial than ever before. Our experience in water-related disasters mitigation in Japan and other Asian countries confirms that there is a prevailing need for the water community to develop a more in-depth and common understanding of the mechanisms underlying the risks associated with each type of water hazards. The usefulness of coherent and comprehensive disaster databases as a fundamental information in the learning, planning and decision processes has become increasingly evident to many governmental and international agencies engaged in disaster management at both proactive and reactive stages.

This technical report presents the first phase of our assessment of the global and regional trends of water-related disasters and their social impacts. The assessment processed in this study is based on the Emergency Disaster Database (EMDAT) developed and maintained by the World Health Organization (WHO) Centre for Research on Epidemiology of Disasters (CRED) at the University of Louvain, Belgium. This work has been initiated as one of the contributions of the Public Works Research Institute (PWRI) to support the United Nations World Assessment Water Programme (UN-WWAP) hosted by UNESCO Headquarters. Our contribution to this collective effort, as members of the UN-Expert Group on Risk, is to provide input (as contributing authors) and technical assistance to the World Meteorological Organization (WMO) and the United Nations International Strategy for Disaster Reduction (UN-ISDR) during the development phases of the Second World Water Development Report (WWDR II).

The ultimate goal behind the assessment of the EMDAT database carried out in this report is to acquire and provide a more in-depth understanding of the global and regional social impacts of water-related disasters, specifically:

- to understand the relationship between the increasing trends of each individual type of natural and human-made water-related disasters and their social impacts (i.e., trends of killed people and affected people); and
- to develop our understanding of the future requirements to build standardized indicators in order to assist in the identification of the underlying risks from water-related disasters, perform policy analysis and evaluate the effectiveness of adopted measures in water hazard mitigation.

To this end, the present technical report is structured around five chapters supported by four related annexes. **Chapter 1** introduces and then briefly discusses the scope and range of our review assessment. EMDAT has been widely used as a reference database in natural and technological disasters and this introductory chapter addresses the fundamentals of our concepts in the assessment process of reported water-related disasters data.

Chapter 2 introduces the disaster database EMDAT of OFDA/CRED, University of Louvain, Belgium. This chapter in association with Annex1 brings together basic information to understand the structure and terminology of EMDAT database without major need to consult additional materials. Along with Annex 2, the chapter also introduces other major disaster databases and initiatives such as GLIDE of the Asian Disaster Reduction Center (ADRC). The end of the chapter put emphasis on our disclaimer on the quality of information processed and the limitation of the results of this investigation.

Chapter 3 offers a review of the global picture of reported disasters in EMDAT. In recent years in addition to natural disasters, technological (i.e., human made) disasters are drawing increasing attention due to their increasing pressures on human health, the natural environment and ecologic diversity. Therefore, this chapter also looks at the global distribution of this category of disaster. The overwhelming difficulties underlying the assessment process are clarified by a series of graphs and tables presented from different perspective analyses. Emphasis is put on the global assessment of the trends of disasters and their social impacts in terms of killed and affected people.

Chapter 4 exclusively focuses on the processing of water-related disasters divided into eight major types as defined within EMDAT, namely flood, windstorm, slide, wave and surge, drought, famine, epidemic water-related, and technological water-related hazards (reported under “epidemic” and “technological” types, respectively). The chapter analyzes the database from the global and regional perspectives and puts emphasis on the underlying complexity and confusion that may results during such an important exercise. The processed data on a 5-year period basis are given in Annex 3.

Chapter 5 gives an overview of the results presented and highlights from the authors’ viewpoints some important challenges and needs to build and promote comparable eminent initiative such as the EMDAT of OFDA/CRED but with focus and study-oriented to water-related disasters.

List of Tables and Figures

List of Tables and Figures

List of Figures

Figure 1.1. Flow chart of the reporting methodology
Figure 3.1. Economic loss by year and by disaster reported in EMDAT from 1900 to 2004.
Figure 3.2. Trend of the number of natural disasters per year: EMDAT from 1900 to 2004.
Figure 3.3. Global distribution of disasters by category and for each 5-year period: EMDAT from 1900 to 2004.
Figure 3.4. Moving average of the total number of killed people from 1900 to 2004.
Figure 3.5. Number of killed people by natural disaster from 1900 to 2004.
Figure 3.6. Temporal distribution of the number of killed people per year and per disaster from 1900 to 2004.
Figure 3.7. 100 and 200-event moving average of the total number of affected people from 1900 to 2004.
Figure 3.8. Total number affected people by individual natural disaster events 1900 to 2004.
Figure 3.9. Temporal distribution of the number of affected people per year and by disaster from 1900 to 2004.
Figure 4.1.a. Global distribution of water-related disasters vis-à-vis other types of natural disasters for the period from 1900 to 2004.
Figure 4.1.b. Global distribution of water-related disasters from 1900 to 2004.
Figure 4.2.a. Global distribution of water-related disasters for the period 1990-2004.
Figure 4.2.b. Global distribution of water-related disaster by continent for the period 1990-2004.
Figure 4.3. Trends of water-related disasters for each 5-year period since 1960 to 2004.
Figure 4.4. Trends of water-related disaster by continent for each 5 year period from 1960 to 2004.
Figure 4.5. Distribution of water-related disaster by continent from 1990 to 2004.
Figure 4.6. Trends of flood disaster by continent for each 5-year period: 1960-2004.
Figure 4.7. Trends of windstorm disaster by continent for each 5-year period: 1960-2004.
Figure 4.8. Trends of landslide and avalanche disaster by continent for each 5-year period: EMDAT 1960-2004.
Figure 4.9. Trends of wave and surge disaster by continent for each 5-year period: EMDAT 1960-2004
Figure 4.10. Trends of drought disaster by continent for each 5-year period: 1960-2004.
Figure 4.11. Trends of famine disaster by continent for each 5-year period: 1960-2004.
Figure 4.12. Temporal distribution of epidemic disasters versus epidemic water-related disasters for each 5-year period: EMDAT 1960-2004.
Figure 4.13. Distribution of epidemic water-related disaster by continent for each 5-year period: EMDAT 1960-2004.

Figure 4.14. Trends of epidemic water-related disaster by continent for each 5-year period: EMDAT 1960-2004.
Figure 4.15. Trends of the number of killed people versus affected people: EMDAT 1960-1990 and the 5-year period 200-2004.
Figure 4.16. Trend of the number of killed people by water-related disaster by continent for each 5-year period since 1960 to 2004.
Figure 4.17. Trend of the number of affected people by water-related disaster by continent for each 5-year period since 1960 to 2004.
Figure 4.18. Distribution of the number of killed people by flood disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.19. Distribution of the number of killed people by windstorm disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.20. Distribution of people killed by both flood and windstorm disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.21. Distribution of people killed by landslide and avalanche disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.22. Distribution of the number of people killed by wave and Surge disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.23. Distribution of the number of people killed by drought disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.24. Distribution of the number of people killed by famine disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.25. Distribution of the number of people killed by epidemic water-related disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.26. Distribution of the number of people killed by technological water-related disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.27. Distribution of the number of affected people by flood disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.28. Distribution of the number of affected people by flood disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.29. Distribution of the number of affected people by landslides and avalanche disasters by continent for each 5-year period from 1960 to 2004.
Figure 4.30. Distribution of the number of affected people by wave and surge disasters by continent for each 5-year period from 1960 to 2004.
Figure 4.31. Distribution of the number of affected people by drought disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.32. Distribution of the number of affected people by both famine disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.33. Distribution of the number of affected people by epidemic water-related disaster by continent for each 5-year period from 1960 to 2004.
Figure 4.34. Distribution of the number of affected people by technological water-related disaster by continent for each 5-year period from 1960 to 2004.
Figure 5.1. Top 1000 disastrous events in terms of affected people from 1900 to 2004.

Figure 5.2.a. Ratios of numbers of events of water-related disaster per type.
Figure 5.2.b. Ratios of numbers of killed people by type of water-related disaster.
Figure 5.2.c. Ratios of numbers of affected people by type of water-related disaster.
Figure 5.3. Extreme one hundred extreme water-related disaster classified by largest number of affected people since 1960 to 2004.
Figure 5.4. Extreme one hundred extreme water-related disaster classified by largest number of killed people since 1960 to 2004.
Figure 5.5. Selected indicators for PWRI Flood Risk Index to assess policy effectiveness in flood mitigation.

List of Tables

Table 2.1. Entry criteria of disaster database information by major organizations.
Table 2.2. Outlook of EMDAT structure and fields of information as of March 2005.
Table 3.1. Relative values of economic loss when using different conversion indices.
Table 3.2. General figures of natural and technological disasters from 1900 to 2004.
Table 4.1. Entry of epidemic water-related disasters in EMDAT.
Table 4.2. EMDAT top 10 water-related disasters in terms of killed people in the 1960s.
Table 4.3. EMDAT top 10 water-related disasters in terms of killed people in the 1970s.
Table 4.4. EMDAT top 10 water-related disasters in terms of killed people in the 1980s.
Table 4.5. EMDAT top 10 water-related disasters in terms of killed people in the 1990s.
Table 4.6. EMDAT top 10 water-related disasters in terms of affected people in the 1960s.
Table 4.7. EMDAT top 10 water-related disasters in terms of affected people in the 1970s.
Table 4.8. EMDAT top 10 water-related disasters in terms of affected people in the 1980s.
Table 4.9. EMDAT top 10 water-related disasters in terms of affected people in the 1990s.
Table 4.10. Top 10 most disastrous floods in terms of affected people.
Table 4.11. Top 10 most disastrous windstorms in terms of affected people.
Table 4.12. Total affected people by regional major wave and surge disasters.
Table 4.13. Top 15 drought disasters in terms of total affected in EMDAT.
Table 4.14. Top 15 famine disasters in terms of total affected people reported in EMDAT.
Table 4.15. Top 10 drought disasters in terms of total affected people in each continent.

Chapter 1: Background and Objectives

1.1. Introduction

Trends in natural disasters are continuously increasing in most regions of the world. Among all observed natural and anthropogenic adversities, water-related disasters are undoubtedly most recurrent and pose major impediments to achieving human security and sustainable socio-economic development. Natural pressures such as climate variability, managemental pressures such as lack of appropriate organization systems, inappropriate land management and uncertainty in water hazard planning, along with social pressures such as escalation of population and settlements in high risk areas (particularly the poor people) amongst others, are factors that have increased the vulnerability of population and property to the wide diversity of natural and human-made water-related disasters. For instance, during the period 2000 to 2004, 1362 water-related disasters have been reported by EMDAT database, killing more than 40,000 people and afflicting more than 810 million people.

The escalating figures of socio-economic impacts affirm the existence of an overall deficiency in up to date managemental strategies to reduce risks from water-related disasters. Consequences that have increasingly forced governments and concerned institutions to intervene directly by formulating policies that places risk management as elements of integrated water resources management. The World Conference on Disaster Reduction, held in Kobe, Hyogo, Japan, from 18 to 22 January 2005, resolved "that Disasters have a tremendous detrimental impact on efforts at all levels to eradicate global poverty; the impact of disasters remains a significant challenge to sustainable development". The Hyogo Declaration adds "that it is critically important that the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters be translated into concrete actions at all levels and that achievements are followed up through the International Strategy for Disaster Reduction, in order to reduce disaster risks and vulnerabilities". The international community "also recognize the need to develop indicators to track progress on disaster risk reduction activities as appropriate to particular circumstances and capacities as part of the effort to realize the expected outcome and strategic goals set in the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters." (WCDR 2005: extracts from the Hyogo Declaration).

In this direction, the end goal of this research is to develop a globally applicable water-related disaster index (i.e., flood risk index at this first stage) to assess the effectiveness of flood mitigation policies and furthermore to be used as a decision tool for policy analysis and assessment of proposed mitigation measures and strategies. The index is built as functional aggregation of constructive set of indicators measurable at the national and global scales. This work has been initiated as a contribution to the ongoing international efforts to produce the second edition of the World Water Development Report (WWDR 2) managed by the UNESCO Secretariat of the World Water Assessment Programme (WWAP).

This technical report presents our preliminary assessment of the trends of different type of water-related disasters at the regional and global scales. The database used in this analysis is based upon the Emergency Events Database (EMDAT), developed by the WHO Centre for Research on the Epidemiology of Disasters (CRED) of the University of Louvain in Belgium. Our primary objective behind this assessment is to acquire and provide a more in-depth understanding of the impacts of natural disasters triggered by hydrometeorological events, specifically, to understand the relationship between the increasing trends of each individual type of water-related disasters and their social impacts (i.e., the trends of the number of killed people and affected people in particular). The other concurrent objective is to develop our understanding of the global requirements and challenges to build standardized global indicators to assist in the identification of underlying risks from water-related disasters and to evaluate the effectiveness of adopted policies in water hazard mitigation.

It is one of the goals of the International Centre for Water Hazards and Risk Management under the auspices of UNESCO after its establishment to undertake a systematic initiative to build a comprehensive water hazard database. We look forward that this analysis will serve to draw practical conclusions on the future needs to construct reliable disaster and risk information system that will be able to respond to the particular challenges imposed by water hazards and related risk management issues. However, it is needless to emphasize that the accomplishment and success of such hardship mission requires synergic cooperation involving all concerned parties to create a safer world from water-related disasters.

1.2. Methodology

Establishing a central database on all disaster events occurring in the world requires a great deal of efforts and commitments from all relevant institutions at the national, regional and international levels. Up to date there is no known standard method to account impact of disasters particularly the accountability of affected people and damages in terms of direct economic loss (not to mention the evaluation of indirect impacts). Our objective is to create the capacity and information base to analyze water hazards and understand the risk mechanism (including the resiliency of affected society) and potential effects (i.e., vulnerability) in time and space for the purpose of its use in disaster management and planning. The usefulness of a sound "disaster database" as a fundamental tool to support this process has become increasingly evident to many government and international agencies engaged in disaster relief and mitigation. To respond to the emerging needs for better disaster records, a number of databases have been established around the world, with different criteria, formats and purposes[1]. While these databases are individually useful, their inconsistencies, data gaps and ambiguity of terminology make comparison and use of the different data sets difficult. This has led to a fair amount of confusion in the perception and evaluation of a disaster situation and poses serious obstacles for planning and fund raising (Guha-Sapir and Below, 2002).

Statistics show that among all natural disasters, water-related disasters are the major cause for loss of life and damage to property. Despite this global recognition there is not yet a single central platform or clearing house for water-related disasters databases with the scope to compile, compatibilize, coordinate and analyze the presently dispersed information. The success of such effort requires a great deal of commitments and collaboration from all national, regional and international engaged parties. Technically, for such project to be efficient there is a need to create systematic, homogeneous, and compatible standard procedures for monitoring and accounting disasters' risk as well as for collecting and reporting disasters information.

At the global scale the most widely used and accepted disaster database is the "EMDAT: The OFDA/CRED International Disaster Database" (hereafter referred to as EMDAT) developed and managed by the Centre for Research on the Epidemiology of Disasters (CRED), University Catholic of Louvain, Belgium. As described in Chapter 2, only events responding to what is called "entry criteria" are reported in EMDAT. The results of this entry selection process will therefore hide

[1] At the national level, governments undertake continuous efforts to build and maintain disaster databases. Chapter 2.3 and Annex 1 of this book introduce some of the existing disaster databases worldwide.

thousands of small and medium scale disasters that occur every year in different regions of the world.

- Since its creation in 1988, EMDAT was structured around two major groups of disasters, namely natural disasters and technological disasters. Disaster information for each event entry is presented in a tabular form. As it will be detailed in Chapter 2, in addition to the temporal (i.e. year of the event) and geographical (i.e. country and region) information, each specific events is described by multi-field entries such as the number of dead, number of injured people, economic loss, etc.

As EMDAT is regularly updated and validated, it is important to notice that the results and figures processed in this report are based on the disasters data last downloaded on 25 March 2005. As mentioned earlier, the fields of data processed are limited to the social impacts of water-related disasters, namely: temporal trends of the number of killed people and the total number of affected people in each of the five regions (Africa, Asia, Americas, Europe and Oceania). Hereafter, the word "water-related disasters" refers to the following eight categories:

- flood (flood, plain flood, valley flood and flash flood);
- windstorm (typhoon, hurricane, cyclone, tornado, tropical or winter storm and others);
- wave & surge (tide wave and tsunami);
- slides (landslide and avalanche);
- drought;
- famine (triggered by drought, food shortage and crop failure);
- epidemic water-related (classified as Epidemic in EMDAT. In this report, type of epidemic water-related are selected based on the WHO definitions); and
- technologic water-related disasters

The flowchart of Figure 1.1 shows the chapters dependencies in this technical report. We have tried to keep the perquisite material between the chapters to a minimum level to allow greater flexibility.

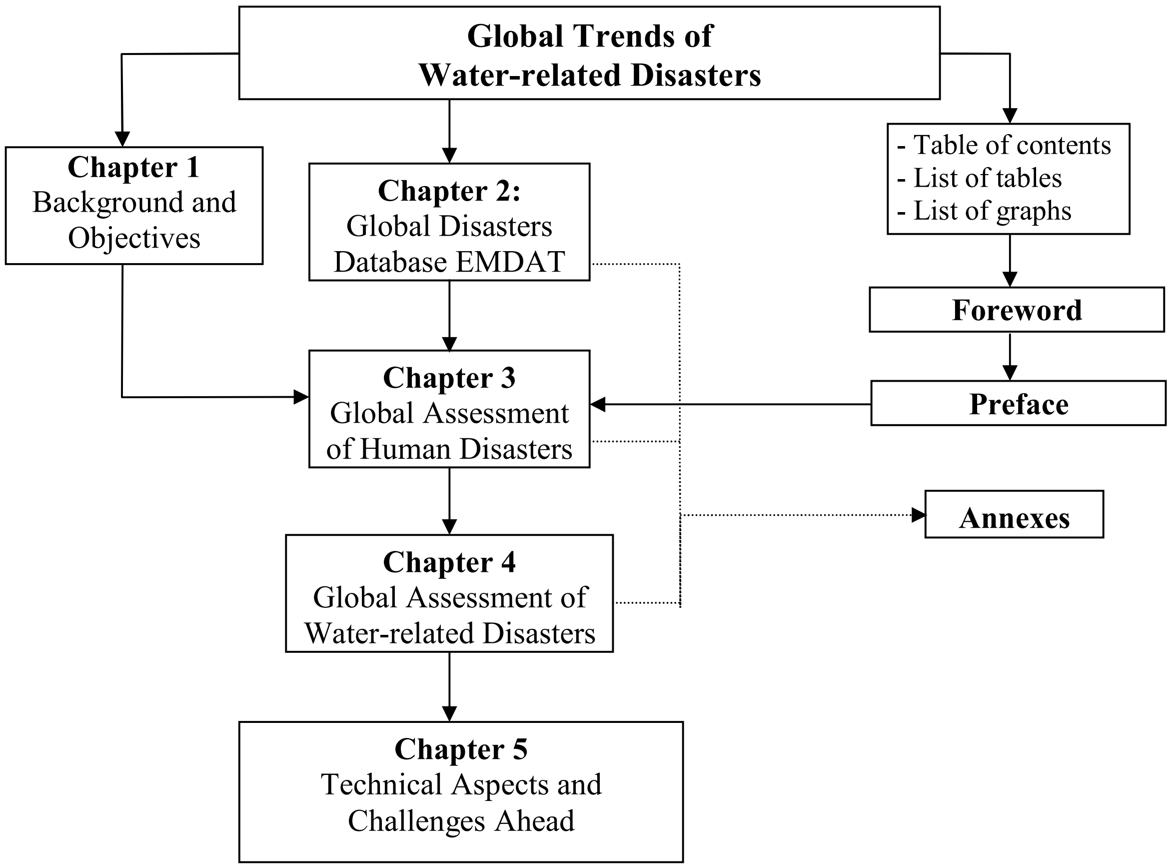


Figure 1.1. Flow chart of the reporting methodology.

Chapter 2: The Global Disasters Database EMDAT

2.1. General criteria

The development and maintenance of an up-to-date informative disaster database is a major concern in many countries. As mentioned earlier, one of our objectives for the development of a disaster database is to create a disaster analysis tool and vulnerability assessment methodology serving the purposes of formulating policy scenarios and rationalizing decision making for disaster proactive preparedness. There are numbers of national and international efforts to create disaster databases. While national databases are built to respond to governments' strategic goals in disaster mitigation, international databases are mainly developed and maintained to help achieving global goals and developing institutions and international standards.

The widely accepted international database on natural and man-made disasters is undoubtedly the OFDA/CRED International Disaster Database (EMDAT). The OFDA/CRED International Disaster Database (EMDAT) is a global database, supplied and maintained since 1988 by the World Health Organization (WHO) Collaborating Centre for Research on the Epidemiology of Disasters (CRED) at the University of Louvain. January 1999 saw the start of collaboration between the Office of Foreign Disaster Assistance (OFDA) of the United States Agency for International Development (USAID/OFDA) and CRED, with a view to completing the EMDAT database and validating its content. Since then, OFDA and CRED have maintained a single database (OFDA/CRED, 2002). In a way this initiative came into being as a response to one of the priorities of the international aid community, namely making better preparations to deal with disasters and doing more to prevent them happening (OFDA/CRED, 2002). The main objective of the database is to serve the purposes of humanitarian action at the national and international levels. It is an initiative aimed to rationalize decision making for disaster preparedness, as well as to provide an objective base for vulnerability assessment and priority setting (EMDAT, 2005).

2.1.1. EMDAT Sources of Data

EMDAT is regularly validated and updated by compiling disaster data collected from various national and international organizations specialized in disaster information analysis and dissemination. Guha-Sapir et al. 2004, reported that the source of information for EMDAT includes:

1. United Nation Agencies;
2. Non governmental institutions;
3. Research institutes;
4. Insurance companies;
5. Humanitarian and disaster agencies;
6. Specialized agencies;
7. Government agencies; and
8. The media.

The primary source for each disaster is defined according to a priority information source-list set up by CRED. The sources identified by CRED as "priority" -judged on their consistency and reliability- include in order of preference: The United Nations agencies are first in line, in the order shown hereafter:

- UN Agencies: the Office for Coordination of Humanitarian Affairs (OCHA), the World Food Program (WFP) and WHO;
- US Government Agencies: USAID/OFDA, the US National Oceanic and Atmospheric Administration and the US Federal Emergency Management Agency;
- Official government sources in the affected nations;
- The International Federation of Red Cross and Red Crescent Societies;
- Research Centers;
- Lloyd's of London; and
- Reinsurance sources.

The sources are continually being assessed with a view to achieving improved reliability. Normally a single primary source will be used to develop disaster entry information. The information is verified with as many as ten other confirming data sources. Where official estimates of the number of killed people or homeless are unavailable, informed proxies are used to develop estimates (ProVention, 2001).

2.1.2. Events Entry Criteria:

The classification of an event as "a disaster" varies from database to database due to the large difference in scope, focus and objectives of the organizations engaged in collecting and distributing disaster information. This variation in classification strategy creates major discrepancies between the existing disaster databases not only in terms of the number of disasters reported but also in terms of the magnitude and impact of each disaster. Guha-Sapir (2002), Arakida and Murata (2003) reported that one of the major factors creating differences between popular disaster databases resides in the disaster entry criteria as shown in Table 2.1.

Table 2.1. Entry criteria of disaster database information by major organizations (*)

Relief Web	ADRC	DesInveter (LARED)	NatCat (MunichRe)	Sigma (SwissRe
•Declaration of state of emergency; and/or •Based of on the IFRC report	•>=1 death (Japan); or •>= 5 death (Mem.); or •>= 10 death (other area); or •>=1 injured (Japan); or •>= 5 injured (Mem.) •>= 10 injured (other area •>=100 affected (Japan); or •>= 500 affected (Mem.); or •>= 1000 affected (other area); or •Serious economic damage; or •Call for international assistance.	•Any disaster in the Latin America	•Any loss of life or livelihood or any serious injury (Only major events before 1980)	•>= 20 death; or •>= 50 injured; or •>= 2000 homeless; or •> 14M US$ of marine loss; or •>28M US$ of aviation loss; or •>35M US$ of others losses; or •>70M US$ of total loss

(*) See Chapter 2.3 and Annex 1 for further information on these databases.

Under the specific scope of the OFDA/CRED EMDAT project, an event is classified as "a disaster" and entered into EMDAT if at least one of the following criteria is fulfilled:

- 10 or more people reported killed; or
- 100or more people reported affected; or
- Declaration of a state of emergency; or
- Call for international assistance.

2.2. EMDAT typology of disasters and structure of the database

A disaster in EMDAT is defined as: "A situation or event which overwhelms local capacity, necessitating a request to the national or international level for external assistance, or is recognized as such by a multilateral agency or by at least two sources, such as national, regional or international assistance groups and the media." (EMDAT, 2005).

As of 23 March 2005, the EMDAT database presents the core data on the occurrence and effects of 14,740 disasters covering the period from 1900 to 2004 (the database covers shorter periods for some types of disasters). Disasters in EMDAT are typically classified into two categories as either natural or technological (i.e. human-made). Following the typology adopted by EMDAT natural and technological disasters are defined as:

- Natural disasters: are disasters triggered by natural geological and/or hydro-meteorological events. This group encompasses 13 disaster types, namely: Drought, Earthquake, Epidemic, Extreme temperature, Famine, Flood, Insect infection, Slides, Volcano, Wave & Surge, Wild fire, and Windstorm. The detailed definitions adopted by EMDAT as well as the sub-sets of each type are summarized in "Annex 2: EMDAT Glossary" for convenience and readability.
- Technological disasters: are disasters triggered by technological hazard or anthropogenic influence. This group of disasters is classified into three major disaster types, namely: Industrial accident (Gas leak, Poisoning, Industrial Fire, etc.), Miscellaneous accident (Explosion, Fire, Collapse, etc.), and Transport accident. For the detailed definition and sub-sets enclosed in each type refer to "Annex 2: EMDAT Glossary" of this technical report.

Each disaster entry is described by 42 fields of data or information as shown in Table 2.2. It includes the main following fields:

- Country: Country(ies) in which the disaster has occurred.
- Disaster group: Two groups of disasters as mentioned above: natural disasters and technological disasters. Some entries are classified as complex emergencies.
- Disaster type: Description of the disaster according to a pre-defined classification.
- Date: When the disaster occurred. The date is entered in three fields as year, month and day (for both the start date and end date of the event).
- Dead or Killed: Persons confirmed as dead and persons missing and presumed dead (official figures when available). Information assessed in this study.
- Injured: People suffering from physical injuries, trauma or an illness requiring medical treatment as a direct result of a disaster (included in the field 'total affected').
- Homeless: People needing immediate assistance for shelter (included in 'total affected').
- Affected: People requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance (included in the field 'total affected').
- Total affected: Sum of injured, homeless, and affected people; it can also include displaced or evacuated people. Information assessed in this study.

- Estimated Damage: The economic impact of a disaster usually consists of direct (e.g. damage to infrastructures, crops, housing) and indirect (e.g. loss of revenues, unemployment, market destabilization) consequences on the local economy.
- Additional fields: Other geographical information (such as location, latitude and longitude), the value and scale of the events (such as the Richter scale value for an earthquake), the international status (international response, aid contribution, request for international assistance, disaster/emergency declaration), and the sectors affected, etc.

Table 2.2. Outlook of EMDAT structure and fields of information as of March 2005.

Year	seq	dis_group	dis_type	dis_subset	event_name	entry_criteria	country_name	location	no_killed	no_injured	no_affected	no_homeless	total_affected	damage_us	damage_eu	aid_contribution	start_year	start_month	start_day
1900	2	Natural	Drought	Drought		Kill	Cape Verde Is	Countrywide	11000	0	0	0	0	0			1900	0	0
1900	7	Natural	Epidemic	Diarrhoeal/Enteric	Gastroenteritis	Kill	Jamaica	Porus	30	0	0	0	0	0			1900	1	13
1900	8	Natural	Volcano	Volcano		Kill	Japan		30	0	0	0	0	0			1900	7	7
1902	2	Natural	Wave / Surge	Tsunami		Kill	El Salvador		185	0	0	0	0	0			1902	1	2
1908	11	Natural	Slides	Landslide		Kill	Canada	Notre Dame de La Salette, Quebec	33	0	0	0	0	0			1908	4	26
1923	5	Natural	Wind Storm	Storm		Kill	Soviet Union	Rostov	23	0	0	0	0	0			1923	7	10
1932	1	Natural	Famine	Food shortage		Kill	Soviet Union	Nationwide	5000000	0	0	0	0	0			1932	0	0
1950	9	Natural	Wind Storm	Hurricane	Dog	OFDA	Antigua and Barbuda		2	0	0	0	0	1000			1950	9	1
1963	61	Natural	Extreme Temperature	Cold wave		Kill	United States		150	0	0	0	0	0			1963	1	0
1970	55	Natural	Flood	Flood		Kill	Italy	Genoa provinces	37	0	1300000	1650	1301650	268300			1970	10	7
1975	121	Natural	Wind Storm	Cyclone		Govern	India	Maharashtra (Coast)	0	0	0	0	0	0			1975	5	29
1978	244	Natural	Insect Infestation	Insect infestation		SigDam	Viet Nam		0	0	0	0	0	0			1978	9	0
1980	211	Natural	Wild Fires	Scrub		Affect	Canada	Red Lake, Ontario	0	0	5000	0	5000	0			1980	6	0
1989	241	Natural	Famine	Crop failure		Kill	Rwanda	South, West of Kigali	237	0	60000	0	60000	0			1989	0	0
1990	598	Technological	Industrial Accident	Ind:Poisoning	Drug (cough syrip)	Kill	Nigeria		109	0	0	0	0	0			1990	9	15
1991	132	Natural	Volcano	Volcano	Mount Pinatubo	Kill	Philippines	Zambales, Pampanga, Olongapo, Tarlac (Luzon Isl.)	640	195	1035870	0	1036065	211000			1991	6	9
1994	645	Natural	Extreme Temperature	Heat wave		Affect	Australia	Southern NSW	0	34	1000000	0	1000034	0			1994	12	0
1999	599	Natural	Wave / Surge	Tidal wave		Affect	Thailand	Surat Thani, Nakhon Si Thammarat, Chumphon	0	0	0	200	200	267			1999	12	23
2002	435	Natural	Epidemic	Unknown	Unknown	Affect	China P Rep	Mishan city (Heilongjiang province)	0	0	1000	0	1000	0			2002	7	17
2002	830	Natural	Slides	Landslide		Kill	Brazil	Teresopolis	13	0	0	0	0	0			2002	12	21
2003	141	Technological	Transport Accident	Water	Ferry 'Kasobwe'	Kill	Burundi	Tanganyiaka lake (between RDC and Burundi)	150	0	48	0	48	0			2003	3	24
2004	644	Technological	Misc Accident	Explosion	Oleoduc	Kill	Nigeria	Near Ilado	27	0	0	0	0	0			2004	12	22
2004	588	Natural	Slides	Mudflow		Affected	Trinidad and Tobago		2	0	1200	0	1200	0			2004	11	12
2004	465	Technological	Transport Accident	Air	Helicopter	Kill	Greece	Near Alonissos Isl. (Egee sea)	17	0	0	0	0	0			2004	9	11
2004	659	Natural	Wave / Surge	Tsunami		Kill	Sri Lanka		35672	23176	1244330	0	1267506	1000000			2004	12	26
2004	383	Natural	Wild Fires	Forest		SigDis	Portugal	Vila Real, Santarem, Faro, Viseu, Bragance	2	0	0	0	0	0			2004	7	0
2004	580	Natural	Wind Storm	Typhoon	Muifa	Affected	Philippines	Catanduanes Isl., Bicol peninsula, Mindoro Isl.	104	240	838434	0	838674	6000			2004	11	19
2005	16	Natural	Earthquake	Earthquake		Affected	Iran Islam Rep	Agh Ghala region	0	110	0	0	110	0			2005	1	10

Table 1 (Continue): Fields Entries for each disaster

end_year	end_month	end_day	dis_subset2	dis_subset3	dis_subset4	iso	region	continent	origin	associated_dis	associated_dis2	ofda_response	eu_response	appeal	declaration	dis_mag_value	dis_mag_scale	latitude	longitude	local_time	river_basin
1900	0	0	--	--	--	CPV	West Africa	Africa				true					km2				
1900	1	13	--	--	--	JAM	Caribbean	Americas				false					vaccinated				
1900	7	7	--	--	--	JPN	East Asia	Asia				false									
1902	1	2	--	--	--	SLV	Central America	Americas				false					Richter				
1908	4	26	--	--	--	CAN	North America	Americas				false									
1923	7	10	--	--	--	SUN	Russian Federation	Europe				true					kph				
1932	0	0	--	--	--	SUN	Russian Federation	Europe				true									
1950	9	1	--	--	--	ATG	Caribbean	Americas				true					kph				
1963	1	0	--	--	--	USA	North America	Americas				false					oC				
1970	10	7	--	--	--	ITA	European Union	Europe				true					km2				
1975	5	29	--	--	--	IND	South Asia	Asia				false					kph				
1978	9	0	--	--	--	VNM	South-east Asia	Asia				false				3550	km22				
1980	6	0	--	--	--	CAN	North America	Americas				false				436	km2				
1989	0	0	--	--	--	RWA	East Africa	Africa				true									
1990	9	15	--	--	--	NGA	West Africa	Africa				true									
1991	6	22	--	--	--	PHL	South-east Asia	Asia		Earthquake	Landslide / Mudslide	true	false	false	false			15.13 N	120.35 E		
1994	12	0	--	--	--	AUS	Oceania	Oceania				false				44	oC				
1999	12	23	--	--	--	THA	South-east Asia	Asia				false				4	height (m)				
2002	7	17	--	--	--	CHN	East Asia	Asia				false					vaccinated				
2002	12	21	--	--	--	BRA	South America	Americas				false				0					
2003	3	24	--	--	--	BDI	Central Africa	Africa	Overloaded boat			false	false	false	false	0					lake
2004	12	22	--	--	--	NGA	West Africa	Africa				false	false	false	false						
2004	11	12	--	--	--	TTO	Caribbean	Americas				false	false	false	false						
2004	9	11	--	--	--	GRC	European Union	Europe				false	false	false	false						
2004	12	26	--	--	--	LKA	South Asia	Asia				false	false	false	false						
2004	8	0	--	--	--	PRT	European Union	Europe		Heat Wave		false	false	false	false	1080	Km2				
2004	11	19	--	--	--	PHL	South-east Asia	Asia		Landslide / Mudslide		false	false	false	false	120	Kph				
2005	1	10	--	--	--	IRN	South Asia	Asia				false	false	false	false	5.8	Richter	37.103 N	54.574 E	22:16	

2.3. EMDAT data quality and limitations

Data quality is one of the major critical problems facing risk managers today. As management becomes more dependent on information systems to fulfill their missions, data quality becomes a larger issue for its impacts on decision making. The results of the global analysis processed in this study clearly prove that the reporting of disasters in EMDAT has greatly improved over the last 40 years. The reason of such progress is due to the evolution of information systems, increasing availability of statistical data and evolution of EMDAT's sources in reporting natural disasters.

Quoting Guha-Sapir et al. (2004), the database has gradually increased the use of insurance companies' reports, while using those form humanitarian and disaster agencies has remained relatively constant over time. Despite efforts to verify and review the data, the quality of disaster databases can only be as good as the reporting systems that feed them. There are strong reasons to believe that the figures presented in EMDAT are probably underestimates. For example, droughts reportedly killed 500,367 people in Ethiopia over the last three decades. But some estimate that the number of people who died from the great Ethiopian drought of 1984-1985 alone may have numbered between 600,000 and one million people[1]. Even worse is the case of economic damages, where not more than a third of reported disasters estimate economic losses (Guha-Sapir et al., 2004).

Under these considerations, the quality and extent of the results are limited by the quality and validity of the original data-sources assuming operator error free. In our coming report on flood disasters we have focused on the numbers of quantitative and qualitative aspects in evaluating economic damages with practical examples from Japan. The future undoubtedly requires great efforts to create a homogenous global strategy to quantify and report disaster information. An initiative toward this global standardization is the "GLobal unique disaster IDEntifier number" known as the GLIDE initiative by the Asia Disaster Reduction Centre (ADRC). At this stage GLIDE defines a globally common identification number or ID code for every disaster that occurs in the world. This initiative will surely make it easier to identify and compare the data on disasters reported in the different existing databases. Annex 1 reviews some major regional and international disaster databases.

Hereafter the abbreviation "EMDAT" is used to refer to the citation requirements of OFDA/CRED and should be literally read as: "Source: "EM-DAT: The OFDA/CRED International Disaster Database, www.cred.be/emdat - Université Catholique de Louvain - Brussels - Belgium".

---

[1] Refer to Chapter 5 to overview our comments on data reporting for some particular events.

Chapter 3: Global Assessment of Human Disasters

3.1. Trends in natural disasters

The viability of risk management approach in water-related disasters is surrounded with complexity as it is subject to multifaceted management of land and water. While water disasters are triggered by hydro-meteorological phenomena yet hard to accurately forecast, the impacts on people and property are very much sensitive to the static and dynamic states of the surrounding environment and its resiliency to risk. Thus, building strategic mitigation plan implies undertaking comprehensive risk assessment of actual and potential causes and consequences of the disaster. Parameters used to evaluate the state of the natural environment and consequent impacts of water hazards are often referred to as indicators (WWAP, 2003). Identification of liable indicators is a complex evolutionary process that is still ill defined for the various types of water-related disasters triggered by natural and human-made factors with diverse direct and indirect social and economic impacts (i.e. also vulnerability). The future is to identify the best and well balanced combination of structural and non-structural measures to alleviate disasters' impact in sustainable manner. We cannot overemphasize that the construction and achievement of a sustainable mitigation policy requires balanced and high-quality disaster database framed to respond to the challenges imposed by water hazards. At this stage, we limited ourselves to analyze the trend of natural water-related disasters as reported in EMDAT that is mainly to assess the social impacts in terms of killed people and total affected people as acknowledged by many practitioners to be valuable global indicators to assess progress in disasters mitigation.

From the period 1900 to 2004 EMDAT reported 14,740 events of natural and technological disasters. The overall events have claimed the life of more than 37 million people and affected the livelihood of nearly 6000 million people. Within this global picture, disasters triggered by hydrometeorological events such as floods, droughts and windstorms, etc., are larger in number and wider in impact as compared to natural disasters triggered by geological hazards such as earthquakes and volcanoes. Table 1 presents comparative values between the different types of disasters as defined by the EMDAT typology. As can be seen from the table the proportion of people killed by natural disasters accounted for more than 70% of the total compared to 30% killed by technological disasters. The figure was even higher in terms of affected people by natural disasters which accounted for 90% of the total as compared to 10% affected by technological disasters. A closer look at the impact of each type of natural disasters, the table reveals a complex inter-relation between the number of killed and the number of affected people by each type of water related disasters. For instance, during the period from 1900 to 2004, flood accounted for about 28 % of the total number of disasters claiming 19% of the total casualties and 48% of the total affected people. When accounting both flood and windstorm events (also acknowledged as major events triggering floods) the values rise up to more than 50% for both killed and total affected people. On the other hand, epidemics which accounted for about 10% of the number of disasters claimed 26% of the total casualties but accounted only for 1% of the total affected people. Other interesting data to explore are the data for earthquake and famine which accounted for 10% and 1% of the total number of disasters, while respectively, killed 5% and 19%, and affected 2% and 1% of the totals reported.

The examination of the dissimilarities underlying the effects related to the trend of disasters and the trend of their respective impacts clearly shows the complexity of risk disasters assessment. While global data can help understand the world status vis-à-vis the impacts of water-related disasters, it is clear that further analysis based on disasters type is a perquisite before concrete conclusions can be drawn on the efficiency of current international actions and practices to mitigate water-related hazards. A complete comparative study shall also include an assessment of the economic damages as more valuable property and high-tech assets are nowadays concentrated in high risk areas.

The value of the global economic damage (or economic loss) reported in Table 3.1 is calculated by accumulating the real value of the accounted damage for the year of the event without any relative conversion to a specific year. The reasons for using brut values are three folds, first, as mentioned above, our main objective is to compare the social impacts of water-related disasters at the global and regional levels and draw explicit figures to help our understanding in the process of indicators development as well as to identify areas of improvement in water-related disaster databases for reliable assessment of vulnerabilities and policy analysis. Second, several institutions have developed methodologies to quantify economic losses. However, there is no globally agreed standard procedure to determine the real figure of economic damages. Therefore, in-depth research is still required to define and set the most appropriate method to calculate the relative value of economic losses at a given year from water disasters in particular. Third, the existing methods and indices of comparison such as GDP or the Consumer Price Index (CPI) among others are often used without deep thought to their consequences and applicability to the multifaceted and diversity of types of direct and indirect economic damages endured by water disasters. In other words, it is clear that using different indices will lead to completely different conclusions. For instance the windstorm (i.e., hurricane) disaster of 8 September 1900 in USA resulted in US$1 million worth of economic loss. Table 3.1 shows that the relative value of the loss of US$1 million in the year 1900 varies, depending on different indices (see Economic History, 2005), from 19 million to 600 million in the year 2003. Thus it is imperative to decide which of these indices (or combination of indices) is more appropriate to analyze the true damage from water-related disasters. Nevertheless, using the brut value as indicator (regardless of using a conversion index) Figure 3.1 shows that economic damages had been continuously increasing during the past three decades in particular (improvement in EMDAT reporting has also to be sought). Floods and windstorms are at the top of the list followed by earthquake disasters as can be seen from Table 3.2.

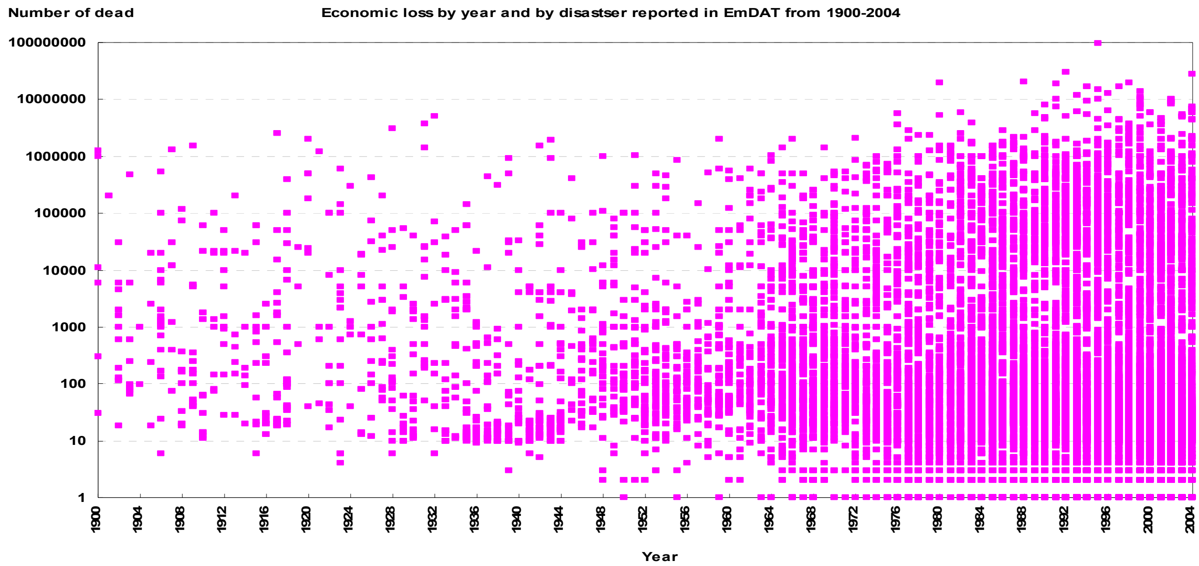


Figure 3.1. Economic loss by year and by disaster reported in EMDAT from 1900 to 2004.

Table 3.1. Relative values of economic loss when using different conversion indices.

In 2003, $1,000,000 of economic loss in 1900 is worth:	
■ $21,788,515	using the Consumer Price Index
■ $18,533,333	using the GDP deflator
■ $107,446,043	using the unskilled wage
■ $154,014,335	using the GDP per capita
■ $588,003,212	using the relative share of GDP

Table 3.2. General figures of natural and technological disasters from 1900 to 2004.

Impact / Event	Number of Disasters	Number of Dead	Total Affected People	Real Damage ($USx1000)
Flood	2636	6,888,152	2,921,323,648	322,552,819
Wind Storm	2569	1,199,041	636,706,948	347,099,342
Earthquake	978	1,881,041	96,294,254	309,181,417
Epidemic	937	9,520,307	39,566,095	4,737
Drought	807	10,008,644	2,192,716,836	58,108,208
Slides	477	53,783	9,797,760	3,469,311
Wild Fire	292	2,650	4,011,734	29,307,293
Extreme Temperature	270	64,699	11,402,747	20,688,659
Volcano	176	95,909	4,199,184	3,692,646
Insect Infection	83	0	2,200	230,125
Famine	76	7,158,299	70,996,301	93,449
Wave/Surge	52	295,011	2,561,120	7,848,747
Totals of Natural Disasters	9353	37,167,536	5,989,578,827	1,102,276,753
Technological	5387	272,471	7, 516,095	24,211,042
Totals	14740	37,440,007	5, 997,094,922	112,648,7795

Looking to the number of disasters from the global scale, there is a continuous increasing trend from decade to decade. For instance (see Figure 3.2), the minimum threshold of the number of natural disasters occurring per year in 1970s was about 50 events, this minimum threshold of recurrent events was 100 events in 1980s, increased to 200 events in 1990s and up to 350 events per year during the past 5-years (i.e., since the beginning of the 21st century). During the years 2000 and 2002 more than 500 disasters occurred, respectively. As shown in Figure 3.3, the average rate at which the number of disasters increased after every 5 years was about 3%. The 5-year periods 1990-1994 and 1995-1999 accounted for about 13% and 16% of the total disasters respectively. The last 5 years 2000-2004 accounted for 24% of the total reported disasters, which represents an increasing rate of about 8% as compared to the previous 5-year period. As depicted in Figure 3.3 the number of disasters attributed to natural phenomena is predominant in number accounting for 63% of the globally reported disasters over the entire period (from 1900 to 2004).

Among all natural disasters, disasters triggered by hydrometeorological events accounted for 77% of the sub-total. In addition to this heavy global picture, it is important to add the number of people killed and affected by technological water-related disasters (mainly accidents triggered by heavy rains, storms and other climate variations). As depicted in Figure 3.3, the number of technological water-related disasters accounted for 14% of the total technological disasters. Despite that only disasters responding to one of the four entry criteria listed above are reported in EMDAT, the statistics show that the trend of natural disasters with water-related disasters at the top of the list has not ceased to increase exponentially. In addition to periodic disasters of given disaster thresholds, extreme events as never experienced before are proven to occur continuously though occasionally. Historical examples are, to cite only few, the flood of July 1931 in the China Republic, which claimed the life of nearly 4 million people, and the Sumatra earthquake triggered Tsunami of December 2004, which claimed the life of nearly 300,000 people. Therefore, in the course of building a so-called holistic risk management strategy for disasters mitigation it is vital to consider such overwhelming events despite their very low probability of occurrence.

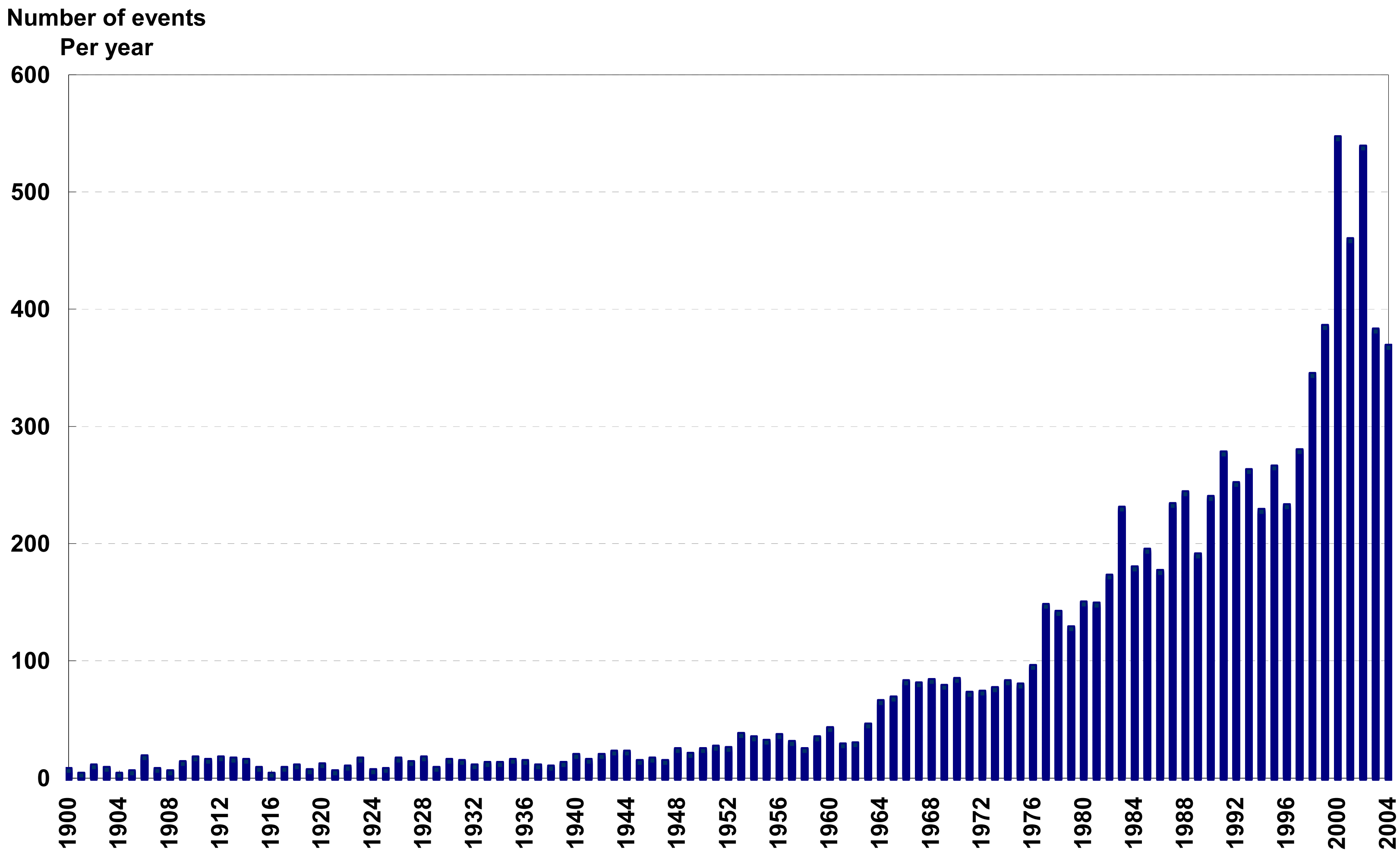


Figure 3.2. Trend of the number of natural disasters per year: EMDAT from 1900 to 2004.

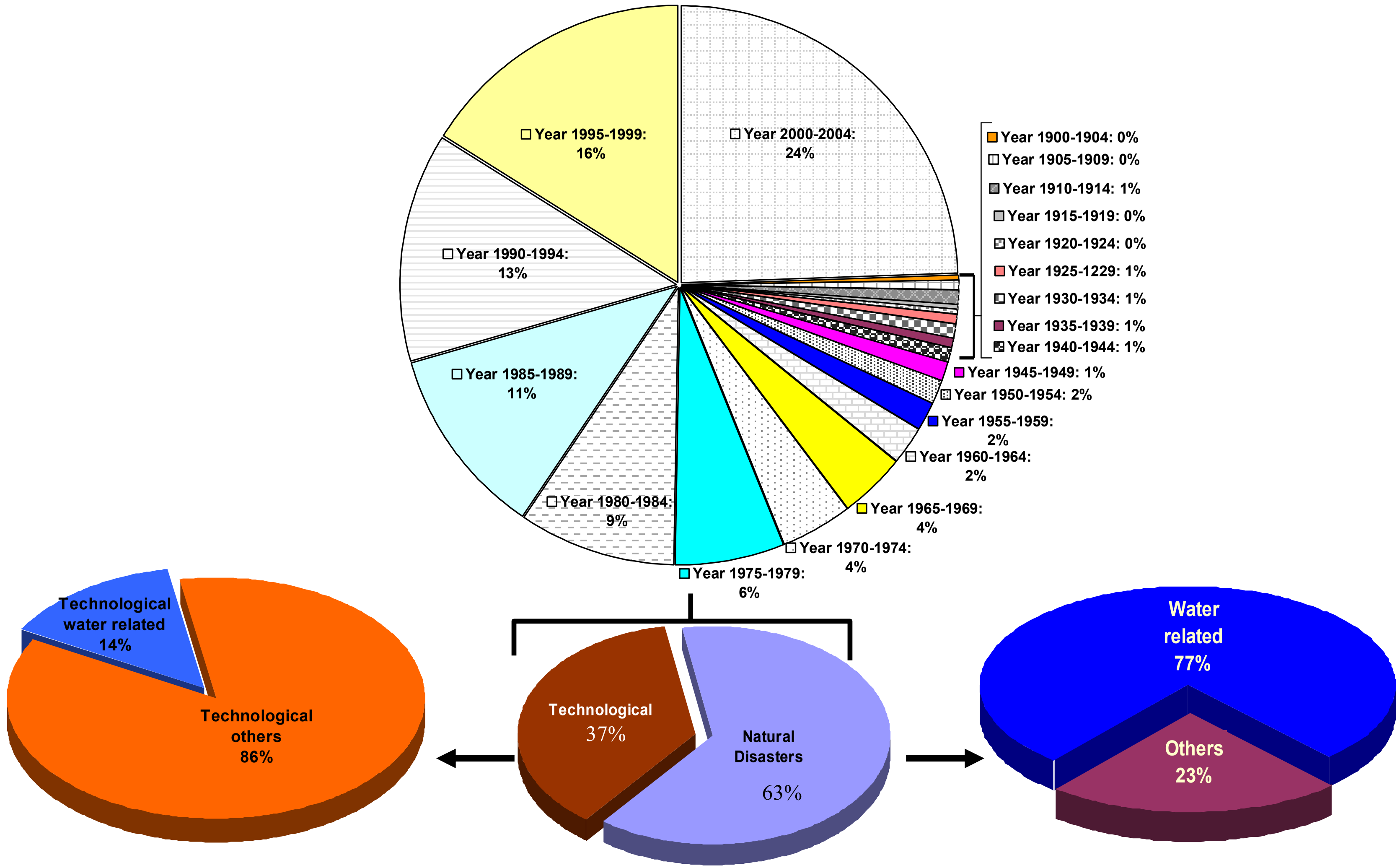


Figure 3.3. Global distribution of disasters by category and for each 5-year: EMDAT from 1900 to 2004.

3.2. Assessment of the social impact of natural disasters

Whether devastating disasters are triggered by natural or technological events, they can have unexpectedly large countable (i.e. direct) and uncountable (i.e., indirect) social and economic effects on individuals, communities, and national stability. With the evidently increasing trend of the number of natural disasters over the past decades, the trends of impacts on people specifically the number of killed and the number of affected people as well as the impact on economy (specifically direct measurable economic losses) shows large variations in scales and numbers. While it is not an end by itself, the examination of the global trends of diverse effects of natural disasters is undoubtedly important to assess the progress made at the global scale to mitigate these negative impacts.

3.2.1. Trend of the number of dead people

Protecting human life from natural disasters has been the goal of major national and international initiatives in hazard mitigation and disaster reduction. Figure 3.4 depicts the 100 and 200-event moving averages of the global trend of the number of killed people by natural disasters. The global picture shows a clear overall decreasing trend. The most distinctive period is from 1900 to the beginning of the 1980s, the trend during the following decades also decreased but evidently at a slower rate marked by severe concurrent increases as shown by the scattered peak values in the graph. Although the peaks from 2000 to 2004 were temporally more scattered, they were severer in magnitude. Special emphasis is placed on the loss of life in 2004 which includes in addition to the large severe flooding that occurred around the globe, the Sumatra earthquake triggered Tsunami, which claimed the life of nearly 300,000 people from nations in the Asian region and others from around the world. In other words, despite the decrease in the number of killed people, when seen from a large temporal scale, the current situation warns that we should raise our social resiliency to face unusual disastrous events that have net yet occurred.

In order to understand the range of these erratic values of the number of killed people per individual disasters reference is made to Figure 3.5. It is clear from the data that extreme disasters claiming the life of more than 100,000 people have become very rare events since the Tangshan earthquake of 1976 in the China Republic, which claimed the life of more than 240,000 people. In recent decades, the only events of similar massive disastrous scale are the windstorm of 1991 in Bangladesh, reported to have killed near 140,000 people, and the Sumatra tsunami of December 2004. On the other hand, the figure shows that since 1994 at least one disaster killing more than 10,000 people has occurred every year.

With the increasing in frequency of natural disasters claiming the life of more than 1,000 people per event, the temporal distribution of disasters warns of new thresholds in terms of the number of people under the threat of death by any one of the 200 events occurring every year in average (see Figure 3.5). To closely examine the variation of the thresholds over time reference is made to Figure 3.6. For instance, while the number of death per event seems to be an independent stochastic process, Figure 3.6 indicates several grouping of nearly the same threshold of casualties. For lower magnitude events, nearly every year the same number of people at different scales (e.g. 10 people, 50 people, and 100 people as new threshold standards) are killed by a single natural disaster event. For several events of higher magnitude, though the impact density lines (i.e. impact on human life, e.g. 1,000; 10,000; or 100,000 etc.) are sparser, consecutive events on a yearly basis which killed nearly the same number of people are clearly seen (e.g. more or less 10,000 death for the period 1960 to 1974, and more or less 50,000 death for the years from 1995 to 2004).

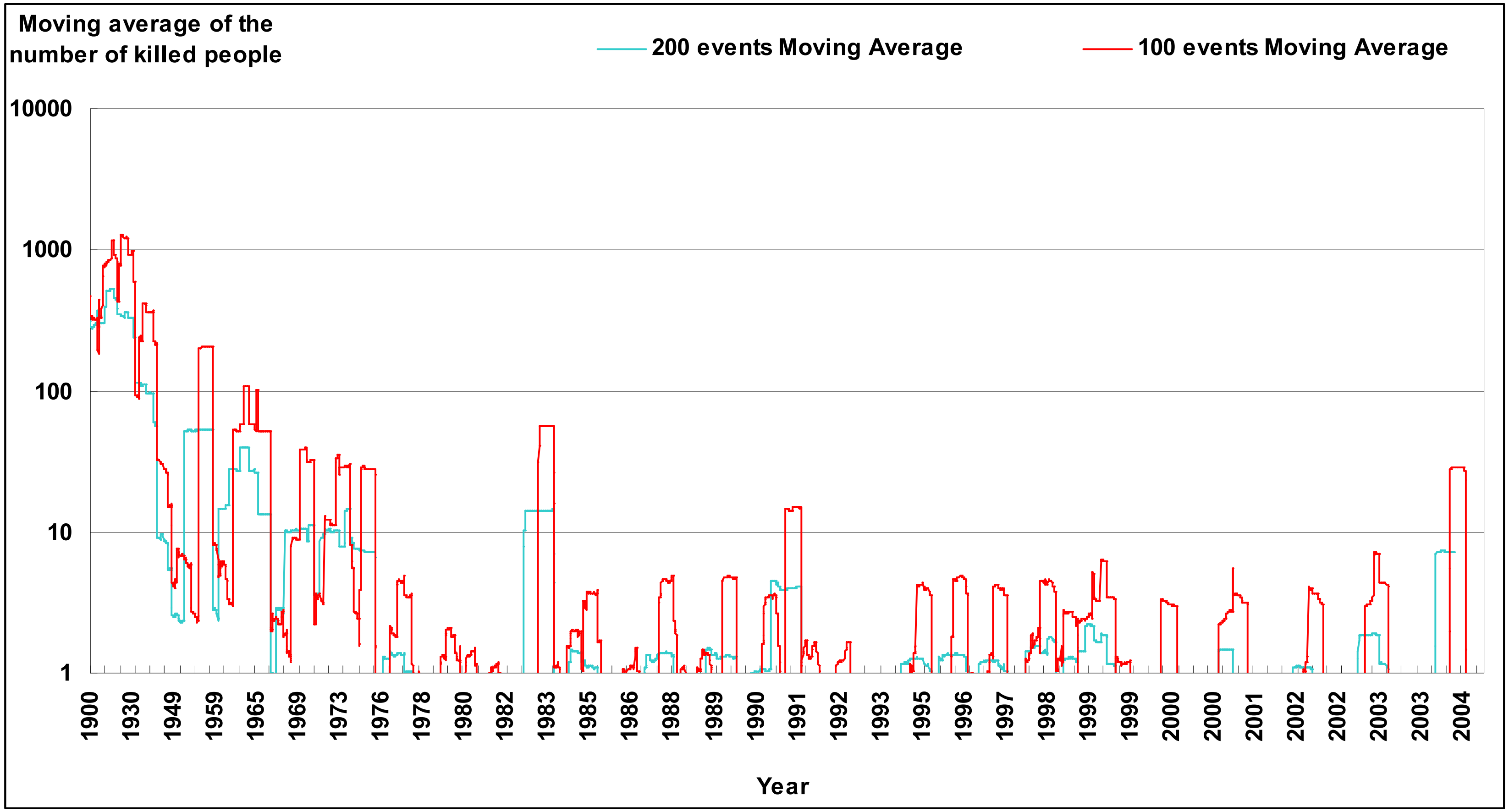


Figure 3.4. Moving average of the total number of killed people from 1900 to 2004.

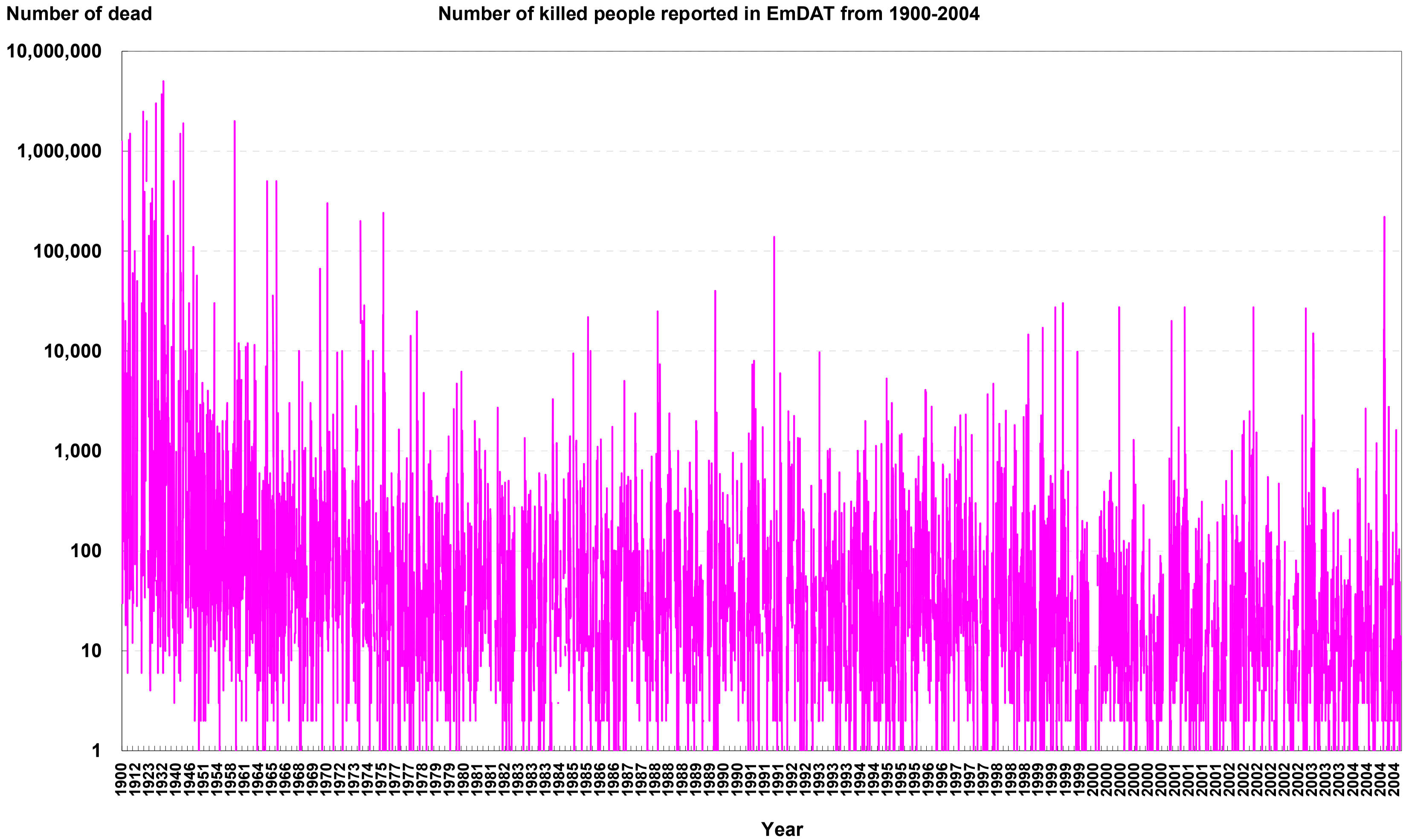


Figure 3.5. Number of killed people by natural disaster from 1900 to 2004.

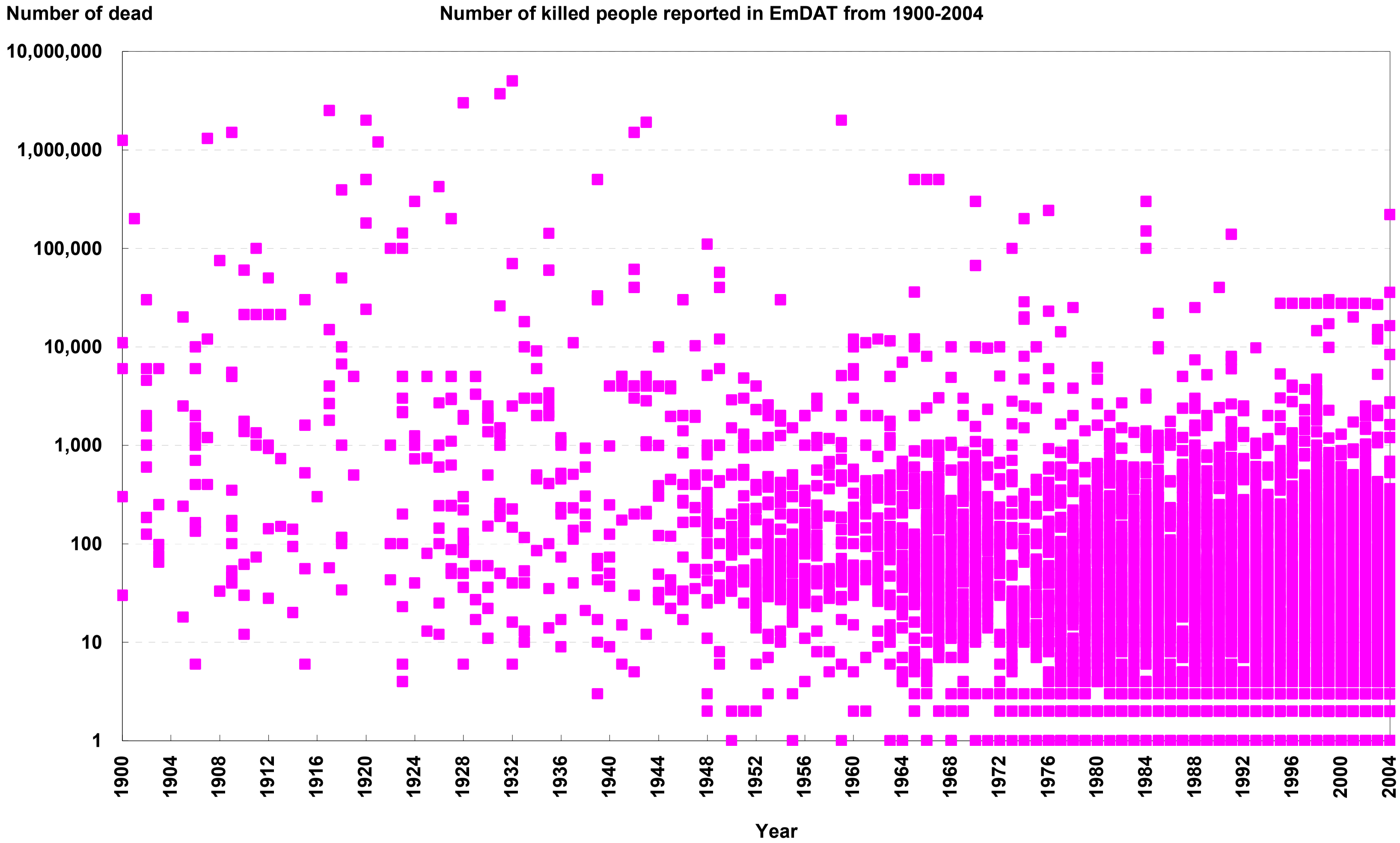


Figure 3.6. Temporal distribution of the number of killed people per year and per disaster from 1900 to 2004.

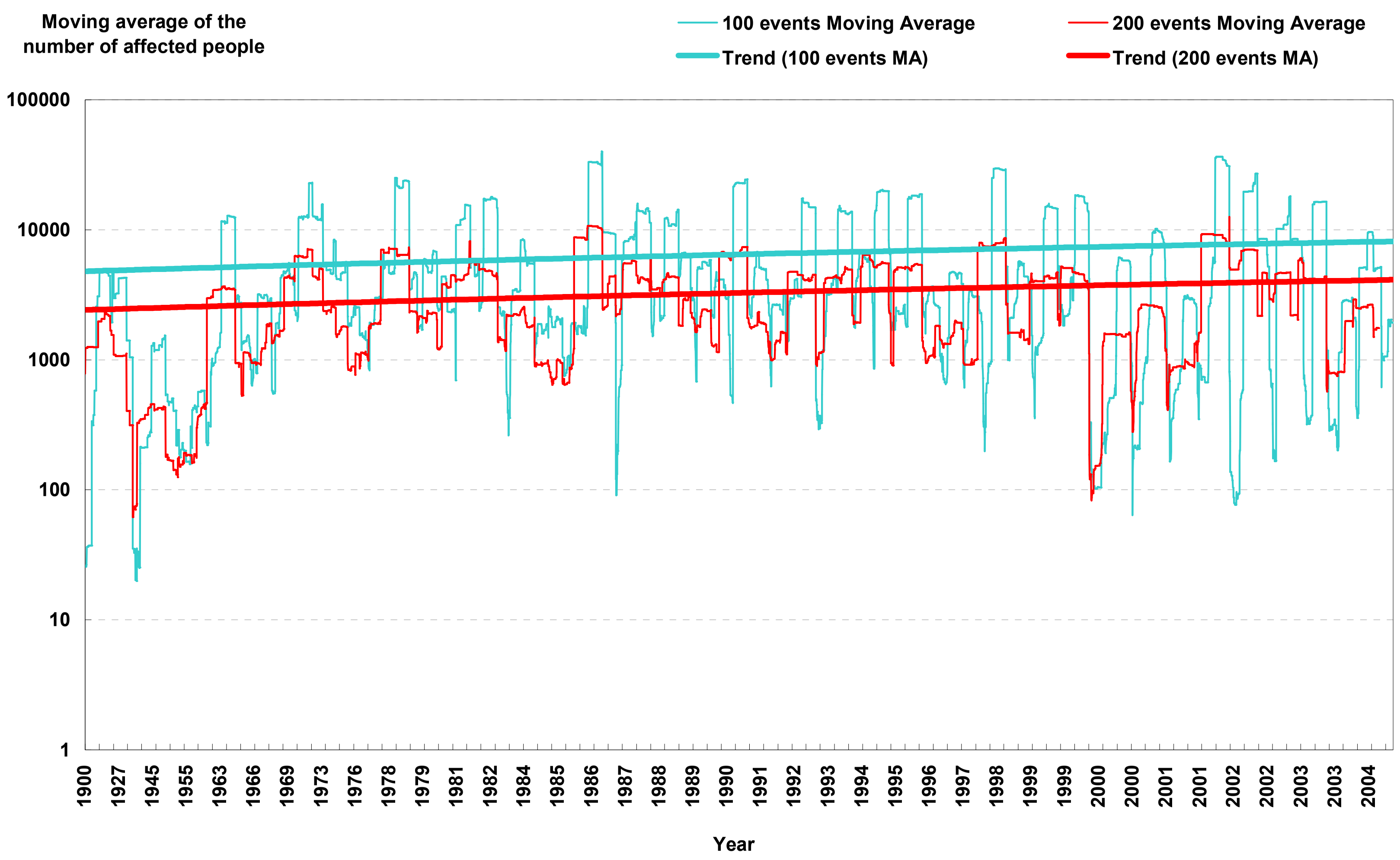


Figure 3.7. 100 and 200-event moving average of the total number of affected people from 1900 to 2004.

3.2.2. Trend of the number of affected people

The number of affected people by a single natural disaster largely varies from several million to several hundred thousands depending on the type of the natural disaster. Attempting to conceive the global resiliency standard, Figure 3.7 draws the moving averages of the number of affected people after 100 and 200 successive events, respectively. The overall trend shows that following every 100 to 200 events the number of affected people at any one year by any one natural disaster is likely to increase by nearly 3000 people in average. In other words, following the minimum threshold of the number of concurrent disasters that are likely to occur at any one year, the global resiliency standard of people to disasters is continuously decreasing. Acknowledging the overall increase of the trend with an erratic conduct, a critical period of the increasing trend is observed for the periods from 1940 to 1980 and from 2000 to 2004. In order to decipher the magnitude of the impact of natural disasters on event basis reference is made to Figures 3.8. Despite that disasters affecting several hundred million people (such as the droughts of 1987 and 2002 in India with 300 million affected people each; or the floods of 1998 and 2002 in the China Republic with 200 million affected people each) are rare events, Figure 3.9 clearly shows that natural disasters affecting 100,000 people and over have occurred at least once in every 5 years. The frequency of natural events affecting from 5 to 10 million people each time a disaster do occur was higher in recent decades and they even occurred several times a year. A clear picture of this increasing frequency can be seen from Figure 3.9 representing the same data as of Figure 3.8 on a temporal basis. This figure also confirms that EMDAT knew clear improvements in the reporting process. Thus, besides undertaking an event based analysis, for instance of the critical successive drought years in Canada from 1931 to 1940, the trend of the number of affected people for the period from 1900 to 1960 (as shown in Figures 3.4 and 3.7) should be interpreted with caution. The largest disasters in terms of the number of affected people are the two droughts of 1987 and 2002 in India, which affected 300 million people in each year, followed by the three flood disasters of 1991, 1998 and 2002 in the China Republic, which were reported to affect nearly 200 million people each.

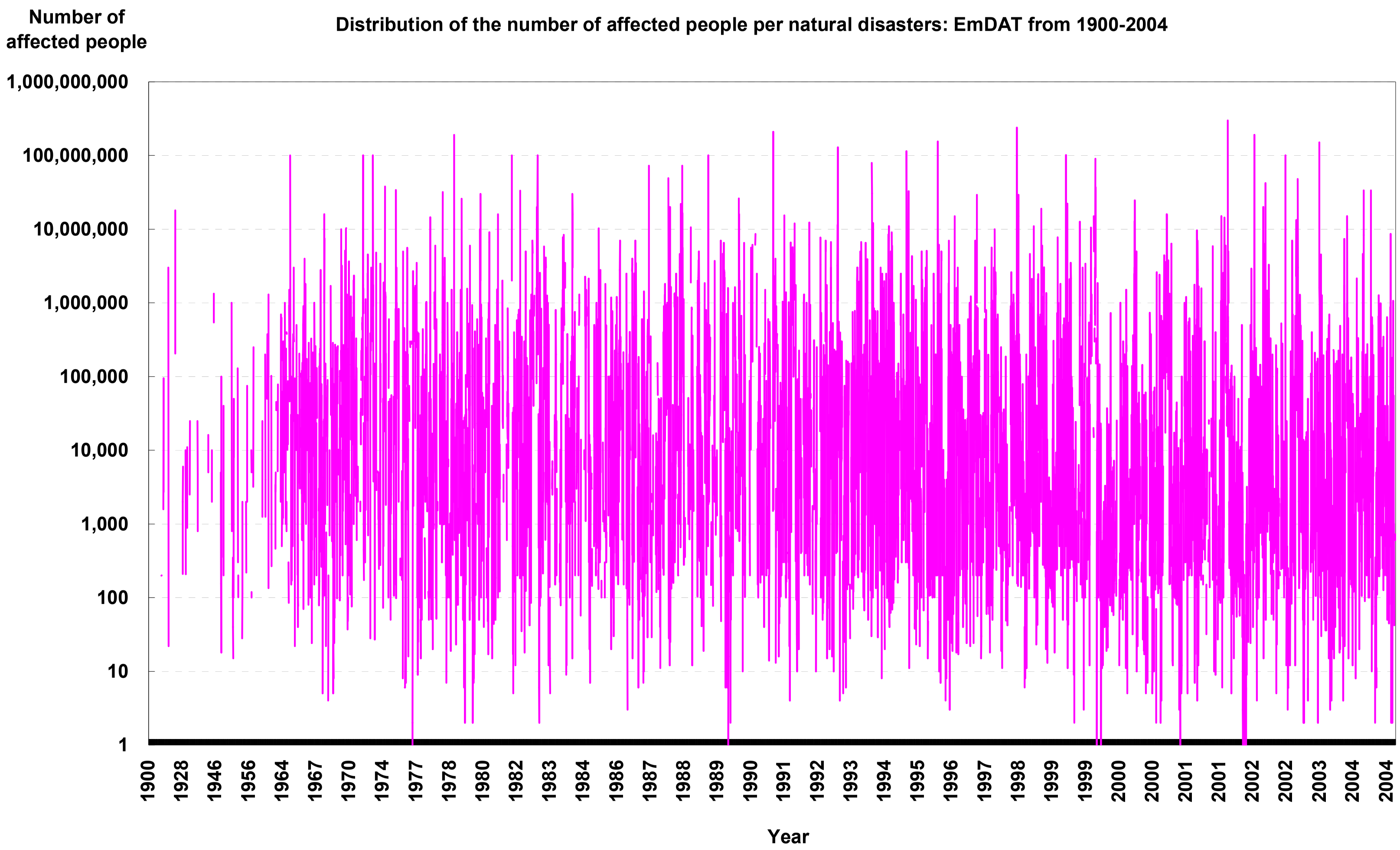


Figure 3.8. Total number of affected people by individual natural disaster events: EMDAT from 1900 to 2004.

Figure 3.9. Temporal distribution of the number of affected people per year and by disaster from 1900 to 2004.

Chapter 4: Trends Analysis of Water-related Disaster

4.1. Trends of water-related disasters

The global picture of the decreasing trend in the number of killed people by natural disasters is an important indicator on the degree of achievements made at the global scale in the field of natural disasters reduction. Nevertheless, the peak values of killed people by extreme disastrous events, the trend of the number of affected people and the trend of economic damages clearly state the importance of carrying out an in-depth analysis by type of disaster at both regional and national scales. This chapter focuses on the analysis of the trends of water-related disasters and their social impacts, namely the number of killed people and the number of total affected people at the global scale in general and at the regional scale in particular. As mentioned earlier, 77% of all natural disasters are triggered by hydrometeorological phenomena either directly such as flood and drought, or indirectly such as famine, water-related epidemic and technological water-related disasters. Despite that tsunami disasters are triggered by earthquakes they are included in the category of “wave/surge” for the consequence of a tsunami disaster is driven by sea-water.

As shown in Figure 4.1.a, disasters other than water-related disasters accounted for 43% of the total number of disasters. Technological water-related disasters (mostly ferry accidents) accounted for 10% of the total. Nonetheless, this later proportion should be carefully interpreted especially when a multi-disaster does occur, such as the earthquake of 2004 in Niigata, Japan. In Niigata earthquake of 5 November 2004, 40 people were reported to be killed and 2,900 injured. There were 395 buildings destroyed and 3,473 damaged in Niigata Prefecture. About 100,000 people had to live in emergency shelters. The main event was followed by strong series of aftershocks, fires, heavy flooding and large scale landslides (at least 151 landslides), some have caused deadly traffic accidents. Under such a dramatic sequence of disasters mainly implicating heavy physiological disturbance, not all countries have the ability or disasters reporting system to accurately distinguish the consequences driven by each individual type of disasters and the real causes of death (in Niigata case: earthquake, flood, landslide, fire, and technologic water-related disasters).

Figure 4.1.b, plotted for the whole period from 1900 to 2004, shows that the proportion of disasters driven by both floods and windstorms accounted for 73% of the total. Drought and famine disasters accounted for 12% of the total. However, it is important to notice that 20% of the famine disasters reported in EMDAT are attributed to drought (i.e., 66% of famine disasters were attributed to food shortage

and 14% were attributed to crop failure). Slides accounted for 6% of the total, only 25 among the 477 slide/avalanche events were attributed to heavy rain (for the rest of the events the main triggering causes were not mentioned). In the same scale, epidemic water-related accounted for 7% of the total (i.e., six sub-types of water epidemic were identified based on the WHO definitions). Diarrhoeal/enteric accounted for 79% of the total number of water epidemic disasters. Wave/surge accounted for 1% of the total number of disasters including 37 tsunami events (i.e., 71% of the sub-total) as compared to tidal wave disasters with 15 events.

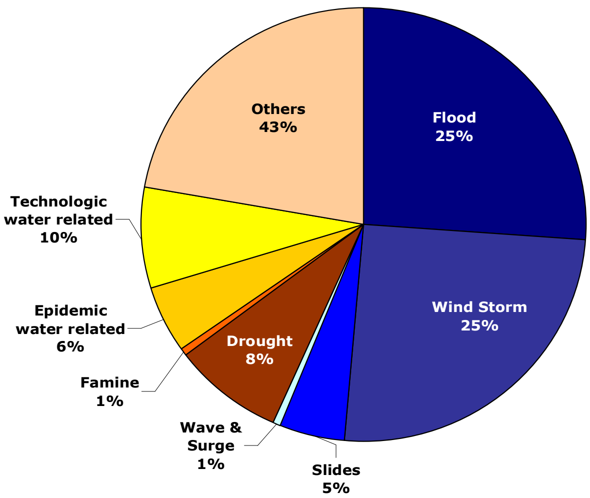


Figure 4.1.a. Global distribution of water-related disasters vis-à-vis other types of natural disasters for the period from 1900 to 2004.

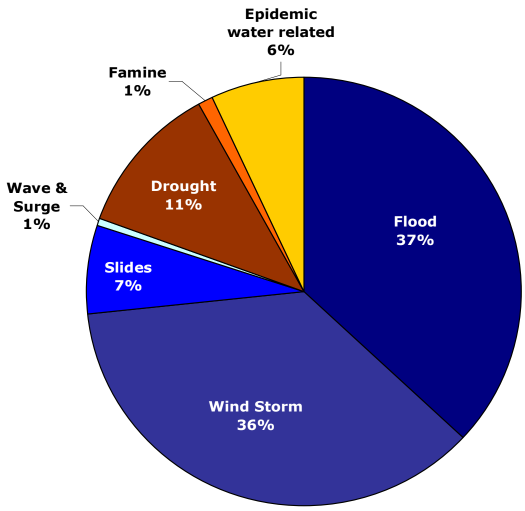


Figure 4.1.b. Global distribution of water-related disasters for the period from 1900 to 2004.

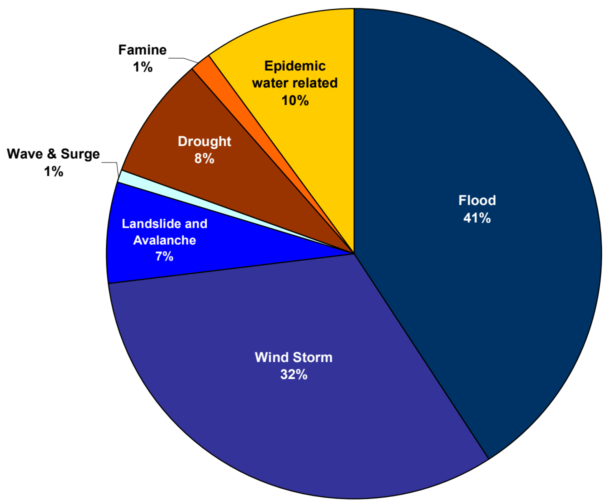


Figure 4.2.a. Global distribution of water-related disasters for the period

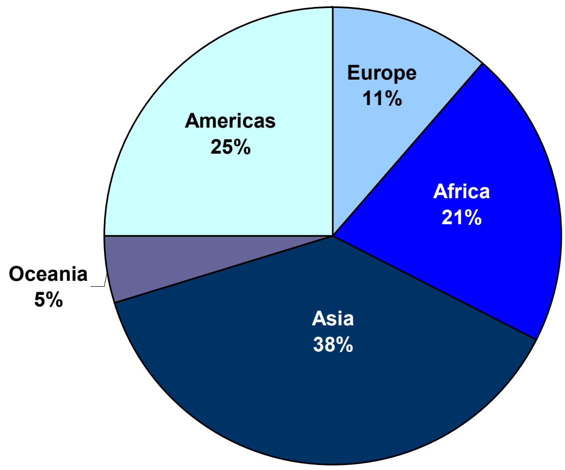


Figure 4.2.b. Global distribution of water-related disaster by continent for the period 1990-2004.

34

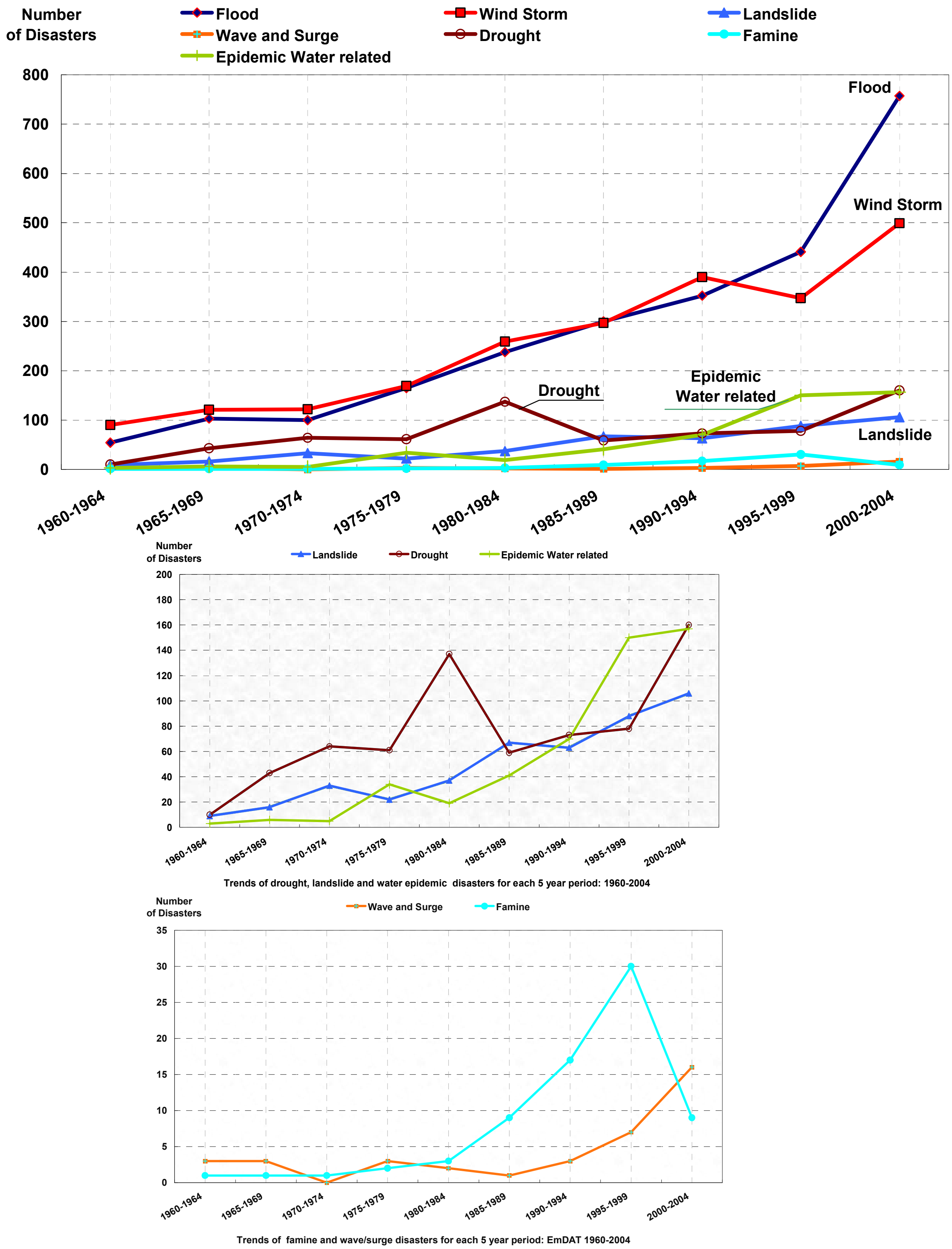


Figure 4.3. Trends of water-related disasters for each 5-year period from 1960 to 2004.

Attention is drawn to the fact that this proportionality is very much influenced by the length of time period taken into consideration. The same data (i.e., water-related disasters not including technological water-related disasters), when plotted for the period 1990-2004 (see Figure 4.2.b) shows a clear difference in the share as compared to the plot for the period from 1900 to 2004 (Figure 4.1.b). For instance, while surge/wave and famine disasters are in the same proportion for both figures, flood accounted 41% (see Figure 4.2.a) (compared to 37% in Figure 4.1.b), drought accounted for 8% (compared to 11%) and water-related epidemic accounted for 10% (compared to 6%). These differences in terms of statistical percentage have greater evidence and importance when analyzing the consequences of disasters in terms of killed or affected people (where 1% may represent as high as 1 million people, as discussed later in this chapter). From another perspective, the distribution of water-related disaster by continent received a disproportional share in terms of the numbers of events and disasters impacts. The data of the recent decades from 1990 to 2004 shows that Asia accounted for more than 40% of the total number of disasters occurring worldwide followed by Americas and Africa with the nearly the same percentage (22%) as shown in Figure 4.2.b. These differences show some of the controversial issues confronting decision makers during the process of risk quantification as will be discussed later in the course of this chapter.

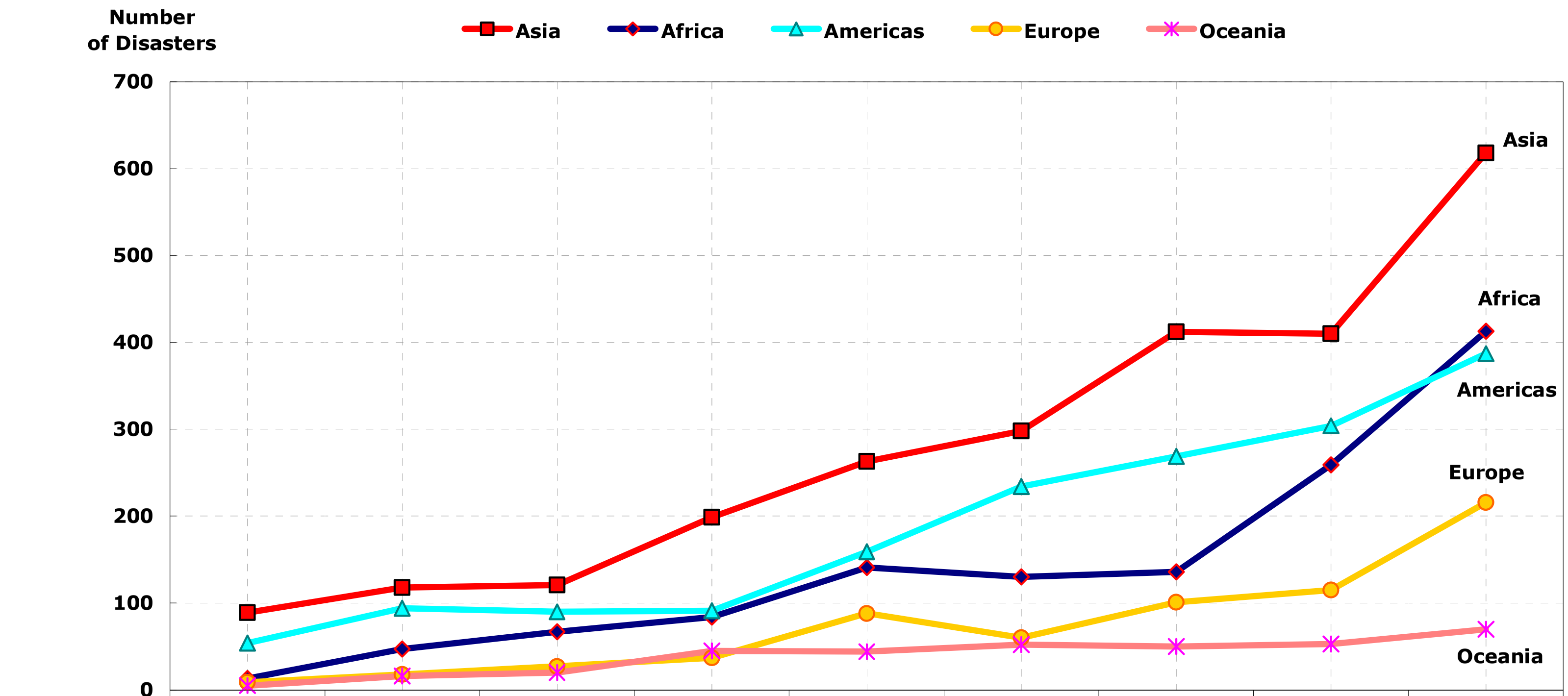
Based on the above and the observations made in Chapter 3 vis-à-vis the qualitative and quantitative aspects of information in EMDAT, most of the rest of the analysis presented hereafter will be based on the disasters database for the period from 1960 to 2004. In the aim of extracting the most comprehensive information from the database in terms of global trends and consequences by type of disaster as well as the share of each of the 5 regions (i.e., Africa, Americas, Asia, Europe and Oceania) the data are processed for each 5-year period with some informative graphs on a decade basis.

Figure 4.3 depicts the global trends of different water-related by type of disasters for the period 1960 to 2004 plotted for each 5-year period. Due to the large difference in the scale of the number of events when comparing the different types of disasters (particularly flood and windstorm to other water disasters) the two sub-groups [drought, slide (including landslide and avalanche), and epidemic water-related], and [wave and surge (includes tsunami), and famine] are re-plotted separately for readability. Globally the number of floods that have turned into disasters, based on the EMDAT criteria, showed a quasi-steady increase of more or less 100 events (in average) after each 5-year period. Unlike the periods from 1965-1969 to 1970-1974 with nearly the same numbers, the first 5-year period of the 21st century was above all expectation with just about 4 times higher number of flood disasters as compared to the 5-year increasing average since 1960. Windstorm events that turned into disasters showed nearly the same trend as floods. In contrast with the decreasing trend for the decade from 1990 to 1999 (i.e. the international decade for disasters reduction), the beginning of the 21st Century showed an alarming increase with nearly 2.5 times higher windstorm disaster events as compared to the 5-year increasing average. The increasing trend of drought disasters showed a drastic raise during the period 1980-1984 and the period 2000-2004 which was about 4 times the 5-year increasing average (which is about 20 events after each successive 5-year). In the same quasi-study increasing scale are landslide disasters with an average of about 20 event increase after each successive 5-year period (save the periods 1975-1979 and 1995-1999). Since 1984 water-related epidemic disasters have continuously increased at the same rate of 20 events after each 5-year period save the drastic increase by nearly 3 times during the period 1995-1999. Although at a lower scale the famine disasters showed an exponential increase in numbers from the period 1980 to 1999, whereas the total number has dropped from 30 events to nearly 10 events for the 5-year period 2000-2004. The characteristics of these trends will be further discussed based on the analysis of the impact in terms of the number affected people. Unlike other events, wave/surge disasters occur at a much lower scale in the range of a single disaster per year in average. Nevertheless, the trend increased tremendously in a quasi polynomial shape at the rate of 2^n since the period 1985-1989 (where n is the increment step unit for each 5-year period).

Figure 4.4 illustrates the state of the trends of water-related disasters in each continent. Evidently, all 5 continents have continuously suffered a larger number of water-related disasters with a particularly drastic increase since the end of 1990s. The regional trend and proportion of water-related disasters, plotted for the period 1960-2004, showed quasi-exponential increasing rates after each successive 5-year period. While the number of disasters for the period 1960-1964 was as low as 170 events for all continents, the global end range of disastrous events by the period 2004-2005 was as high as 1700 events. For instance, the number of disasters in the Oceania increased from 5 events for the period 1960-1964 to 20 events by 1974 to 45 events during the next 5 year period (1975-1979). While the trend from 1979 to 1999 was quasi-invariable the following 5-year period showed a drastic increase by nearly 20 events. In Europe, beside the decreasing trend during the period 1984-1989, the European continent suffered continuous increase at different rates. For instance, the increasing rate was quasi-linear for the periods 1960-1979 and 1985-1999 (i.e., an increase by 10 and 20 events correspondingly as compared to the respective previous 5-year period). The rate exponentially increased for the period 2000-2004 by about 100 events. In Africa, unlike the steady period from 1980 to 1994 (i.e., equal number of disasters for each 5-year period), two distinctive trends were representative of the data, the linear increasing rate of about 25 events in average for every 5-year period (period from 1960 to 1984), and a drastic increase at the rate of 25 events per year (i.e., 100 events per successive 5-year period) for the period from 1994 to 2004. In the Americas, apart from the steady increase of nearly 10 events after each 5-year period for the periods from 1965 to 1979 and the period 1995-1999, the number of water-related disasters has uniformly increased at the rate of 50 events in average after each 5-year period. At the top of the list of all continents, the number of water disasters after each 5-year period in Asia has increased from about 90 events in the period 1960-1964 to more than 600 events by the end of 2004. While the increasing rate was at about 20 events for each 5-year period in average by the year 1974, the increasing magnitude rose to nearly 70 events in average for each 5-year period by 1999. The period 2000-2004 counted nearly 200 additional events as compared to the previous periods.

As commented earlier (see in particular Figures 3.2, 3.6 and 3.9), there is undoubtedly an increasing improvement in the reporting mechanism of disasters in EMDAT. Nevertheless, the temporal variation of the trends plotted for each individual water-related disaster as in Figure 4.3 and the temporal variation of the trends by continent as in Figure 4.4 clearly reflect the decreasing resiliency of the world communities to water-related disasters. Figure 4.5 illustrates the exposure ratio of each continent to the different types of water-related disasters (for this figure we have excluded the technological water-related disasters from the statistics). The figure shows flood and windstorm at the top of the list of water-related disasters striking most of the continents (i.e. accounted for more than 80% of the total number of disasters that occurred in each continent). The exception is for the African continent where the number of flood disasters (including flood and windstorm), drought (including famine) and epidemic water-related disasters are relatively equal in scale. The number of water-related disasters in Asia exceeded a total of 1400 events, which is about one third higher than the number of disasters in the Americas and Africa and more than three times the total disasters in Europe and Oceania.

Under these conditions it is one of our set targets to acquire an in-depth understanding of the major temporal variations of each type of water-related disaster in terms of the trends of events and impacts. The assessment is separated into three groups, namely the trends of events, the trends of the number of killed people and trends of the total number of affected people as reported in EMDAT. At the national levels further analysis is undergoing to define similarities and differences in the vulnerability and resiliency of affected countries to particular water-related disasters. In-depth knowledge of the details behind such classification and resulting consequences is a step forward to enhance know-how sharing between countries suffering from similar water-related disasters.



	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	89	118	121	199	263	298	412	410	618
Africa	13	47	67	84	141	130	136	259	413
Americas	54	94	90	91	159	234	269	304	387
Europe	9	18	27	37	88	60	101	115	216
Oceania	5	16	20	45	44	52	50	53	70

Figure 4.4. Trends of water-related disaster by continent for each 5 year period from 1960 to 2004.

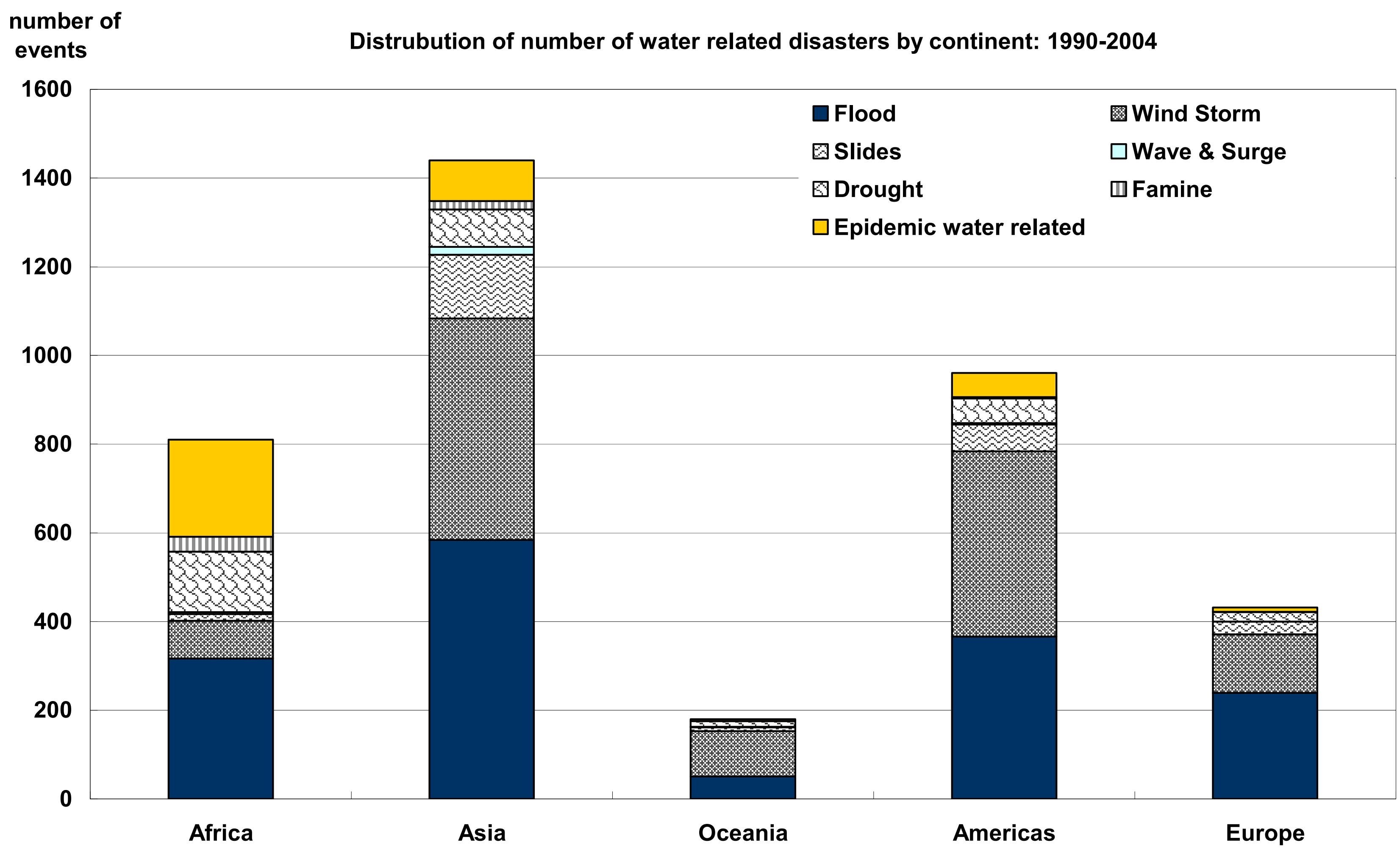
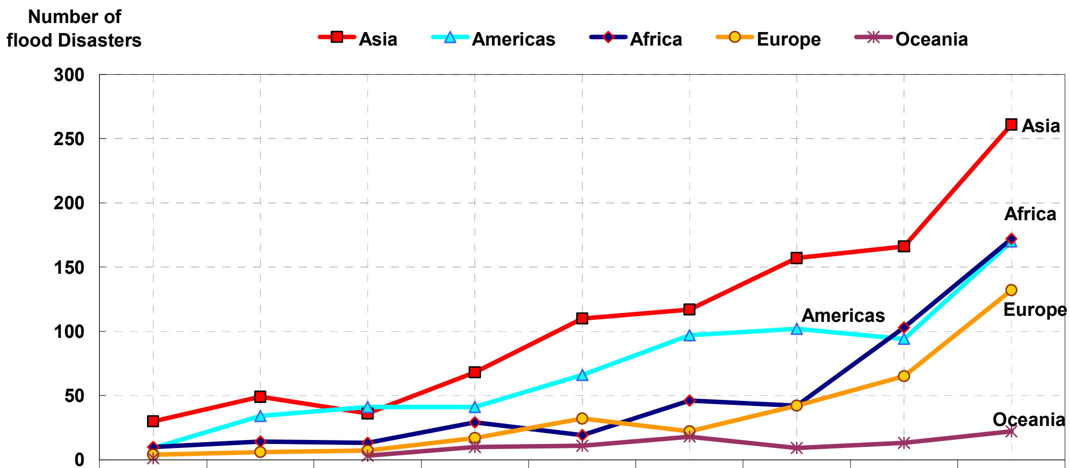


Figure 4.5. Distribution of water-related disaster by continent for the period from 1990 to 2004.

Figures 4.6 through 4.14 depict the temporal variations of the trends of the number of water-related disasters reported for each continent plotted on a 5-year period basis. Flood, windstorm, landslide and wave/surge disasters are the highest for Asia and Americas, while the trends in Europe, Africa and Oceania were closely within the same scale. On the other hand drought, famine and epidemic water-related disasters have shown drastic increases in Africa while the trends for all other continents increased at lower rates or even decreasing.

Figure 4.6 illustrates that the number of flood events have increased globally during the past decade interfered by a number of decreasing and steady periods (i.e., periods of a decreasing or eventually equal number of disasters during two successive 5-year periods). Unlike Oceania which witnessed an increasing trend by few events after each period, Europe and Africa showed large shifts in the trends' directions since early 1990s. In recent decades, the data shows that the American continent was continuously the second most vulnerable continent to flood after Asia. The most affected countries in terms of the number of disasters in Asia are India and China Republic, followed by Bangladesh, the Philippines and Iran. Japan ranked number 10 after Pakistan in terms of the numbers of flood disasters.



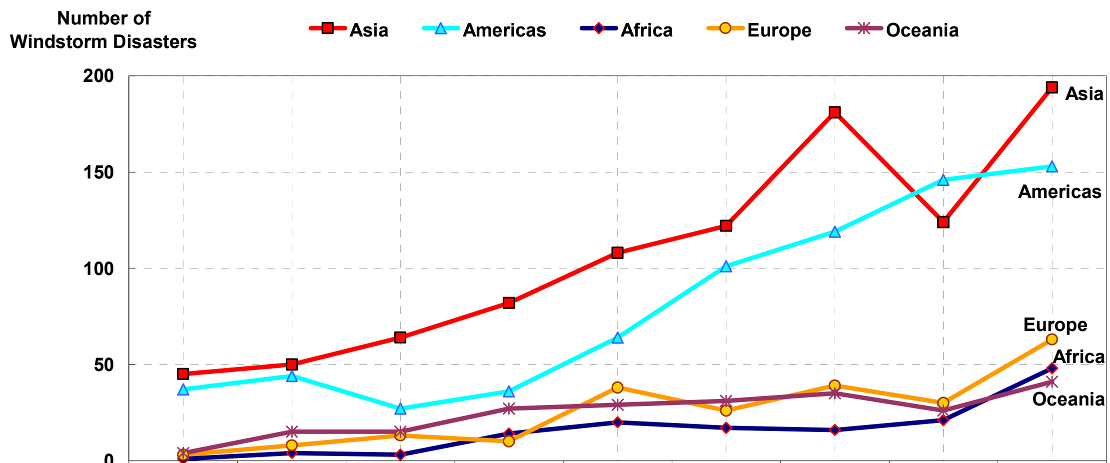
	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	30	49	36	68	110	117	157	166	261
Americas	9	34	41	41	66	97	102	94	170
Africa	10	14	13	29	19	46	42	103	172
Europe	4	6	7	17	32	22	42	65	132
Oceania	1		3	10	11	18	9	13	22

Figure 4.6. Trends of flood disaster by continent for each 5-year period: EMDAT 1960-2004.

At the global scale, windstorm disasters are about 100 events fewer in number as compared to floods. The number of events showed continuously increasing trends in Asia and the Americas (save the exceptional decrease in Asia for the period 1995-1999). For the rest of the continents the range was quasi-uniform around 30 to 40 events per 5-year period since the early 1980s (see Figure 4.7). At this stage it is important to notice the difficulties to distinguish between flood disaster and windstorm disaster (i.e., for instance, most floods occurring in Asia and Americas are triggered by typhoons and tropical cyclones, respectively.).

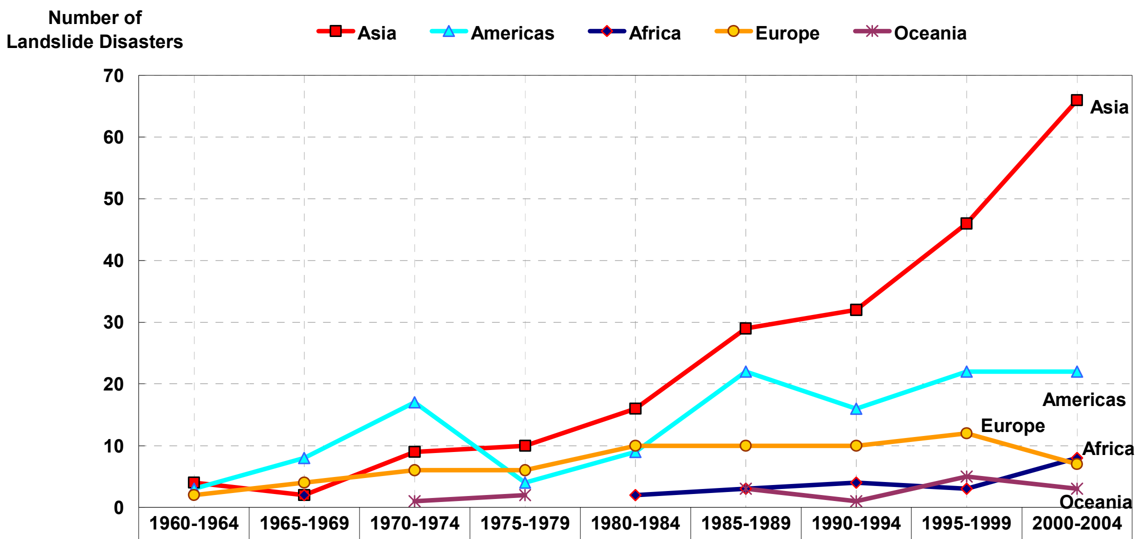
Figure 4.8 depicts the trend of landslide disasters (including avalanche) for the five continents from 1960 to 2004. Africa, Europe and Oceania suffered nearly constant number of disastrous landslide events since the mid 1980s. In contrast, the number of disasters in Americas has nearly doubled since 1980s, while the number in Asia has increased with quasi exponential rate from nearly 10 to 70 events by the end of the year 2004.

Figure 4.9 depicts the number of wave and surge disasters (including tsunami). Beside the increasing trend in Asia the data for the other continents are scattered and rare events. The historical event was undoubtedly the Indian Ocean Tsunami triggered by the Sumatra Earthquake in 26 December 2004.



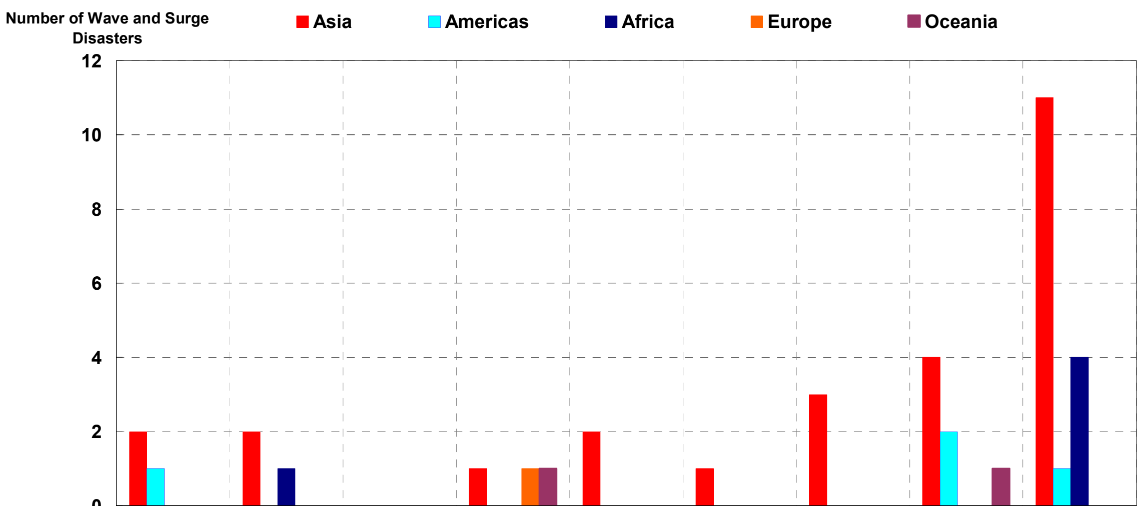
	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	45	50	64	82	108	122	181	124	194
Americas	37	44	27	36	64	101	119	146	153
Africa	1	4	3	14	20	17	16	21	48
Europe	3	8	13	10	38	26	39	30	63
Oceania	4	15	15	27	29	31	35	26	41

Figure 4.7. Trends of windstorm disaster by continent for each 5-year period: EMDAT 1960-2004.



	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	4	2	9	10	16	29	32	46	66
Americas	3	8	17	4	9	22	16	22	22
Africa		2			2	3	4	3	8
Europe	2	4	6	6	10	10	10	12	7
Oceania			1	2		3	1	5	3

Figure 4.8. Trends of landslide and avalanche disaster by continent for each 5-year period: EMDAT 1960-2004.

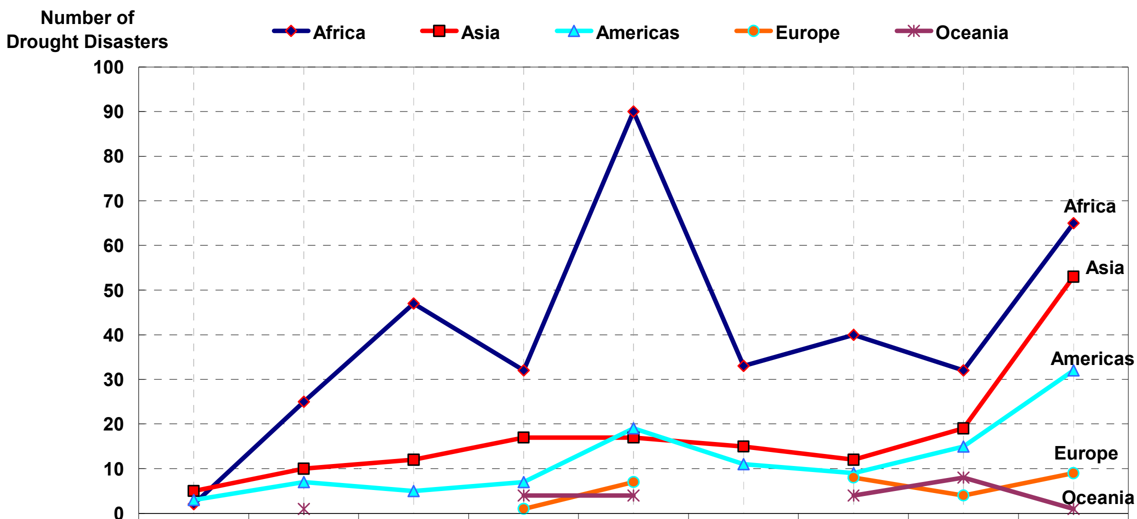


	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	2	2		1	2	1	3	4	11
Americas	1							2	1
Africa		1							4
Europe				1					
Oceania				1				1	

Figure 4.9. Trends of wave and surge disaster by continent for each 5-year period: EMDAT 1960-2004.

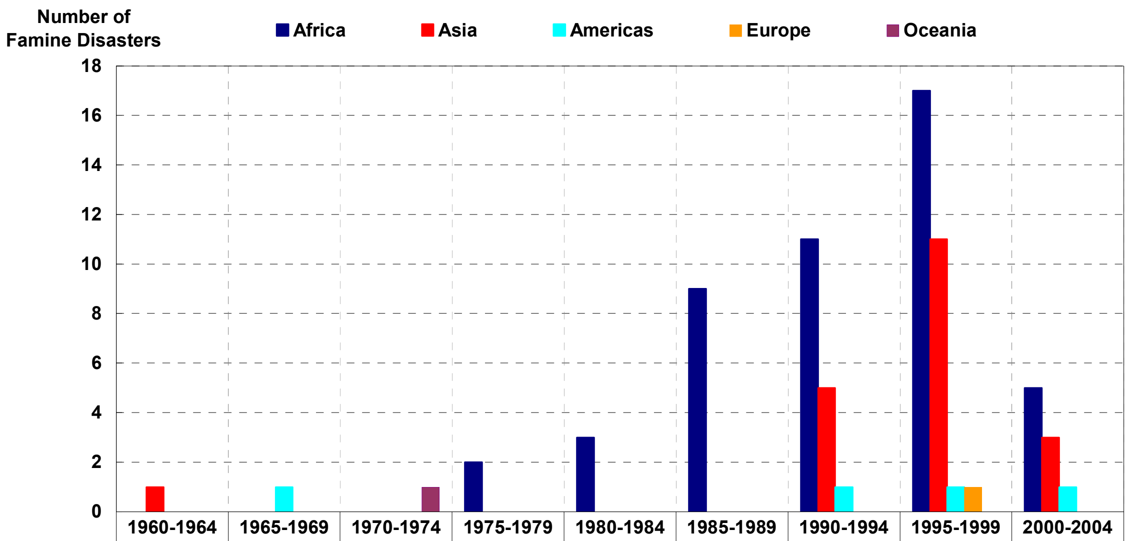
Droughts and famines (which are also a major direct consequence of drought) are the most prevailing disasters in Africa. As shown in Figure 4.10, the average number of drought disasters in Africa were about 40 events in average, while for the other continents the number was around 10 events at each 5-year period. The demarcating value is the total number of droughts in the 1980-1984 period. Unlike the limited spatial coverage of flood disasters, most of the countries in Africa were stricken an annual average of 2 to 4 events. Among the 41 affected states, 16 states were stricken by a single drought event while as high as 6 events were recorded in Mozambique alone. Another demarcating, if not alarming, condition is the drastic increase in the number of drought events during the 2000-2004 period.

Figure 4.11 depicts the number of famine disasters during the past four decades and a half. The continuous and drastic increase of famine disasters in Africa since the mid 1970s and Asia during the 1990s requires an in-depth assessment to evaluate the effectiveness of decades of international actions to reduce extreme poverty (i.e., famine at the top of the list). The radical declining numbers in 2000-2005 are not a strong evidence to claim victory against poverty, indeed famine disasters in the Americas had periodically occurred since the 1990s and Europe was not an exception for the period 1995-1999.



	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Africa	2	25	47	32	90	33	40	32	65
Asia	5	10	12	17	17	15	12	19	53
Americas	3	7	5	7	19	11	9	15	32
Europe				1	7		8	4	9
Oceania		1		4	4		4	8	1

Figure 4.10. Trends of drought disaster by continent
for each 5-year period: EMDAT 1960-2004.



	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Africa				2	3	9	11	17	5
Asia	1						5	11	3
Americas		1					1	1	1
Europe								1	
Oceania			1						

Figure 4.11. Trends of famine disaster by continent for each 5-year period: EMDAT 1960-2004.

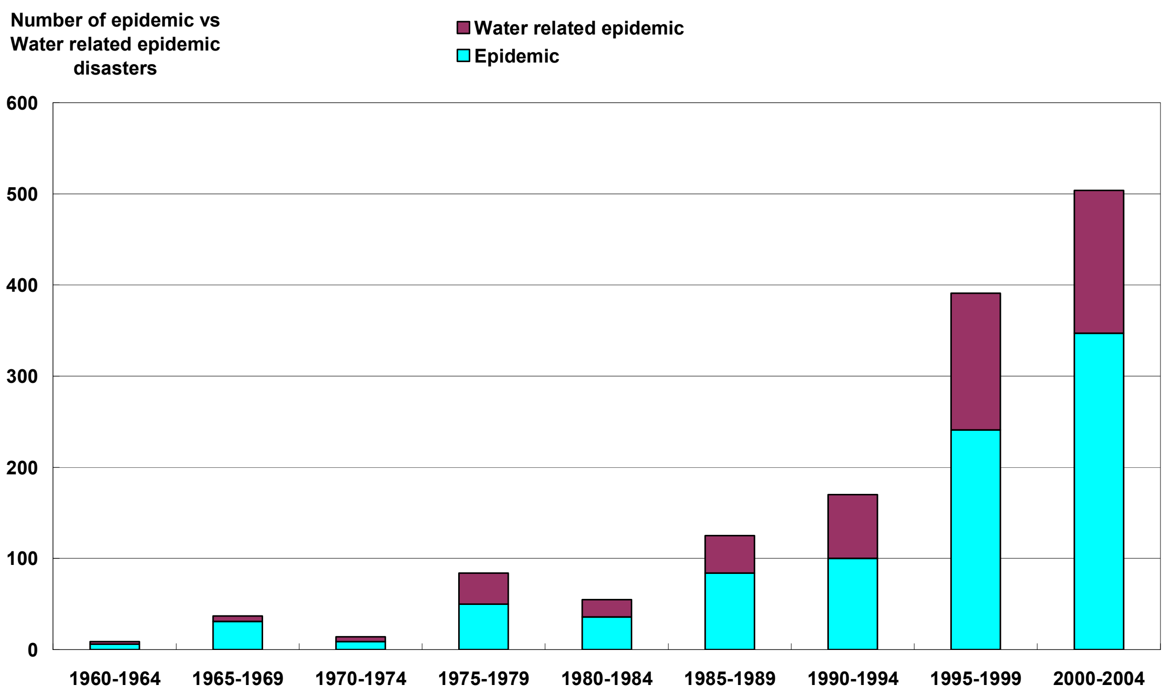
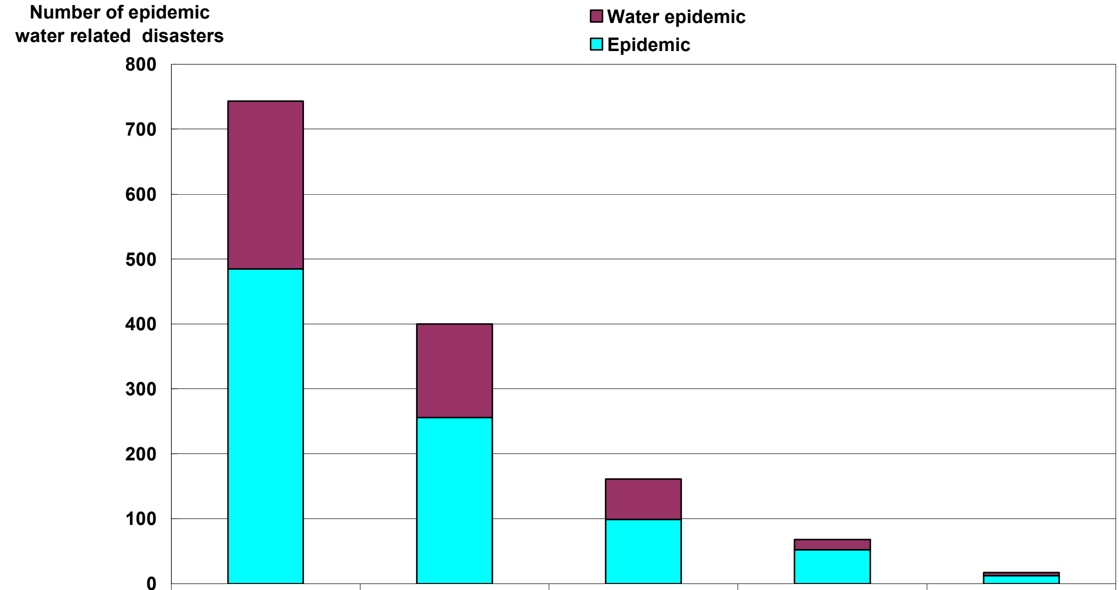


Figure 4.12. Temporal distribution of epidemic disasters versus epidemic water-related disasters for each 5-year period: EMDAT 1960-2004.



	Africa	Asia	Americas	Europe	Oceania
Water epidemic	258	144	62	16	5
Epidemic	485	256	99	52	12

Figure 4.13. Distribution of epidemic water-related disaster by continent for each 5-year period: EMDAT 1960-2004.

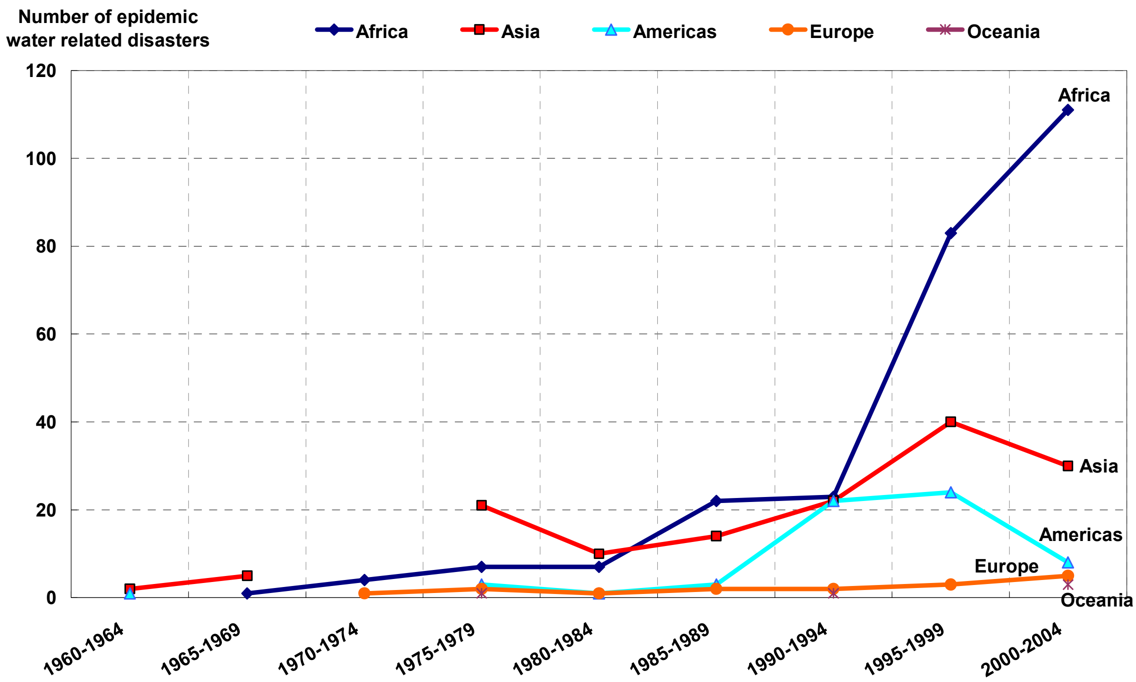


Figure 4.14. Trends of epidemic water-related disaster by continent for each 5-year period: EMDAT 1960-2004.

Along with famine disasters, epidemic disasters also increased in number during the past decades. Epidemic disasters in EMDAT are reported by type with reference to the disease names and categories. The list of epidemic water-related considered hereafter (see Table 4.1) was made based on the World Health Organization (WHO) definitions (WHO, 2005). As can be seen from Figure 4.12, water-related epidemics accounted for nearly a third of the total number of epidemic disasters.

Whereas the number of epidemic disasters were expected to decrease as results of the continuous worldwide efforts to ensure increasing access of population to safe drinking water and better sanitation, controversially the figure shows continuous sever increase in number after each period. The geographical distribution by region (see Figure 4.13) places Africa at the top of the list with nearly 250 water-related epidemic events out of a total of nearly 700 epidemic disasters.

The related temporal variation of trends plotted for each 5-year period is shown in Figure 4.14. The figure shows that the number of disastrous events in Africa still shows an exponential increase, while the trends in Asia and Americas have started to decrease since the beginning of the 21st Century.

In the following sections we present the analysis undertaken on the consequences of each of the above introduced water-related disasters in terms of the numbers of killed people and the number of total affected people.

Table 4.1. Entry of epidemic water-related disasters in EMDAT.

Type of epidemic	Disease name
Arbovirus	Acute Hepatitis
Diarrhoeal/Enteric	Cholera
Diarrhoeal/Enteric	Typhoid
Diarrhoeal/Enteric	Shigellosis
Diarrhoeal/Enteric	Acute diarrhoeal syndrome
Diarrhoeal/Enteric	Acute respiratory syndrome
Diarrhoeal/Enteric	Acute watery diarrhoeal syndrome
Diarrhoeal/Enteric	Typhoid fever
Diarrhoeal/Enteric	Shigellosis
Diarrhoeal/Enteric	Typhoid fever
Diarrhoeal/Enteric	{NOT DEFINED in EMDAT}
Viral Hepatitis	Acute Hepatitis E
Malaria	

4.2. Regional assessment of social impacts of water-related disasters

Undoubtedly, the development of an appropriate mitigation plan begins by developing a mechanism for accurate risk quantification leading to accurate assessment of socio-economic damages and impacts of disasters. The United Nation General Assembly, held in 1998, has declared the decade 1990-1999 the "International Decade for Natural Disaster Reduction". One of the specific goals set for the decade is "to disseminate existing and new information related to measure for the assessment, prediction, prevention, and mitigation of natural disasters." Its objectives were to reduce the loss of life and property damage by natural disasters through concreted international action and appropriate use of science and technology (Ajmad, 1999). While a lot has been achieved since the start of the decade, the UN Secretary General declared that: "…we continue to confront major challenges…It is a tragic irony that 1998, the penultimate year of the Disaster Reduction Decade was also a year in which natural disasters increased so dramatically."

The analysis of actual and potential impacts of water-related disasters is problematic due to the multifaceted uncertainties and challenges that we are still confronting to accurately define and afterward evaluate social damages. The most ambiguous definition is undoubtedly that of affected people. The countability of social impacts (i.e., the number of killed people and the number of total affected people as reported in the existing international databases) responds to the goal and objectives of the developing institute. Nevertheless, the reported values are also affected by the social and political conditions imposed in the country where the disaster has occurred. Some of these issues, particularly related to EMDAT and other natural disaster databases, have been discussed elsewhere and are not repeated here (see for example Guha-Sapir 2002; Wisner et Al. 2004). In addition to the influence of the reporting mechanism, reliable identification and quantification of the social and economical damages are also strongly biased by the assessment methodology.

- **Temporal trend analysis based on each decade:**

In the aim of clarifying some of the dilemma coupled with the assessment of social impacts, the analysis of the trends of the number of killed people and the number of total affected people by water-related disasters was carried out under two time scales, specifically decade period and 5-year period scales. Each value on the decade graph represents the total of all reported data (the number of killed or affected) during the specific decade, whereas for the 5-year period the value on the graph is the accumulated data reported during the considered 5-year period.

The analysis of disasters data on a decade basis has gained wide acceptance among professionals and practitioners at all levels of decision making especially when it is desired to understand the trend of impacts of hazards and/or mitigation progress over long-term periods. Nevertheless, it is important to note that while the decade analysis of impact of disasters allows to put clear emphasis on the long-term variation of the trends from a global standpoint, results such as of figures 3.1, 3.5 and 3.9 put strong emphasis on the importance to carry out vigilant data processing on short-term basis in order to draw reliable conclusions for assessing the progress achieved and effectiveness of adopted policies in water-related disaster mitigation.

The analysis of the social impacts reported by EMDAT database for the period from 1960 to 1999 is shown in Figure 4.15. The figure allows to extract focal particulars concerning the temporal variation of the trends of social impacts which are hardly visible under different time scales. From this long-term and global perspective it is clear that the numbers of killed people after each successive decade showed a continuous decrease from nearly 2 million people in the 1960s to 0.5 million in the 1990s. A distinctive characteristic is the variations of the values of the successive gradients of the trends of killed people between decades. Particular denomination is the gradient of the trend between the 1960s and the 1970s dropping by nearly 10 million people compared to about 0.2 million people each for the trends during the successive between the 1970s and the 1990s. It is not granted that the steep gradient of killed people shown by the trend between 1960s and the 1970s is a result of effective policies at the global level to mitigate water-related disasters. In fact, while some of this success could be attributed to what is called an improved disaster reduction polices, a close examination of the database reveals that the picture is more complex and might also include an improved political will to fairly report disasters' information (especially records on extreme disastrous events).

Tables 4.2 through 4.5 show the impacts of the top 10 disastrous events in terms of the number of killed people as reported by EMDAT for each decade from the 1960s to the 1990s. It is clear from the tables that the respective trends and their gradients (see Figure 4.15) are delineated by the trend of top ten disastrous events reported during the decade. In other words, about 90% of the total number of killed people during the decade in question is included within the top 10 events. For instance, Table 4.1 shows that the trend 1960s-1970s is mainly delineated by the extreme events during the period 1965-1969 characterized by the three successive years of the sever drought in India (from 1965 to 1967), which claimed the life of 500,000 people at each one year (i.e., 1.5 million people were reported killed in total)[1]. The

---

[1] For this particular drought, in spite of the reported 500,000 death each year, the total number of affected people was 100 million people (about 1/5 of the population in 1965) during the first year (1965) whereas the values for the 2nd and 3rd year were zero, respectively. While we can provide a series of assumptions to explain these data, it is clear that the consistency of such extreme values should be interpreted with caution as it can only be verified with reference to the national disasters database.

deadliest calamities after the 1965 drought in India are the epidemic malaria in Sri Lanka (which killed 200,000 people killed), followed by the series of floods in Bangladesh (reported to kill between 10,000 and 36,000 people) and lastly the drought in Indonesia, which killed 8,000 people. The maximum, minimum and average values of killed people during the two decades 1970s and 1980s were closely the same which delineates the gentle gradient between the two decades. In the 1990s the only event that killed more than 100,000 people was the windstorm of 1991 in Bangladesh. Demarcating data are the five successive years (1995-1999) of famine disasters in the Democratic People's Republic of Korea. While no location was specified for the years 1995, 1996 and 1999, the disaster of 1997 had occurred in the Northern and Southern Hamgyong provinces, whereas in 1998 it affected the whole country. In addition to the above, the disasters were reported to kill the same number of 27,500 people each year. The quality assessment of such data is not discussed herein, but for this particular disaster we highly recommend reviewing the report by Action for Hunger (see ReliefWeb, 2000).

In the contrast to the slow rate decrease in the number of killed people during the past decades, the trends of the total numbers of affected people had exponentially increased from nearly 500 million in the 1960s to about 3000 million people in the 1990s (see Figure 4.15). In other words, at each decade the number of affected people have increased by over 3 times as compared to the former decade. Tables 4.6 through 4.9 report the top 10 disastrous events in terms of affected people by water-related disasters. Demarcating data are the numbers of affected people by the top most devastating water-related disasters in each decade ranging from 100 million to 300 million people for the droughts of 1965, 1979 and 1987 in India. The top 10 disastrous events in the 1990s were all flood type affecting between 240 millions (flood of 1998 in China Rep.) to 30 millions people (flood of 1997 in India). Comparing respective tables (table of killed people and respective table of affected people) for each decade, it is clear that the term “disastrous event” is subjective as we do not consider the exposed population to the disaster (see UNDP, 2004). It is also interesting to notice that the same event is rarely reported in both tables (i.e., table of killed people and table of total affected people for each decade). If occasionally the same event is reported in both tables (such as the floods of 1987 and 1974 in Bangladesh) then their ranking in terms of severity is different (save the drought of 1965 in India, which is the most disastrous event in EMDAT reporting history). A close look at larger ranking (e.g., top 100 events for example) shows further complicated interrelation between the multifaceted consequences triggered by any single event (a further discussion on some of these issues is presented in Chapter 5).

As presented earlier (see Figure 3.3), 24% of the total number of natural disasters (assessed on a 5-year period basis) have occurred during the 2000-2004 period. In order to delineate the ratio of the global social impacts since the beginning of the 21st century (2000-2004) as compared to the past decades, the numbers of killed and affected people are also depicted in Figure 4.15 (dotted bar graph of the figure). The figure points out that since the beginning of the 21st Century the number of killed people is nearly in the same range as of the past decade, whereas the number of affected people has already surpassed two-thirds of the records in the 1990s decade. The conclusions behind these numbers are better understood when seen from the global picture plotted for each 5-year period and for each continent as shown in Figure 4.16 (trends of the number of killed people) and Figure 4.17 (trends of the total number of affected people).

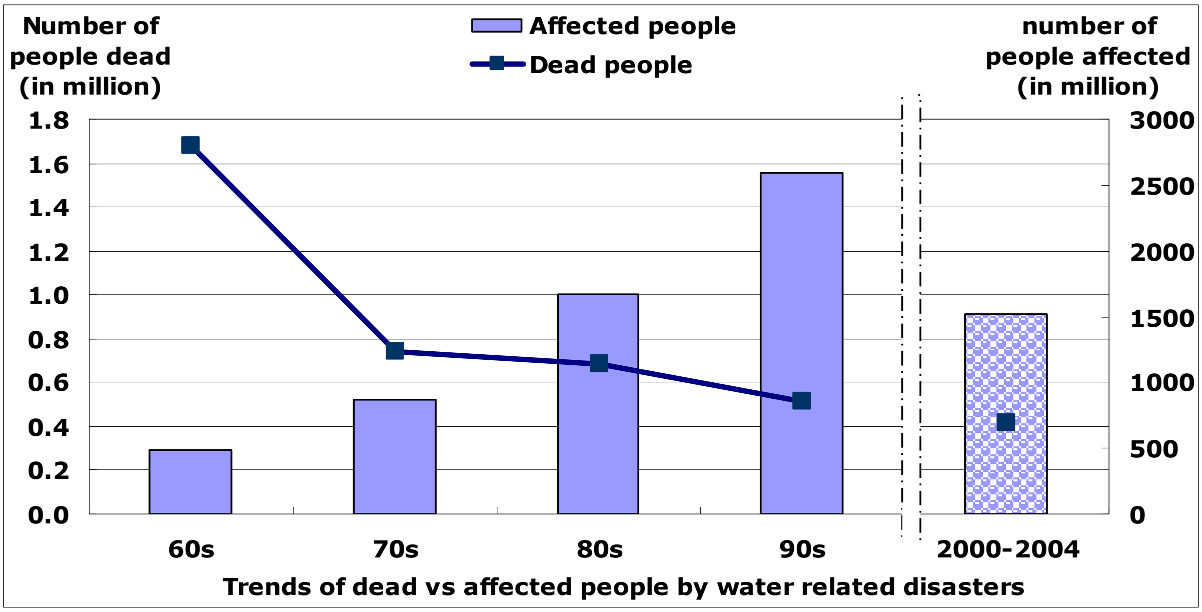


Figure 4.15. Trends of the number of killed people versus affected people: EMDAT 1960-1990 and the 5-year period 200-2004.

Table 4.2. EMDAT top 10 water-related disasters in terms of killed people in the 1960s.

Rank	year	dis_type	dis_subset	country_name	no_killed
1	1965	Drought	Drought	India	500,000
2	1966	Drought	Drought	India	500,000
3	1967	Drought	Drought	India	500,000
4	1965	Wind Storm	Cyclone	Bangladesh	36,000
5	1965	Wind Storm	Cyclone	Bangladesh	12,047
6	1963	Wind Storm	Cyclone	Bangladesh	11,500
7	1961	Wind Storm	Cyclone	Bangladesh	11,000
8	1960	Flood	Flood	Bangladesh	10,000
9	1965	Wind Storm	Cyclone	Pakistan	10,000
10	1966	Drought	Drought	Indonesia	8,000
				Average 60s	159,855

Table 4.3. EMDAT top 10 water-related disasters in terms of killed people in the 1970s.

Rank	year	dis_type	dis_subset	country_name	no_killed
1	1970	Wind Storm	Cyclone	Bangladesh	300,000
2	1974	Drought	Drought	Ethiopia	200,000
3	1973	Drought	Drought	Ethiopia	100,000
4	1974	Flood	Flood	Bangladesh	28,700
5	1974	Drought	Drought	Somalia	19,000
6	1977	Wind Storm	Cyclone	India	14,204
7	1971	Wind Storm	Cyclone	India	9,658
8	1974	Wind Storm	Hurricane	Honduras	8,000
9	1978	Flood	Flood	India	3,800
10	1973	Slides	Landslide	Honduras	2,800
				Average 70s	68,616

Table 4.4. EMDAT top 10 water-related disasters in terms of killed people in the 1980s.

Rank	year	dis_type	dis_subset	country_name	no_killed
1	1984	Drought	Drought	Ethiopia	300,000
2	1984	Drought	Drought	Sudan	150,000
3	1984	Drought	Drought	Mozambique	100,000
4	1985	Wind Storm	Cyclone	Bangladesh	10,000
5	1980	Flood	Flood	China P Rep	6,200
6	1989	Famine	Food shortage	Mozambique	5,200
7	1984	Drought	Drought	Chad	3,000
8	1988	Epidemic	Arbovirus	India	3,000
9	1982	Epidemic	Diarrhoeal/Enteric	Bangladesh	2,696
10	1987	Flood	Flood	Bangladesh	2,379
				Average	58,248

Table 4.5. EMDAT top 10 water-related disasters in terms of killed people in the 1990s.

Rank	year	dis_type	dis_subset	country_name	no_killed
1	1991	Wind Storm	Cyclone	Bangladesh	138,866
2	1999	Flood	Flood	Venezuela	30,000
3	1995	Famine	Food shortage	Korea Dem P Rep	27,500
4	1996	Famine	Food shortage	Korea Dem P Rep	27,500
5	1997	Famine	Food shortage	Korea Dem P Rep	27,500
6	1998	Famine	Food shortage	Korea Dem P Rep	27,500
7	1999	Famine	Food shortage	Korea Dem P Rep	27,500
8	1998	Wind Storm	Hurricane	Honduras	14,600
9	1999	Wind Storm	Cyclone	India	9,843
10	1991	Epidemic	Diarrhoeal/Enteric	Peru	8,000
				Average 90s	33,881

Table 4.6. EMDAT top 10 water-related disasters in terms of affected people in the 1960s.

Rank	year	dis_type	dis_subset	country_name	no_affected
1	1965	Drought	Drought	India	100,000,000
2	1968	Flood	Flood	Bangladesh	14,910,892
3	1965	Wind Storm	Cyclone	Bangladesh	10,000,000
4	1968	Flood	Flood	India	7,500,000
5	1963	Wind Storm	Storm	India	5,000,000
6	1966	Slides	Landslide	Brazil	4,000,000
7	1965	Flood	Flood	Japan	3,000,000
8	1968	Drought	Drought	Korea Rep	2,800,000
9	1967	Drought	Drought	Korea Rep	1,905,944
10	1966	Wind Storm	Cyclone	Bangladesh	1,500,000
				Average 60s	15,061,684

Table 4.7. EMDAT top 10 water-related disasters in terms of affected people in the 1970s.

Rank	year	dis_type	dis_subset	country_name	no_affected
1	1979	Drought	Drought	India	190,000,000
2	1972	Drought	Drought	India	100,000,000
3	1973	Drought	Drought	India	100,000,000
4	1974	Flood	Flood	Bangladesh	36,000,000
5	1978	Flood	Flood	India	32,000,000
6	1975	Flood	Flood	India	27,000,000
7	1979	Flood	Flood	India	26,000,000
8	1970	Flood	Flood	India	10,000,000
9	1970	Drought	Drought	Brazil	10,000,000
10	1970	Flood	Flood	Bangladesh	10,000,000
				Average 70s	54,100,000

Table 4.8. EMDAT top 10 water-related disasters in terms of affected people in the 1980s.

Rank	year	dis_type	dis_subset	country_name	total_affected
1	1987	Drought	Drought	India	300,000,000
2	1989	Flood	Flood	China P Rep	100,010,000
3	1982	Drought	Drought	India	100,000,000
4	1983	Drought	Drought	India	100,000,000
5	1987	Flood	Flood	Bangladesh	73,000,000
6	1988	Flood	Flood	Bangladesh	73,000,000
7	1988	Drought	Drought	China P Rep	49,000,000
8	1982	Flood	Flood	India	33,500,000
9	1989	Wind Storm	Storm	China P Rep	30,007,500
10	1980	Flood	Flood	India	30,000,023
				Average 80s	88,851,752

Table 4.9. EMDAT top 10 water-related disasters in terms of affected people in the 1990s.

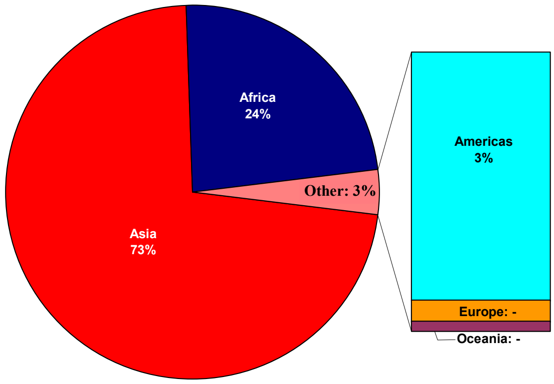
Rank	year	dis_type	dis_subset	country_name	total_affected
1	1998	Flood	Flood	China P Rep	238,973,000
2	1991	Flood	Flood	China P Rep	210,232,227
3	1996	Flood	Flood	China P Rep	154,634,000
4	1993	Flood	Flood	India	128,000,000
5	1995	Flood	Flood	China P Rep	114,470,249
6	1999	Flood	Flood	China P Rep	101,024,000
7	1994	Flood	Flood	China P Rep	78,974,400
8	1995	Flood	Flood	India	32,704,000
9	1994	Flood	Flood	China P Rep	30,547,665
10	1997	Flood	Flood	India	29,259,000
				Average 90s	111,881,854

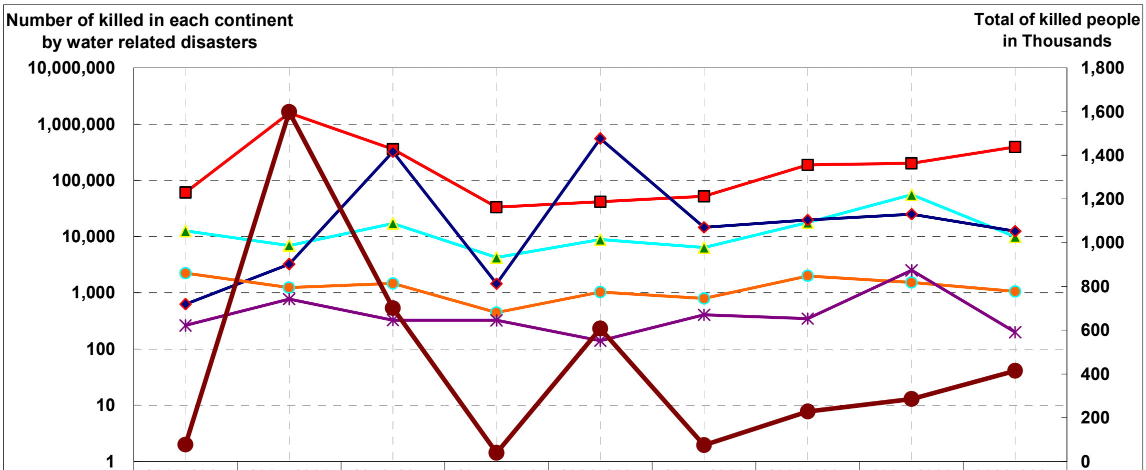
- **Temporal trend analysis based on each 5-year period:**

Figure 4.16 (trends of the number of killed people) and Figure 4.17 (trends of the total number of affected people) show that Asia is the most affected region by water-related disasters in the world. The number of killed people in Asia accounted for 73% of the total number of people killed by water-related disasters as compared to 24% for Africa and 3% for the Americas (ranked 3rd and 2nd respectively in terms of number of events). While statistically uncountable (>>1% for the entire period) the table of Figure 4.16 exemplifies the high number of people killed by water-related disasters in Europe and Oceania (about 12,000 and 5,000 people respectively).

Total numbers of affected people by water-related disasters from 1960 to 2004

Rank	Continent	Killed people	%
1	Asia	2,912,700	73
3	Africa	955,891	24
2	Americas	138,610	3
4	Europe	11,736	-
5	Oceania	5,274	-
Total		470,842,591	





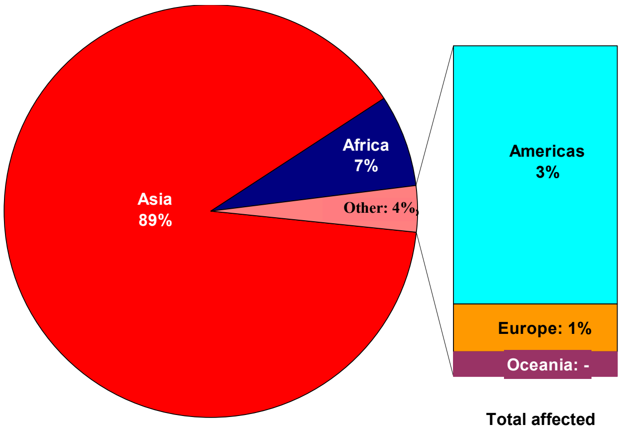
	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	60,902	1,585,940	359,193	33,256	41,332	52,016	187,760	200,976	391,325
Americas	12,512	6,914	17,065	4,231	8,839	6,352	17,590	55,201	9,906
Africa	626	3,227	322,800	1,451	556,413	14,529	19,748	24,933	12,420
Europe	2,219	1,242	1,455	443	1,026	784	2,000	1,513	1,054
Oceania	262	768	326	322	140	405	346	2,506	199
Total	76,521	1,598,091	700,839	39,703	607,750	74,086	227,444	285,129	414,904

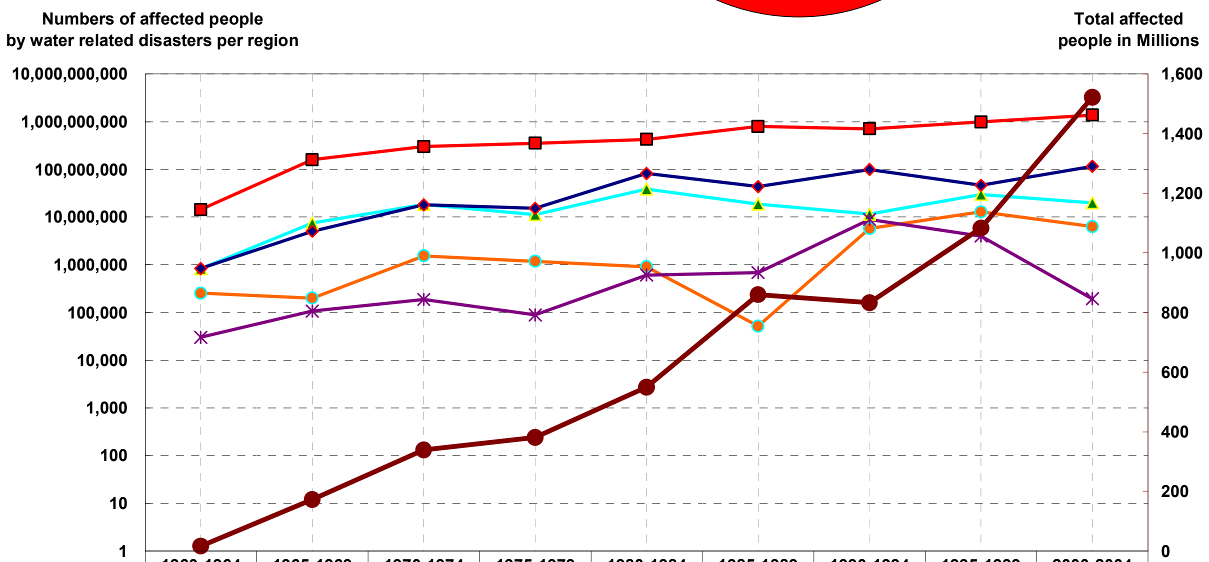
Figure 4.16. Trend of the number of killed people by water-related disaster by continent for each 5-year period from 1960 to 2004.

Concurrently the number of affected people in Asia accounted for 89% of the world total compared to 7% in Africa and 3% in Americas. As mentioned earlier, for more accurate risk evaluation these ratios should be also regarded with reference to the country population or the total exposed population (see UNDP 2004, and ISDR 2004). Nevertheless, the examination of the results presented in figures 4.16 and 4.17 explicitly confirms several important reflections:

Total numbers of affected people by
water-related disasters from 1960 to 2004

Rank	Continent	Killed people	%
1	Asia	5,127,208,992	89
3	Africa	426,953,362	7
2	Americas	156,638,252	3
4	Europe	29,071,205	1
5	Oceania	14,818,024	-
Total		470,842,591	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Aff. Asia	14,396,328	159,560,261	300,071,854	353,035,574	427,254,276	796,972,697	706,982,721	990,062,212	1,378,873,069
Aff. Americas	827,992	7,465,598	18,445,519	11,297,746	38,650,257	18,819,732	11,561,484	29,641,086	19,928,838
Aff. Africa	835,510	5,000,229	18,039,827	15,350,220	81,787,301	43,297,762	99,330,525	46,722,040	116,589,948
Aff. Europe	255,000	200,122	1,546,290	1,186,941	907,260	52,213	5,746,604	12,834,887	6,341,888
Aff. Oceania	30,000	107,204	186,090	88,932	611,755	685,078	8,909,076	4,004,877	195,012
Aff. Total	16,344,830	172,333,414	338,289,580	380,959,413	549,210,849	859,827,482	832,530,410	1,083,265,102	1,521,928,755

Figure 4.17. Trend of the number of affected people by water-related disaster by continent for each 5-year period since 1960 to 2004.

1. The statistical ratios are hardly representative of the true global image of disasters impact. For instance, during the period from 1960 to 2004, 3% of killed people by water-related disasters in Americas accounted for as high as 138,610 lives (see table of Figure 4.16); whereas 1% in terms of affected people in Europe accounted for as high as 20 million people (see table of Figure 4.17).
2. The global trend of dead people showed a continues increase since the end of the 20th Century. This finding put clear emphasis that the decreasing trend

between 1980s and 1990s plotted on decade basis is mainly driven by the low scale values of the 1990s decade as compared to the values of the 1980s decade;

3. The global trends of social impacts (both killed and affected people) are mainly delineated by the respective trends in Asia. Exceptionally, the trends for the periods between 1975 and 1989 are delineated by the trends in Africa;
4. At the regional level the trend of killed people is rather erratic with several drops and peaks with a slight decrease in the 2000-2004 period. Major drops are seen for the 1975-1979 and 1985-1989 periods. These deeps are the major values delineating the decreasing trends between the 1970s and 1980s plotted on a decade basis;
5. In the Americas, excepts the slight drop in the 1980-1984 period, the trend of killed people drastically increased from nearly 9,000 to 60,000 people; and
6. Apart from Asia the number of killed people showed a clear regional decrease at different scales and magnitudes. These regional characteristics must be taken into consideration when analyzing the results plotted on a decade basis. Further investigation in the following section is also undertaken for each type of disasters.

In terms of affected people:

7. Excepts the slight drop in the 1990-1994 period, the gradients of the trends of the total number of affected people showed continuous steepness after each 5-year period;
8. Apart from the continuous increase from 1960-1964 period to 1970-1974 period, the trend of affected people in Africa was demarcated by numerous peaks and drops (the average peaks were about 100 millions and the average drops were about 50 millions). The value by the end of the 2004 period was about 120 million people;
9. The trends of affected people in Americas observed similar erratic behavior. The range of affected people is however equivalent to the size of the population in the region (peaks were in the range of 40 million and drops were in the range of 10 million affected people);
10. The trend in Europe showed distinctive decrease during the periods from 1970 to 1989. However, the trends drastically increased from about 50,000 people in the 1985-1989 period to about 13 million in the 1995-1999 period;
11. The trend in Oceania drastically increased from 30 thousand people in the 1960s to 8 million people in the 1990-1995 period compared to 4 million people in 1996-2000 period. During the 2000-2004 period the total number of affected people in Oceania dropped to nearly 200 thousands people; and

12. During the 2000-2004 period, demarcating values are the decreasing trends of affected people in Europe, the Americas and Oceania as compared to the large increase in Asia and Africa.

In order to build a complete understanding of the regional characteristics of the social impacts, further analysis was carried out for each type of water-related disasters. The above observations and the following analysis of the regional trends carried out at finer temporal scale (5-year period basis) highlights some of the complication underlying the quantification of risks in water-related disasters from global and regional perspectives. In other words, extreme vigilance is sought in handling the data and interpreting the results of risk quantification in water-related disasters.

4.2.1. Regional trends of killed people by type of water-related disasters

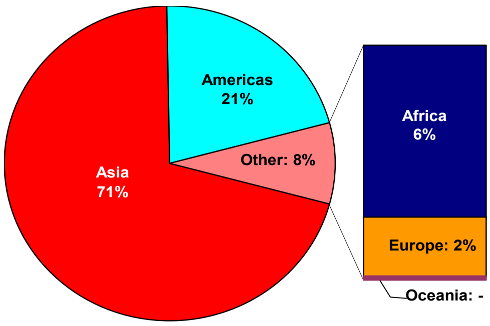
All the results hereafter are assessed on the basis of 5-year period from 1960 to 2004.

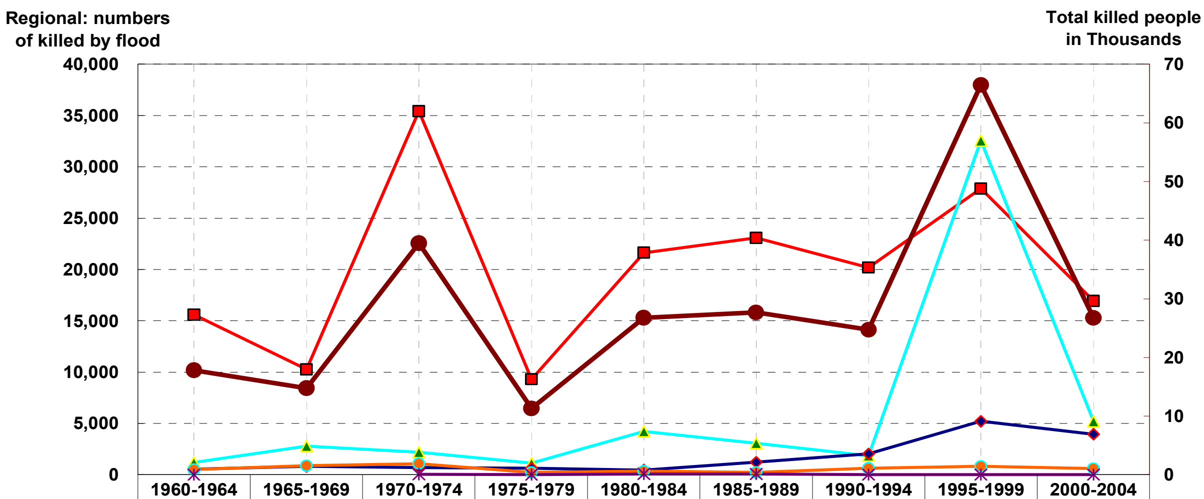
- **Flood (Figure 4.18):**

During the period from 1960 t0 2004 flood disasters claimed the life of nearly 300 thousand people. The trends of the number of killed people observed erratic conduct with an average of 5000 people killed each year. In contrast to the increasing values during the periods from 1975 and 1999, the trend of killed people in most continents was nearly 50% less in 2000-2004 (save Oceania, which showed a 50% increase) as compared to the previous period 1995-1999.

Total numbers of people killed by flood disasters from 1960 to 2004

Rank	Continent	Killed people	%
1	Asia	180,354	71
2	Americas	54,224	21
3	Africa	15,581	6
4	Europe	5,306	2
5	Oceania	269	-
Total		255,734	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	15,599	10,279	35,426	9,309	21,640	23,083	20,195	27,882	16,941
Americas	1,195	2,782	2,195	1,144	4,228	3,068	1,844	32,559	5,209
Africa	534	809	705	623	460	1,238	2,049	5,208	3,955
Europe	495	896	1,085	229	350	216	620	814	601
Oceania	1		53	7	94	68	13	11	22
Total	17,824	14,766	39,464	11,312	26,772	27,673	24,721	66,474	26,728

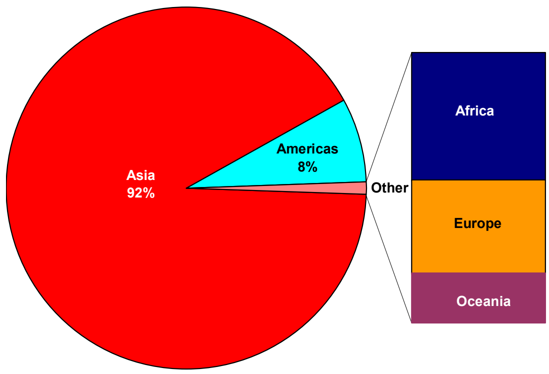
Figure 4.18. Distribution of the number of killed people by flood disaster by continent for each 5-year period from 1960 to 2004.

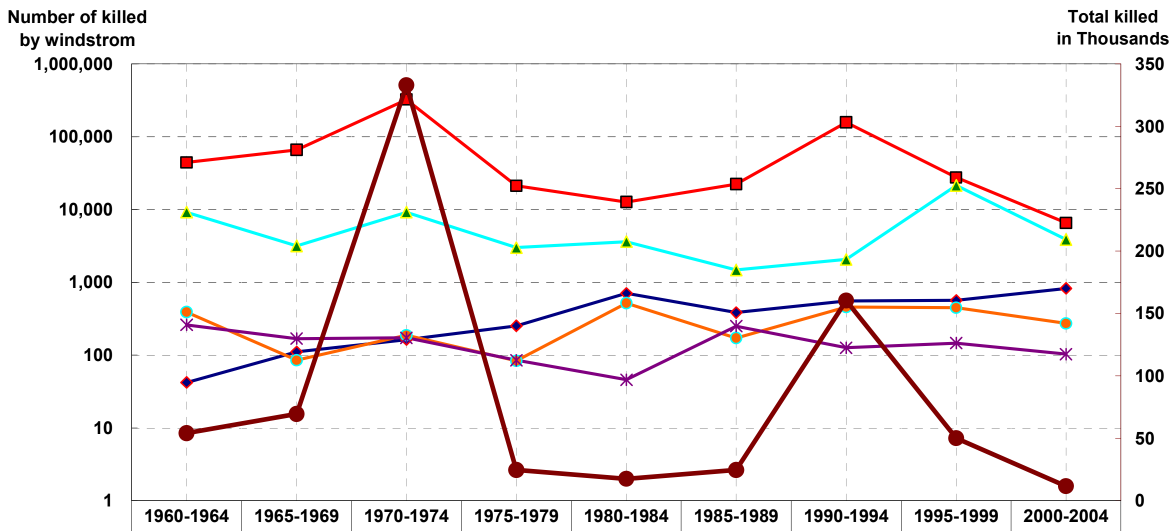
● Windstorm disasters (Figure 4.19):

In average, during any 5-year period from 1960 to 2004, 40% of the number of windstorm disasters occurred in Asia and the Americas, respectively. As can be seen from Figure 4.19, the share of the globally killed people is equivalent to the size number of disasters at regional level. Demarcating is the continuous decreasing trend between 1970 and 1989 in both Asia and Americas and the continuous increasing trend in Africa. In contrast to the severe peaks in the 1990s the trend of killed people largely decreased during the period 2000-2004, which for nearly 20% of the total number of disasters.

Total numbers of people killed by windstorm disasters from 1960-2004

Rank	Continent	Killed people	%
1	**Asia**	680,336	92
2	**Americas**	56,865	8
3	**Africa**	3,594	-
4	**Oceania**	2,609	-
5	**Europe**	1,358	-
Total		**744,762**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	44,121	65,867	323,254	21,077	12,631	22,327	157,090	27,457	6,512
Americas	9185	3149	9161	2984	3,603	1,478	2,053	21,382	3870
Africa	42	110	163	252	704	384	554	563	822
Europe	390	85	187	83	517	172	457	447	271
Oceania	261	168	173	85	46	250	126	146	103
Total	53,999	69,379	332,938	24,481	17,501	24,611	160,280	49,995	11,578

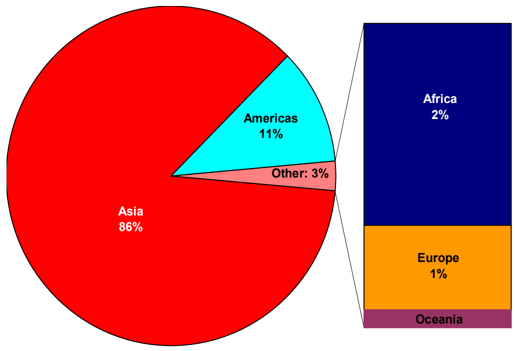
Figure 4.19. Distribution of the number of killed people by windstorm disaster by continent for each 5-year period from 1960 to 2004.

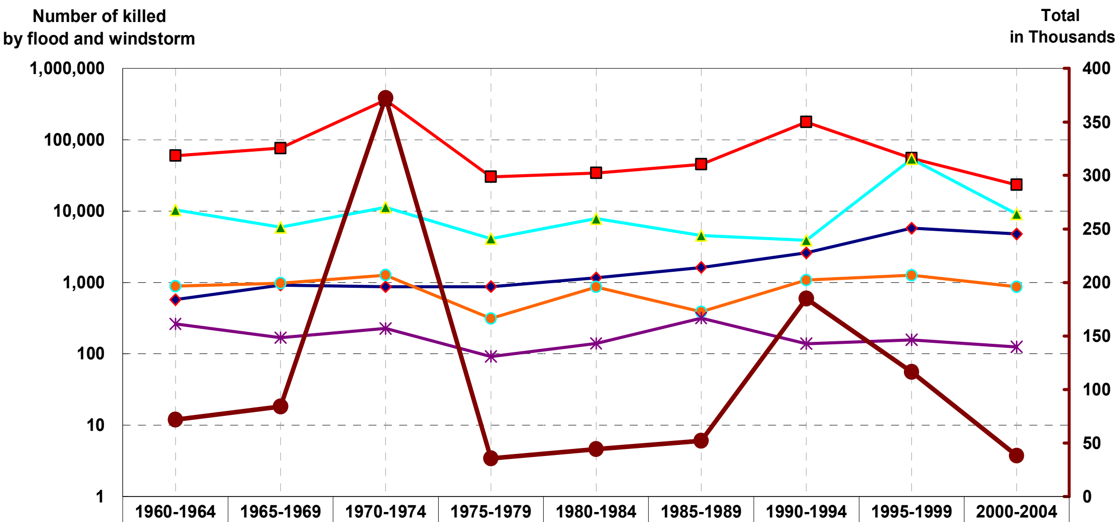
- **Flood and windstorm disasters (Figure 4.20):**

In Asia and Americas (most vulnerable continents to flood and windstorm) it is not an easy practice to separate between the consequences of the two events. For instance, in the monsoon Asia major large floods are triggered by typhoons. As seen from Figure 4.20, the 1970-1974 period and the 1990-1999 period have witnessed the most disastrous flooding events around the world. Besides, the slight numbers of peaks and drops during the whole period, demarcating values are the increasing trends in Africa, and the steady average numbers in Europe and Oceania for a number of periods. Detailed analysis on flood and windstorm disasters focusing on a comparative assessment between the national data of Japan and EMDAT is under-progress and will be the outcome of our next technical report.

Total numbers of people killed by flood and windstorm disasters from 1960-2004

Rank	Continent	Killed people	%
1	**Asia**	860,690	92
2	**Americas**	111,089	11
3	**Africa**	19,175	2
4	**Europe**	7,915	1
5	**Oceania**	1,627	-
Total		**1,000,496**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	59,720	76,146	358,680	30,386	34,271	45,410	177,285	55,339	23,453
Americas	10,380	5,931	11,356	4,128	7,831	4,546	3,897	53,941	9,079
Africa	576	919	868	875	1,164	1,622	2,603	5,771	4,777
Europe	885	981	1,272	312	867	388	1,077	1,261	872
Oceania	262	168	226	92	140	318	139	157	125
Total	71,823	84,145	372,402	35,793	44,273	52,284	185,001	116,469	38,306

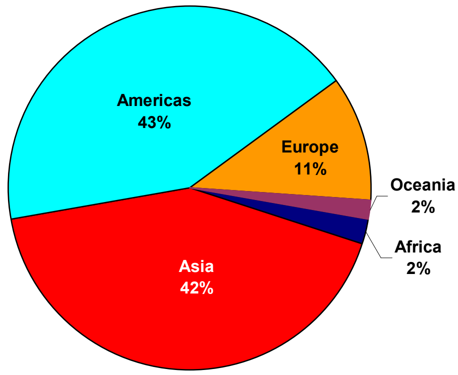
Figure 4.20. Distribution of people killed by both flood and windstorm disaster by continent for each 5-year period from 1960 to 2004.

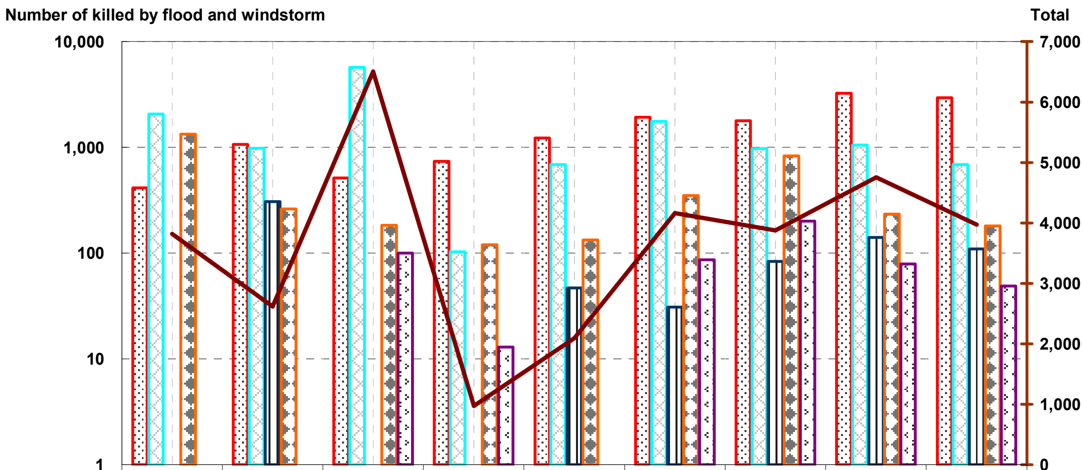
- **Landslide disasters (Figure 4.21):**

As can be seen from Figure 4.21, despite that over 50% of slide disasters occurred in Asia (compared to 25% in Americas and 10% in Europe) during each 5-year period, the most appealing values are the global equivalent ratios of killed people in Asia and Americas (despite the large difference in population). Particular increasing trends were observed during the periods from 1970 to the mid 1990. However, this global ratio is mainly delineated by the extreme value of 1970-1975 in Americas and the quasi-steady increase in Asia. Despite that the number of disasters in each continent was nearly the same at each 5-year period since 1990 (in average 25% in Asia, 18% in Americas and 15% in Europe), the number of killed people during the period 2000-2004 globally decreased by over 15% in average as compared to 1995-1999 period with clear distinctive ratios between continents.

Total numbers of people killed by landslide and avalanche disasters from 1960-2004

Rank	Continent	Killed people	%
1	**Americas**	14,037	43
2	**Asia**	13,864	42
3	**Europe**	3,603	11
4	**Africa**	721	2
5	**Oceania**	528	2
Total		**32,780**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	414	1,064	513	738	1,227	1,923	1,788	3,254	2,943
Americas	2071	983	5709	103	688	1,769	972	1,051	691
Africa		308			47	31	84	141	110
Europe	1,334	261	183	120	133	351	832	234	182
Oceania			100	13		87	200	79	49
Total	3,819	2,616	6,505	974	2,095	4,161	3,876	4,759	3,975

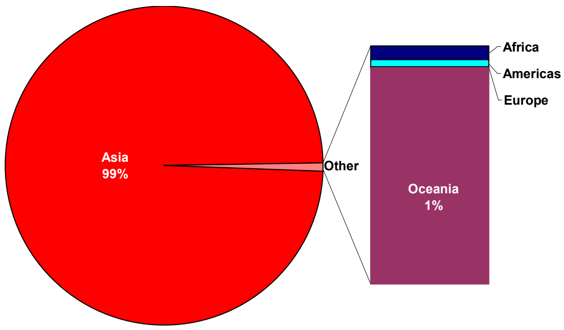
Figure 4.21. Distribution of people killed by landslide and avalanche disaster by continent for each 5-year period from 1960 to 2004.

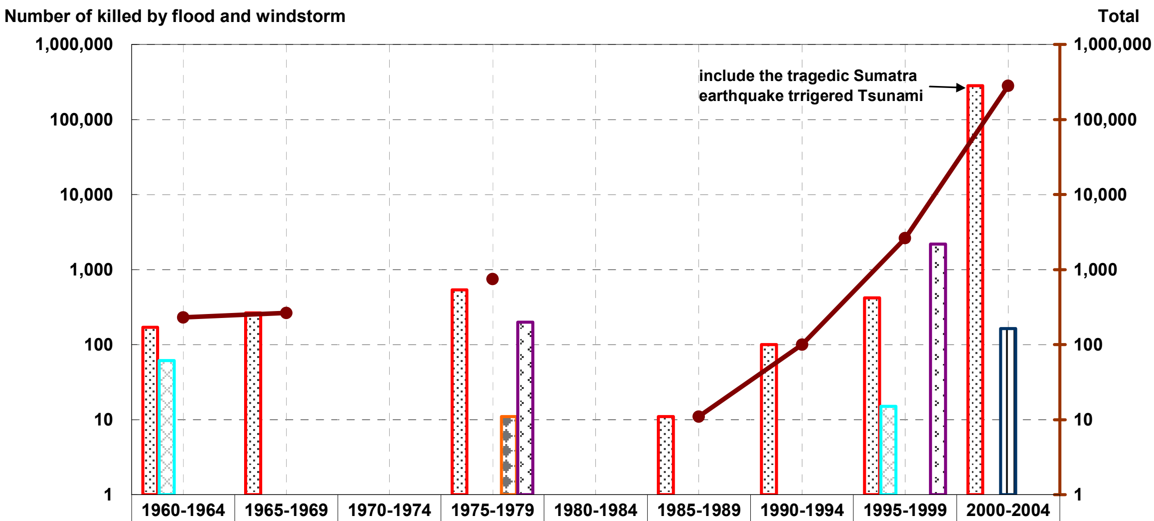
● **Wave and surge disasters (Figure 4.22):**

It is clear from Figure 4.22 that the data on wave and surge disasters must be undertaken at a finer temporal scale (e.g. on a yearly basis) due to the sparse information. At this stage the reporting mechanism on wave and surge events is not argued, nevertheless in order to draw concrete conclusion it is necessary to undertake an in-depth analysis including the events that do not meet the EMDAT criteria. From Figure 4.22 there is clearly higher social vulnerability to this type of disaster as compared to flood or landslide. The year 2004 was marked in our memories by the tsunami tragedy in the Indian Ocean, which claimed the life of more than 200,000 people. In response to this disaster UN Commission agreed to launch the first tsunami warning system in the Indian Ocean. The permanent system, in development, is expected to be operational by July 2006.

Total numbers of people killed by wave & surge disasters from 1960-2004

Rank	**Continent**	**Killed people**	**%**
1	Asia	282,386	99
2	Oceania	2382	1
3	Africa	164	-
4	Americas	76	-
5	Europe	11	-
Total		**1,000,496**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	170	264		539		11	100	420	280,882
Americas	61							15	
Africa									164
Europe				11					
Oceania				200				2,182	
Total	231	264		750		11	100	2,617	281,046

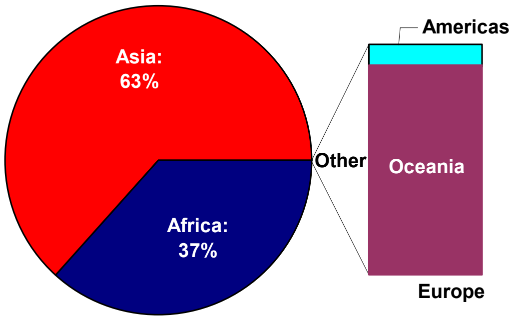
Figure 4.22. Distribution of the number of people killed by wave and Surge disaster by continent for each 5-year period from 1960 to 2004.

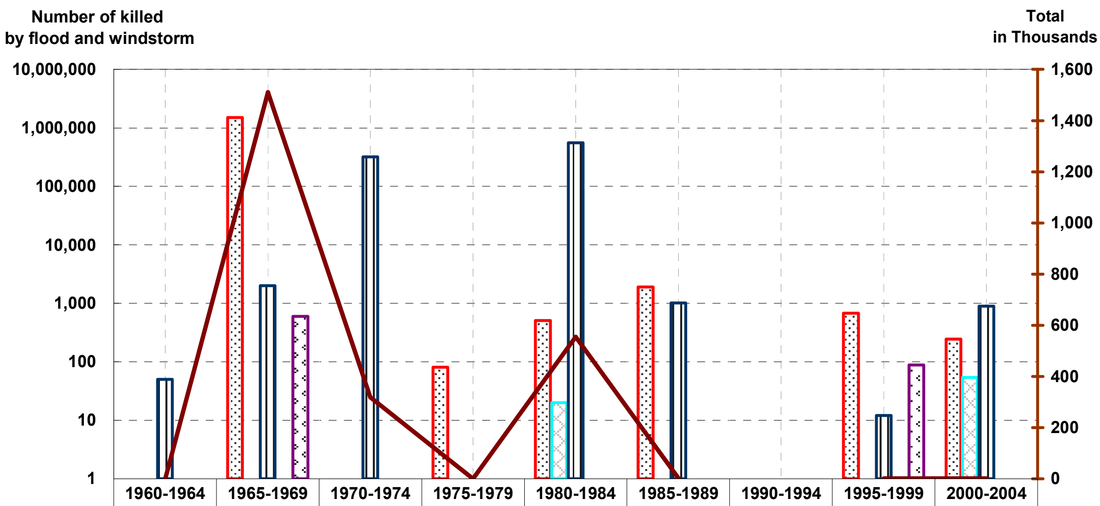
- **Drought disasters (Figure 4.23):**

It is clear from the database that since 1960 all reported drought disasters with extreme impact on human life are regionally localized. For instance, during the period 1965-1969 the 1.5 million death in Asia were attributed to the drought of 1965 to 1968 in India and the drought of 1966 in Indonesia, which killed 8,000 people. In Africa 99% of the drought disasters reported during the period 1980-1984 have actually occurred in 1984 (which was a sever drought year for the entire African continent). Nevertheless, it is interesting to note that all the heavy casualties occurred only in four countries with the following figures: Sudan 150,000; Ethiopia 300,000; Mozambique 100,000; and Chad 3,000 people. In EMDAT the numbers above were reported as the consequence of one single event per country acknowledging the long-term impact of drought events in the continent.

Total numbers of people killed by drought disasters from 1960-2004

Rank	Continent	Killed people	%
1	Asia	1,511,408	63
2	Africa	876,474	37
3	Oceania	688	-
4	Americas	74	-
5	Europe	-	-
Total		**2,388,644**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia		1,508,000		81	510	1,894		680	243
Americas					20				54
Africa	50	2,000	319,000		553,500	1,017		12	895
Europe									
Oceania		600						88	
Total	50	1,510,600	319,000	81	554,030	2,911		780	1,192

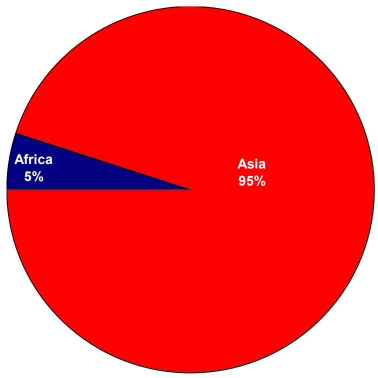
Figure 4.23. Distribution of the number of people killed by drought disaster by continent for each 5-year period from 1960 to 2004.

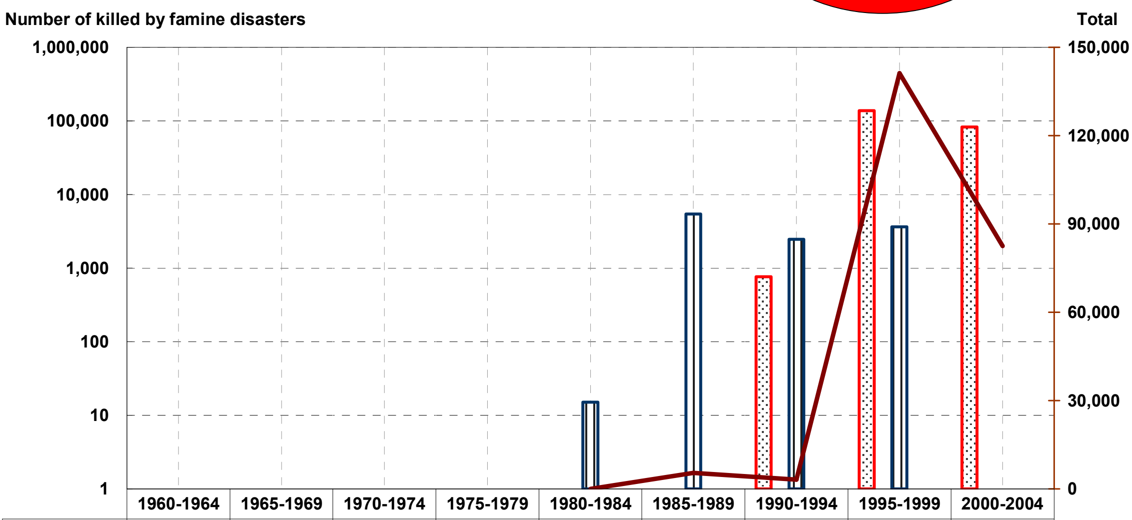
- **Famine disasters (Figure 4.24):**

Despite the heavy figures of dead people plotted in Figure 4.24, the related data on famine disasters undoubtedly requires more strict and objective analysis in order to draw constructive conclusions. For instance, in Asia the data for the period 1995-1999 and 2000-2004 were attributed to two series of famine disasters in North Korea with the following scenario 27,500 x 5years = 137,500 death, and 27,500 x 2years = 82,500 death. In Africa the figures were shared between 4 countries, namely Mozambique and Rwanda in 1989 with 5,200 death and 237 death respectively; Mauritania 2,243 death in 1992; and Mali 3,615 death in 1998.

Total numbers of people killed by famine disasters from 1960-2004

Rank	Continent	Killed people	%
1	Asia	220,760	95
2	Africa	11,539	5
Total		**232,299**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia							760	137,500	82,500
Americas									
Africa					15	5,437	2,443	3,644	
Europe									
Oceania									
Total					15	5,437	3,203	141,144	82,500

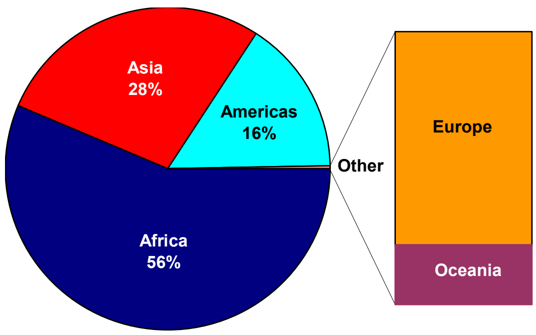
Figure 4.24. Distribution of the number of people killed by famine disaster by continent for each 5-year period from 1960 to 2004.

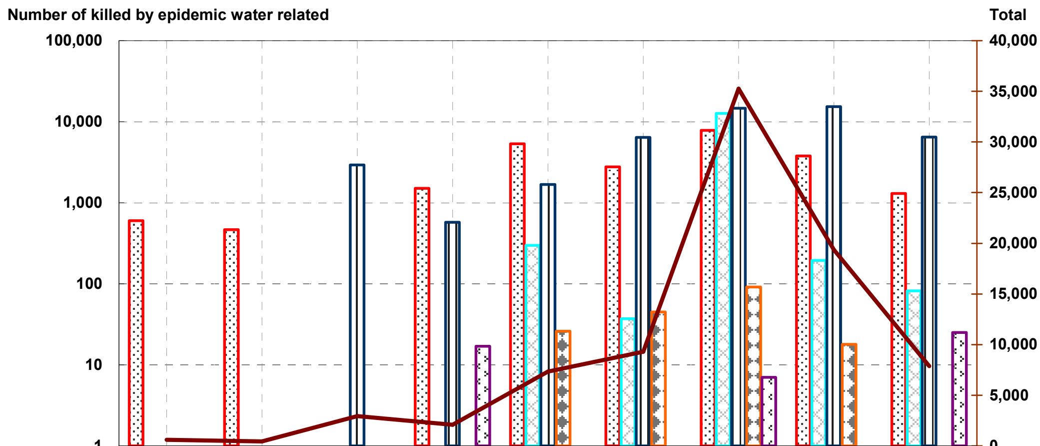
- **Epidemic water-related disasters (Figure 4.25):**

Epidemic water-related has undoubtedly known a drastic improvement in the reporting mechanism due to the global efforts of the UN Agencies to motivate countries to improve public access to safe drinking water and better sanitation. Figure 4.25 shows that there were two distinctive phases in terms of the number of killed people by epidemic water-related, an increasing phase of the trend up to the mid 1990s and a decreasing phase up to the end of the 2000-2004 period. The big exception was for the African Continent where the number of killed people increased from nearly 1,000 death in 1970s to about 15,000 death in 1990s. The figure during the period 2000-2004 was as high as 6,474 death. Nevertheless, it is important to notice that more than 50% of all reported epidemic disasters for a given period are mainly triggered by a single hazard at a country level. For instance, the cholera epidemic of 1991 killed 7,289 in Nigeria (Africa), and a Diarrhoeal/Enteric type epidemic in 1991 was reported to kill 8,000 people in Peru (Americas).

Total numbers of people killed by epidemic water-related disasters from 1960-2004

Rank	Continent	Killed people	%
1	Africa	48,074	56
2	Asia	23,592	28
3	Americas	13,334	16
4	Europe	180	-
5	Oceania	49	-
Total		**85,229**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	598	466		1,512	5,324	2,778	7,827	3,783	1,304
Americas					300	37	12721	194	82
Africa			2,932	576	1,687	6,422	14,618	15,365	6,474
Europe					26	45	91	18	
Oceania				17			7		25
Total	598	466	2,932	2,105	7,337	9,282	35,264	19,360	7,885

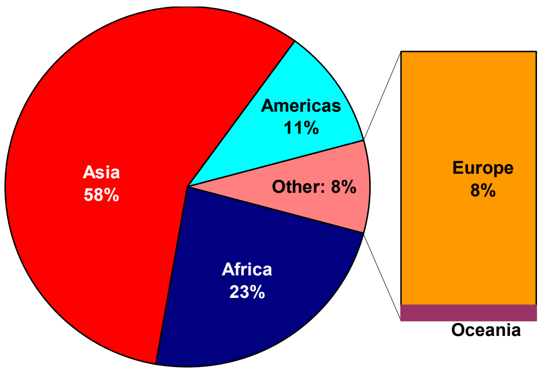
Figure 4.25. Distribution of the number of people killed by epidemic water-related disaster by continent for each 5-year period from 1960 to 2004.

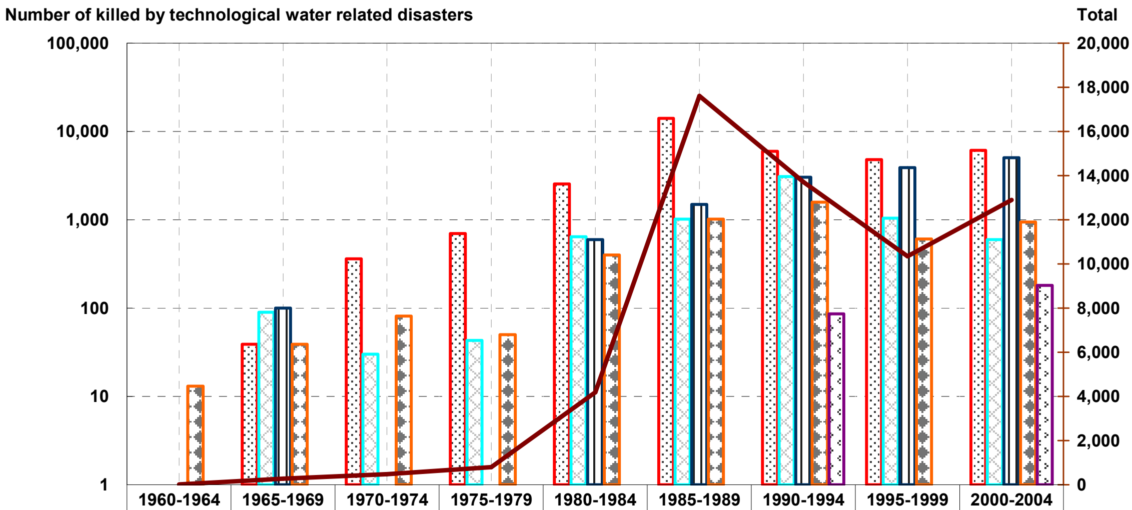
- **Technological water-related disasters (Figure 4.26):**

The disasters of this type reported in EMDAT were with no exception, attributed to transportation accidents. Most of the reported disasters are of marine type and only few were attributed to bad weather conditions or floods in particular. Unlike all other types of disasters attributed to water, the trend for the period 2000-2004 has increased from 30 to 50% in all continents save the Americas, where continuous decrease is observed since the early 1990s. In addition to the heavy figures of killed people, very large environmental and ecological disasters have accompanied these marine disasters as reported by other information systems.

Total numbers of people killed by technological water-related disasters from 1960-2004

Rank	Continent	Killed people	%
1	Asia	34,580	58
2	Africa	14,165	23
3	Americas	6,547	11
4	Europe	4,728	8
5	Oceania	267	-
Total		**60,287**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia		39	360	700	2,553	14,076	5,929	4,806	6,117
Americas		90	30	43	644	1021	3080	1042	597
Africa		100			596	1,495	3,033	3,893	5,048
Europe	13	39	81	50	400	1,017	1,575	609	944
Oceania							86		181
Total	13	268	471	793	4,193	17,609	13,703	10,350	12,887

Figure 4.26. Distribution of the number of people killed by technological water-related disaster by continent for each 5-year period from 1960 to 2004.

4.2.2. Regional trends of affected people by water-related disasters

All the results bellow are assessed for each 5-year period from 1960 to 2004.

- **Flood disasters (Figure 4.27):**

The gradient of the global trend of affected people by flood had drastically changed over 3 major periods as clearly seen in Figure 4.27. Despite that the global trend is mainly delineated by the trend in Asia, demarcating data are the decreasing values for the period 2000-2004 in all continents. During the previous decades the number of affected people by flood in Asia increased from 3.3 millions people in 1960-1964 period to above 840 millions in the 1995-1999 period . The average in Americas was about 3 millions people in each period save the drastic increase in the 1980s. Besides the slight drops in the period 1980-1984, the number in Africa has increased from 130 thousand to nearly 12 million by 1999. The figure in Europe followed the same drastic increase from about 240 thousand people to 3 million by 1999. The data for Oceania were extremely variable with a maximum peak of 200 thousand in 1985-1989 and a minimum value of 12 thousand in the period 1970-1975, the period 2000-2004 ended with the value of nearly 28 thousand affected people.

As mentioned above when presenting the impacts of water-related disasters in statistical ratios one must be aware of the magnitude of the impacts at the regional and global levels. For instance, the table of Figure 4.27 shows that 1% of affected people by flood in Africa accounted for about 40 million people, and while the impact can be statistically negligible (<0.1%) for Europe the value was as high as 11 million people.

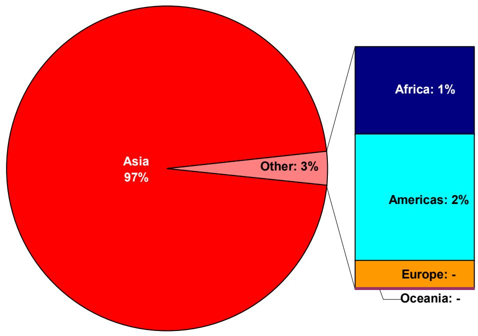
- **Windstorm disasters (Figure 4.28):**

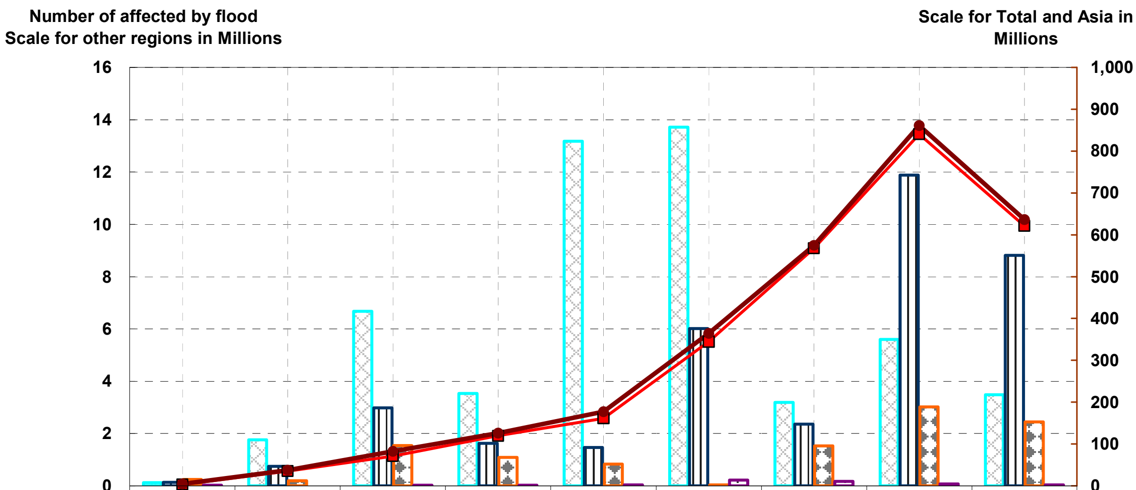
Acknowledging the scale of globally affected people by windstorms (in the range of 200 million people as compared to about 900 million by flood), the trends' gradients were as acute as for the case of flood. An exception is for the period 2000-2004 that witnessed a drastic increasing number of affected people in Asia, Americas and Africa. For this later period, while the trend in Europe was in the range of 3 million people, the reported number for Oceania dropped from 1 million in the 1995-1999 period to about 160 thousands in the 2000-2004 period. The global picture of the affected people by windstorm jumped from 9.5 millions in 1960-1964 period to near 200 million in 2000-2004 period. The combined effect of flood and windstorm exponentially rose from about 13 million in 1960-1964 to nearly one billion in 1990s and over 800 million in 2000-2004. To understand the magnitude of these numbers as well as their impacts on the regional trends, reference is made to tables 4.10 and 4.11. The tables outline the magnitudes of the top 10 disastrous flood and windstorm events in terms of total affected people. A single flood disaster in populated regions is likely to kill as high as 100 million people in average (the maximum was over 200 million in China Republic). The top 10 windstorm disasters have all occurred in Asia with larger geographic spread as compared to top 10 floods. The magnitude of the impact of windstorms is nearly 10% of the impacts measured for floods.

Aware of the aggravating condition worldwide it is important to initiate pilot case studies at country levels in order to identify accurate and healthy indicators to explain the reasons behind these increasing trends in the number of affected people and the humble decrease in the number of killed people.

Total numbers of affected people by flood disasters from 1960-2004

Rank	Continent	Affected people	%
1	Asia	2,763,819,066	97
2	Americas	51,244,764	2
3	Africa	36,014,832	1
4	Europe	10,916,943	-
5	Oceania	552,159	-
Total		**2,862,547,764**	



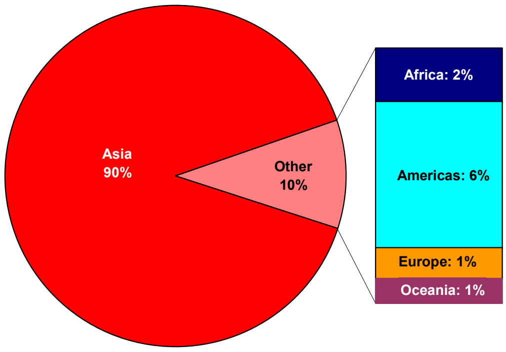


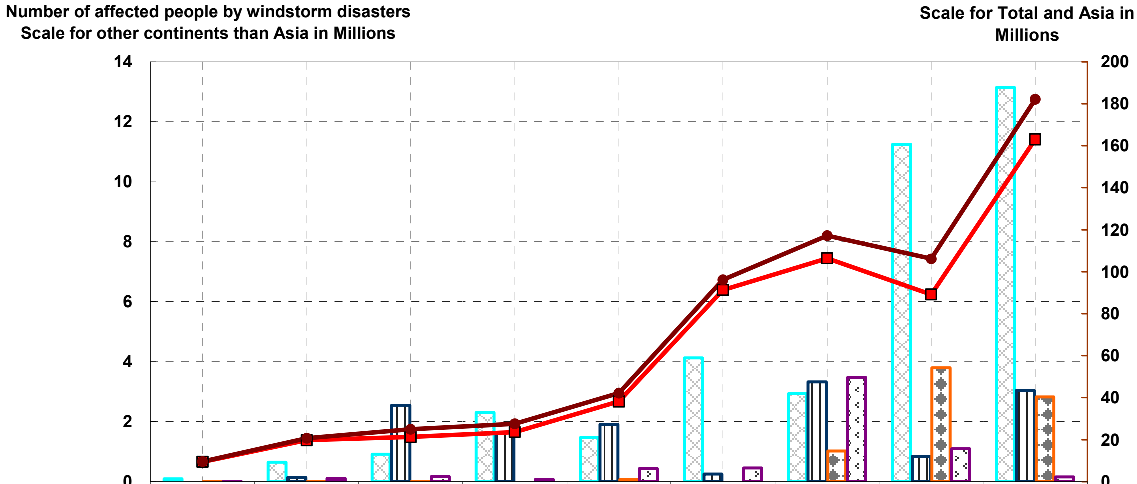
	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Americas	120,000	1,757,747	6,669,785	3,535,740	13,184,145	13,714,920	3,182,908	5,593,659	3,485,860
Africa	130,310	736,731	2,974,684	1,624,842	1,467,719	6,010,913	2,361,934	11,887,220	8,820,479
Europe	243,000	196,200	1,541,005	1,086,870	828,247	34,580	1,520,147	3,019,596	2,447,298
Oceania	18,000		12,000	12,975	25,095	219,912	170,935	65,251	27,991
Asia	3,317,421	34,650,437	70,892,281	119,539,124	161,328,823	344,149,344	567,632,267	841,000,440	621,308,929
Flood	3,828,731	37,341,115	82,089,755	125,799,551	176,834,029	364,129,669	574,868,191	861,566,166	636,090,557

Figure 4.27. Distribution of the number of affected people by flood disaster by continent for each 5-year period from 1960 to 2004.

Total numbers of affected people by windstorm disasters from 1960-2004

Rank	Continent	Killed people	%
1	Asia	562,293,392	90
2	Americas	36,899,615	6
3	Africa	13,701,655	2
4	Europe	7,736,270	1
5	Oceania	6,005,686	1
Total		626,636,618	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Americas	91,868	652,508	922,706	2,311,483	1,474,004	4,127,618	2,937,112	11,241,455	13,140,861
Africa		141,579	2,545,072	1,628,592	1,910,950	258,444	3,324,048	849,871	3,043,099
Europe	12,000	3,900	5,200	19	71,962		1,022,071	3,793,421	2,827,697
Oceania	12,000	107,204	174,090	75,005	435,660	461,166	3,481,917	1,096,504	162,140
Asia	9,477,059	19,746,665	21,303,460	23,574,046	38,240,203	91,342,961	106,438,734	89,201,795	162,968,469
Wind Storm	9,592,927	20,651,856	24,950,528	27,589,145	42,132,779	96,190,189	117,203,882	106,183,046	182,142,266

Figure 4.28. Distribution of the number of affected people by flood disaster by continent for each 5-year period from 1960 to 2004.

Table 4.10. Top 10 most disastrous floods in terms of affected people.

year	Disaster Subset	Country	Total affected People
1998	Flood	China Pop. Rep.	238,973,000
1991	Flood	China Pop. Rep.	210,232,227
2002	Flash Flood	China Pop. Rep.	190,035,257
1996	Flood	China Pop. Rep.	154,634,000
2003	Flood	China Pop. Rep.	150,146,000
1993	Flood	India	128,000,000
1995	Flood	China Pop. Rep.	114,470,249
1999	Flood	China Pop. Rep.	101,024,000
1989	Flood	China Pop. Rep.	100,010,000
1994	Flood	China Pop. Rep.	78,974,400

Table 4.11. Top 10 most disastrous floods in terms of affected people.

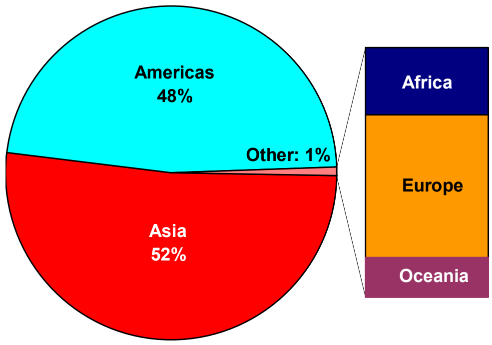
year	Disaster Subset	Country	Total affected People
1989	Storm	China Pop. Rep.	30,007,500
1965	Cyclone	Bangladesh	15,600,000
1991	Cyclone	Bangladesh	15,438,849
1996	Typhoon	China Pop. Rep.	15,005,000
1977	Cyclone	India	14,469,800
1999	Cyclone	India	12,628,312
1994	Typhoon	China Pop. Rep.	11,001,800
1998	Storm	China Pop. Rep.	11,000,038
1988	Cyclone	Bangladesh	10,568,860
1980	Typhoon	Viet Nam	9,027,174

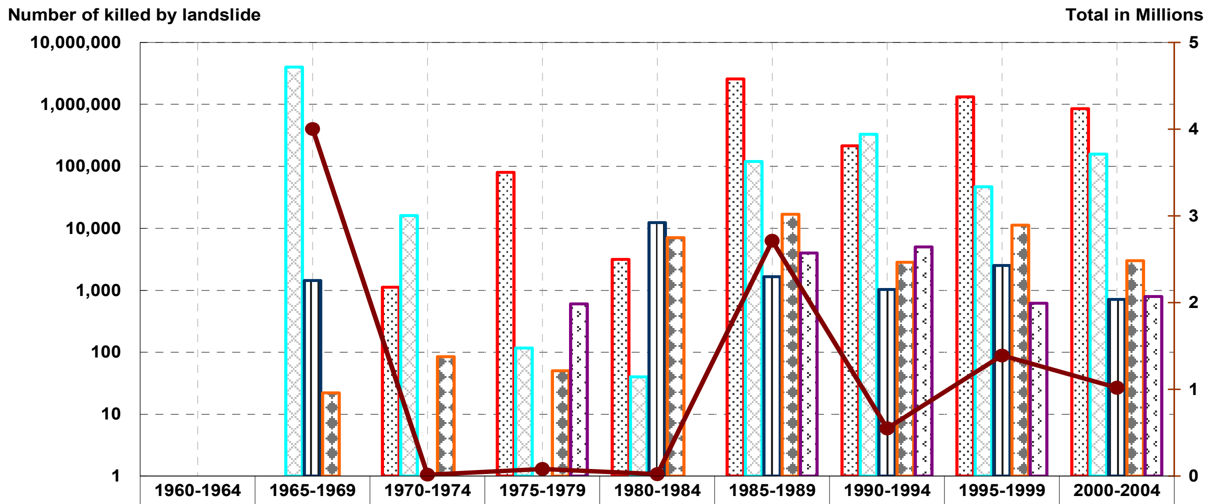
- **Slide disasters (Figure 4.29):**

In average there is no clear global decrease in the number of affected people by slide disasters. The global trend is mainly delineated by the trends in Asia and the Americas. However, it is important to notice that 85% of the total in the Americas was attributed to the impact of single event in Brazil (4 million were people affected). Concurrently 70% of the total number in Asia was attributed to two events in India (2.5 million people in 1986 and 1.1 million people in 1995). These annotations applies to even smaller scale disasters such as for the 2000-2004 period in Americas where over 90% of the period-total was attributed to the landslide(s) of 2000 in Brazil that affected 143 thousands people in four states. Beside these extreme events the trends in most continents showed periodic peaks and drops over time.

Total numbers of affected people by landslide disasters from 1960-2004

Rank	Continent	Affected people	%
1	Asia	5,056,326	51.6
2	Americas	4,667,096	47.7
3	Europe	41,156	0.4
4	Africa	19,740	0.2
5	Oceania	11,015	0.1
Total		**9,795,333**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia			1,113	80,125	3,150	2,571,402	215,196	1,328,503	856,837
Americas		4,000,022	16,028	116	40	119,302	327,849	46,757	156,982
Africa		1,436			12,416	1,648	1,025	2,500	715
Europe		22	85	50	7,035	16,841	2,834	11,278	3,011
Oceania				600		4,000	5,000	620	795
Slides		4,001,480	17,226	80,891	22,641	2,713,193	551,904	1,389,658	1,018,340

Figure 4.29. Distribution of the number of affected people by landslides and avalanche disasters by continent for each 5-year period from 1960 to 2004.

- **Wave and surge disasters (Figure 4.30):**

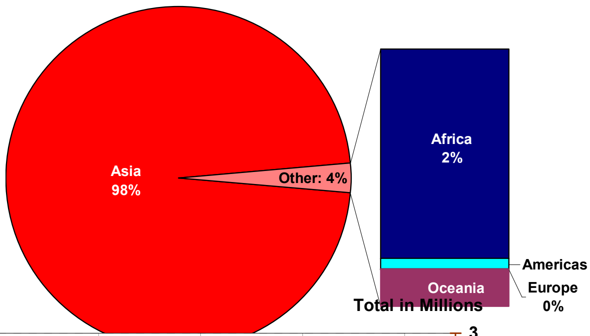
Major wave and surge disaster were attributed to tsunamis. Table 4.12 gives the number of affected people by major tsunami disasters. In Asia most of the disasters are attributed to the Sumatra tsunami of December 2004.

Table 4.12. Total affected people by regional major wave and surge disasters.

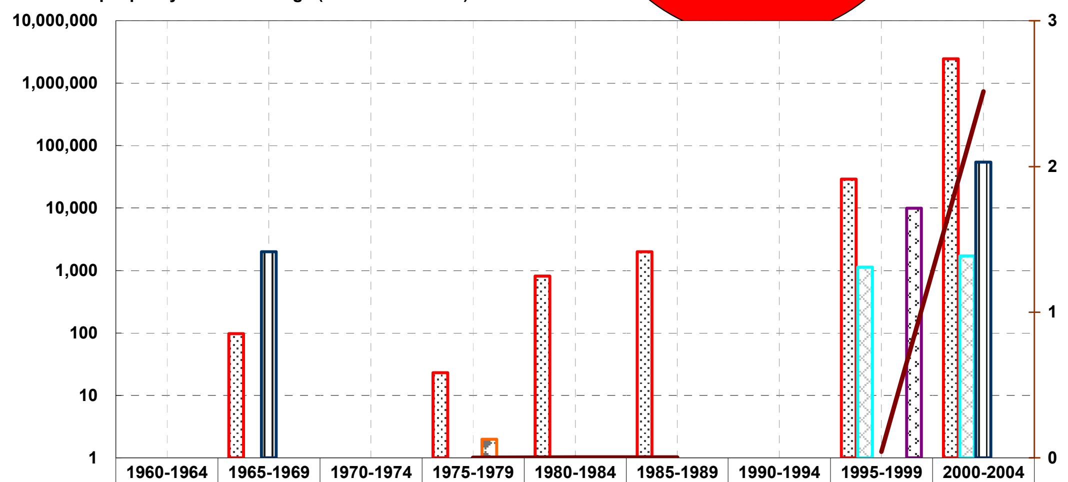
year	dis_subset	Country	t. affected
2004	Tsunami	Sri Lanka	1,267,506
2004	Tsunami	India	654,512
2004	Tsunami	Indonesia	419,682
2004	Tsunami	Thailand	66,457
2004	Tsunami	Somalia	54,283
2002	Tsunami	Honduras	1,720
1998	Tsunami	Papua New Guinea	9,199

Total numbers of affected people by wave and surge disasters from 1960-2004

Rank	Continent	Killed people	%
1	Asia	2,491,929	98
2	Africa	56,478	2
3	Oceania	9,867	-
4	Americas	2,844	-
5	Europe	2	-
Total		**2,561,120**	



Number of affected people by wave and surge (includes tsunami) disasters



	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia		97		23	818	2,000		29,200	2,459,791
Americas								1,124	1,720
Africa		2,000							54,478
Europe				2					
Oceania								9,867	
Wave and Surge		2,097		25	818	2,000		40,191	2,515,989

Figure 4.30. Distribution of the number of affected people by wave and surge disasters by continent for each 5-year period from 1960 to 2004.

- **Drought disasters (Figure 4.31):**

The figure of affected people by a single drought disaster is the highest in number as compared to other water-related disasters (see Figure 4.31 and Table 4.13). Table 4.13 shows that nearly all the top fifteen drought disasters during the past decades have occurred in Asia with the highest figure in India (as high as 300 million people were affected by the 1987 and 2002 droughts respectively). During the past four decades and a half over 2 billion people were affected by drought (1.8 billion in Asia alone as compared to 300 thousand in Africa). Demarcating values are the historical extremes during the period 2000-2004 that occurred worldwide.

Figure 4.31 illustrates that since the 1980s there were no clear increase or decrease in regional trends as compared to the global increase during the periods from 1960 to 1984. Nevertheless, the data of Table 4.13 clearly pinpoints that this global trend variation plotted on a 5-year basis is particularly delineated by a number of historical peaks. Additionally, Table 4.14 illustrates that 50% of top ten famine disasters were also triggered by drought. At the regional level, though Ethiopia is at the top of the ten most vulnerable countries in Africa, many countries are equivalently affected (such as South Africa, Sudan, and Malawi among others). The trend of affected people in Europe (see Figure 4.31) can not be used to affirm an increasing trend of droughts in the region, as the values reported for each 5-year period since 1990 are rather focally centered in time and geographic distribution. Concurrently, the trend of drought in Oceania was delineated by the series of drought in Australia reported affecting 1.75 million people at every single year since 1992 to 1995.

- **Famine disasters (Figure 4.32):**

Data on famine disasters continuously affected the largest population in Africa (see Figure 4.32 and Table 4.14). For instance, a famine disaster in 1982 affected over 12 million people. During the year 2002, famine attributed to crop failure mainly affected four countries in Africa, namely 500 thousands people in Lesotho, 400 thousand people in Madagascar, 150 thousand people in Swaziland, and 30 thousand people in Cape Verde Is). In Asia the average of affected people by famine disasters was about 1 million people geographically distributed among 9 countries. As shown in Table 4.14, the largest disaster was attributed to the famine event of 2002 in Korea Democratic Popular Republic (with 2.9 million affected people), and the two second largest disasters were the famines of 1995 and 1996 in Cambodia, which affected 2.5 million people, respectively. During the periods 1995 through 2001 the database reported that 1 million people at each single year were affected by famine in Korea Democratic Popular Republic. Among the 9 affected countries in Asia, the only famine disaster attributed to Arab states was the famine of 1995 in Iraq (which affected over 800 thousand people). In Europe beside the famine disaster of 1932 in the former Soviet Union (reported to kill 5 million people but zero affected people), the only recent famine disaster was in 1995 in Macedonia, which was reported to have affected 10 thousand people nation wide.

Table 4.13. Top 15 drought disasters in terms of total affected in EMDAT.

year	country_name	total_affected
1987	India	300,000,000
2002	India	300,000,000
1979	India	190,000,000
1965	India	100,000,000
1972	India	100,000,000
1973	India	100,000,000
1982	India	100,000,000
1983	India	100,000,000
2000	India	90,000,000
1988	China P Rep	49,000,000
2003	China P Rep	48,000,000
2000	Iran Islam Rep	37,000,000
2001	Iran Islam Rep	25,000,000
1983	Bangladesh	20,000,000
1983	Brazil	20,000,000

Table 4.14. Top 15 famine disasters in terms of total affected people reported in EMDAT.

year	dis_subset	country_name	t. affected
1982	Drought	Ghana	12,500,000
1999	Crop failure	Ethiopia	7,767,594
1993	Food shortage	Ethiopia	6,700,000
1994	Food shortage	Ethiopia	3,900,000
2002	Food shortage	Korea Dem P Rep	2,900,000
1998	Food shortage	Sudan	2,600,000
1995	Drought	Cambodia	2,500,000
1996	Drought	Cambodia	2,500,000
1989	Food shortage	Ethiopia	1,850,000
1990	Food shortage	Niger	1,630,000
1993	Food shortage	Eritrea	1,600,000
1987	Drought	Malawi	1,429,267
1988	Drought	South Africa	1,350,000
1988	Drought	South Africa	1,320,000
1992	Food shortage	Armenia	1,300,000

Table 4.15. Top 10 drought disasters in terms of total affected people in each continent (for Asia see Table 4.13)

Top 10 drought disasters in Africa

year	country	t. affected
2004	South Africa	15,000,000
2002	Ethiopia	14,300,000
2003	Ethiopia	13,200,000
2000	Ethiopia	10,500,000
1991	Sudan	8,600,000
1984	Sudan	8,400,000
1984	Ethiopia	7,750,000
1983	Ethiopia	7,000,000
1987	Ethiopia	7,000,000
1993	Malawi	7,000,000

Top 10 drought disasters in Americas

year	country	t. affected
1983	Brazil	20,000,000
1970	Brazil	10,000,000
1998	Brazil	10,000,000
1979	Brazil	5,000,000
1990	Peru	2,200,000
1983	Bolivia	1,583,049
1983	Bolivia	1,500,000
1992	Peru	1,100,000
2001	Brazil	1,000,000
2001	Honduras	791,394

Top 10 drought disasters in Europe

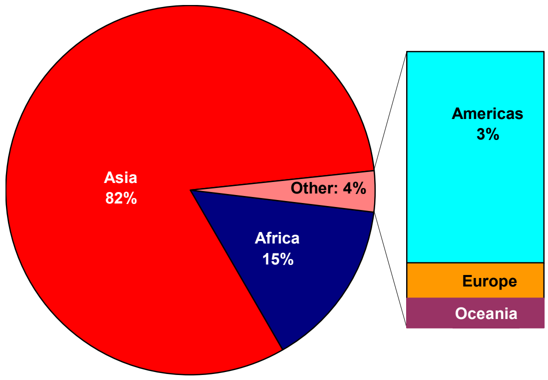
year	country	t. affected
1995	Spain	6,000,000
1921	Soviet Union	5,000,000
1991	Albania	3,200,000
2003	Russia	1,000,000
2003	Bosnia-Hercegovenia	62,575
1976	Belgium	0
2000	Bosnia-Hercegovenia	0
1983	Bulgaria	0
2003	Croatia	0
1991	Cyprus	0

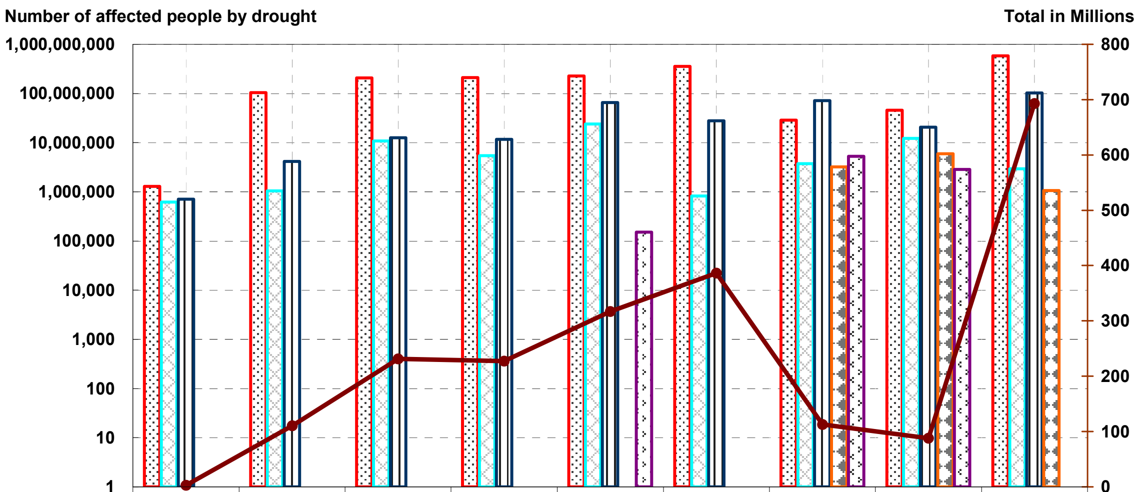
Top 10 drought disasters in Oceania

year	country	t. affected
1992	Australia	1,750,000
1993	Australia	1,750,000
1994	Australia	1,750,000
1995	Australia	1,750,000
1997	Papua New Guinea	700,000
1998	Fiji	263,455
1999	Kiribati	84,000
1982	Australia	80,000
1981	Papua New Guinea	40,000
1983	Fiji	31,000

Total numbers of affected people by drought disasters from 1960-2004.

Rank	Continent	Killed people	%
1	Asia	1,770,081,014	82
2	Americas	317,143,582	15
3	Africa	61,714,030	3
4	Europe	10,262,575	-
5	Oceania	8,233,635	-
Total		**2,167,434,836**	



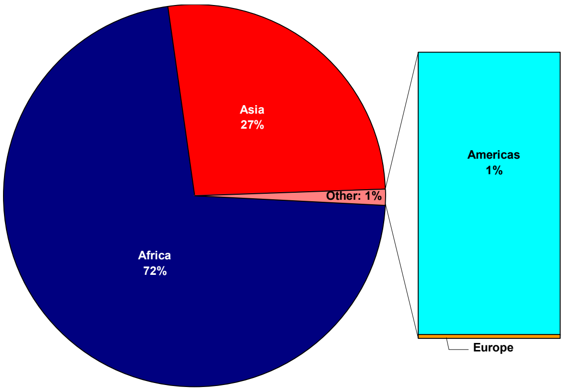


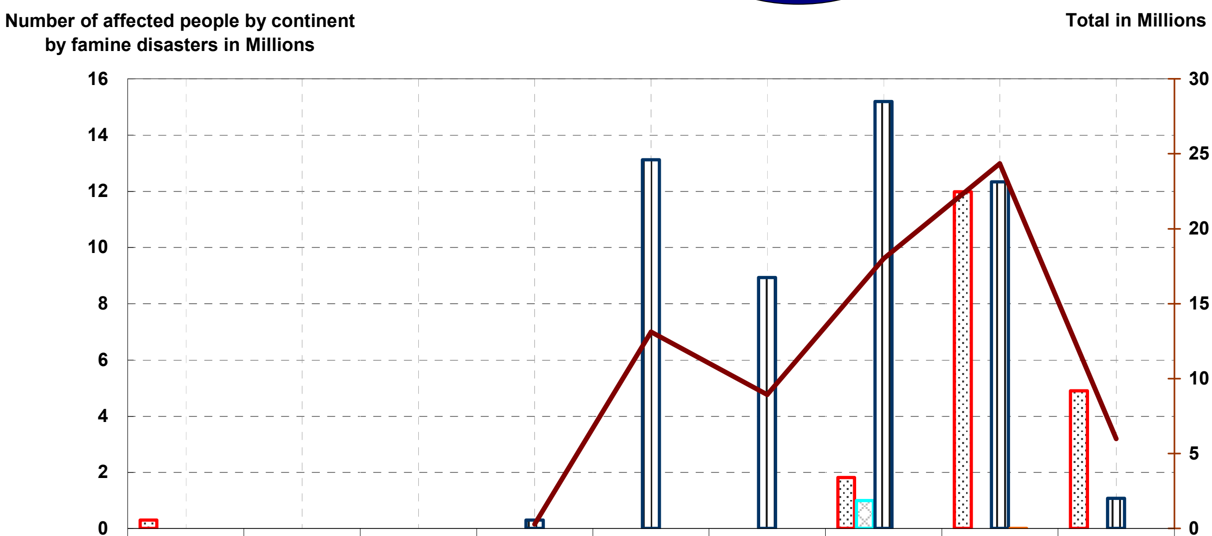
	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	1,291,000	104,957,944	207,875,000	209,772,885	227,502,000	357,737,000	28,746,385	46,049,000	586,149,800
Americas	613,400	1,054,821	10,837,000	5,450,000	23,992,049	823,000	3,713,160	12,298,200	2,932,400
Africa	705,000	4,118,483	12,506,595	11,780,400	65,260,840	28,027,000	71,575,007	20,586,349	102,583,908
Europe							3,200,000	6,000,000	1,062,575
Oceania					151,000		5,250,000	2,832,635	
Drought	2,609,400	110,131,248	231,218,595	227,003,285	316,905,889	386,587,000	112,484,552	87,766,184	692,728,683

Figure 4.31. Distribution of the number of affected people by drought disaster by continent for each 5-year period from 1960 to 2004.

Total numbers of affected people by famine disasters from 1960-2004

Rank	Continent	Killed people	%
1	Africa	50,983,301	72
2	Asia	19,000,000	27
3	Europe	1,003,000	1
4	Americas	10,000	-
5	Oceania	--	--
Total		**70,996,301**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	300,000						1,812,000	11,988,000	4,900,000
Americas							1,000,000		3,000
Africa				300,000	13,123,000	8,937,267	15,203,900	12,339,134	1,080,000
Europe								10,000	
Oceania									
Famine	300,000			300,000	13,123,000	8,937,267	18,015,900	24,337,134	5,983,000

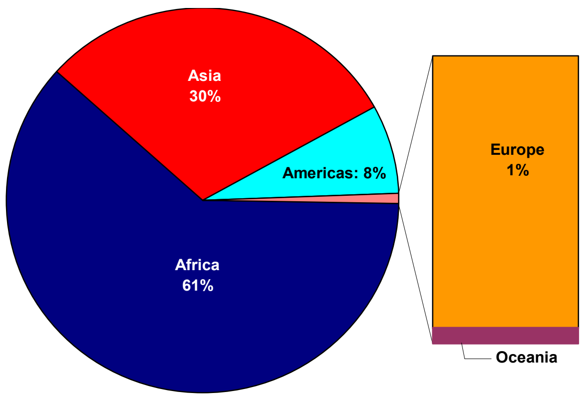
Figure 4.32. Distribution of the number of affected people by both famine disaster by continent for each 5-year period from 1960 to 2004.

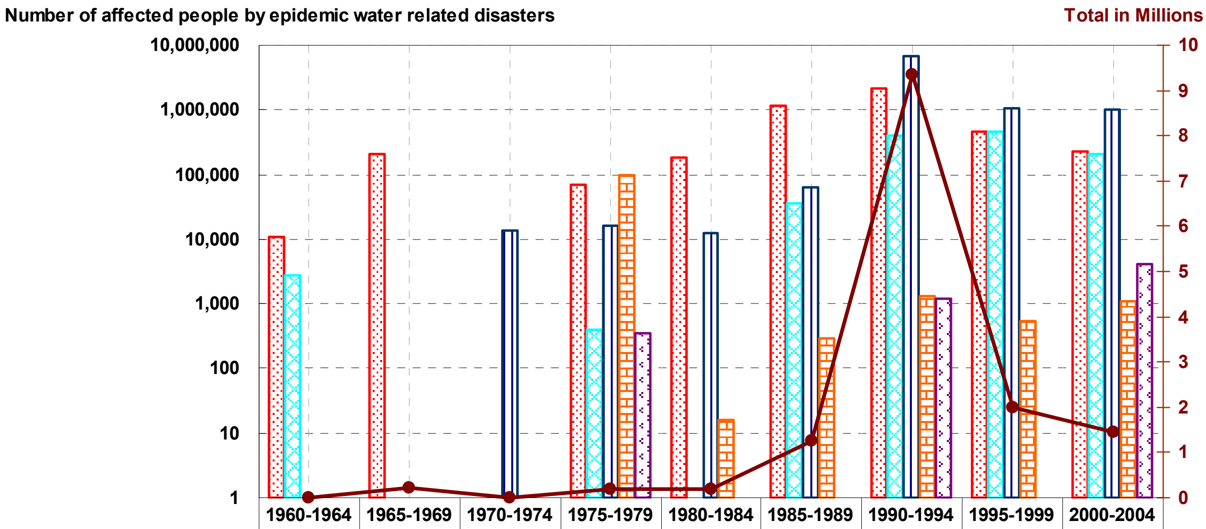
- **Epidemic water-related disasters (Figure 4.33):**

As mentioned earlier over 50% of water-related epidemic occurred in Africa with a drastic increase in number during the two past decades. Figure 4.33 shows that the trend of affected people at all regions started to know a net decrease since the mid 1990s after the drastic decrease and alarming figures during the period 1990-1994. The figure also illustrates that during the past fifteen years, the average number of affected people by epidemic water-related in Africa is over one million people. The largest figure was attributed to the malaria disaster of 1994 in Kenya, which affected over 6 million people. In Asia the largest disasters was the 1991 Diarrhoeal/Enteric type disaster in Bangladesh, which affected 1.5 million people. Other largely affected countries in Asia are India, Indonesia and Bangladesh. In Europe after the malaria disaster of 1923 in the former Soviet Union, which affected 1.8 million people and the malaria of 1977 in Turkey, which affected 100 thousand people, no large scale water epidemic disasters have since been recorded in EMDAT. Nevertheless, individual epidemic water-related disasters likely to affect thousands of people have been higher in number during the past decade and a half.

Total numbers of affected people by epidemic water-related disasters from 1960-2004

Rank	Continent	Killed people	%
1	Africa	8,981,942	61
2	Asia	4,463,798	30
3	Americas	1,105,932	8
4	Europe	103,303	1
5	Oceania	5,638	-
Total		**14,660,613**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia	10,848	205,118		69,371	178,375	1,169,700	2,137,951	465,221	227,214
Americas	2,724			407		34,892	400,435	459,779	207,695
Africa			13,476	16,386	12,376	62,490	6,813,919	1,056,966	1,006,329
Europe				100,000	16	294	1,333	554	1,106
Oceania				352			1,200		4,086
Epidemic Water related	13,572	205,118	13,476	186,516	190,767	1,267,376	9,354,838	1,982,520	1,446,430

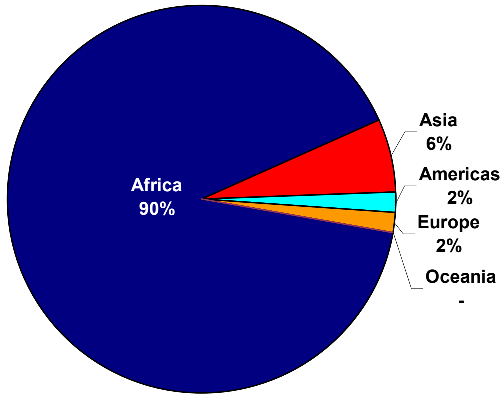
Figure 4.33. Distribution of the number of affected people by epidemic water-related disaster by continent for each 5-year period from 1960 to 2004.

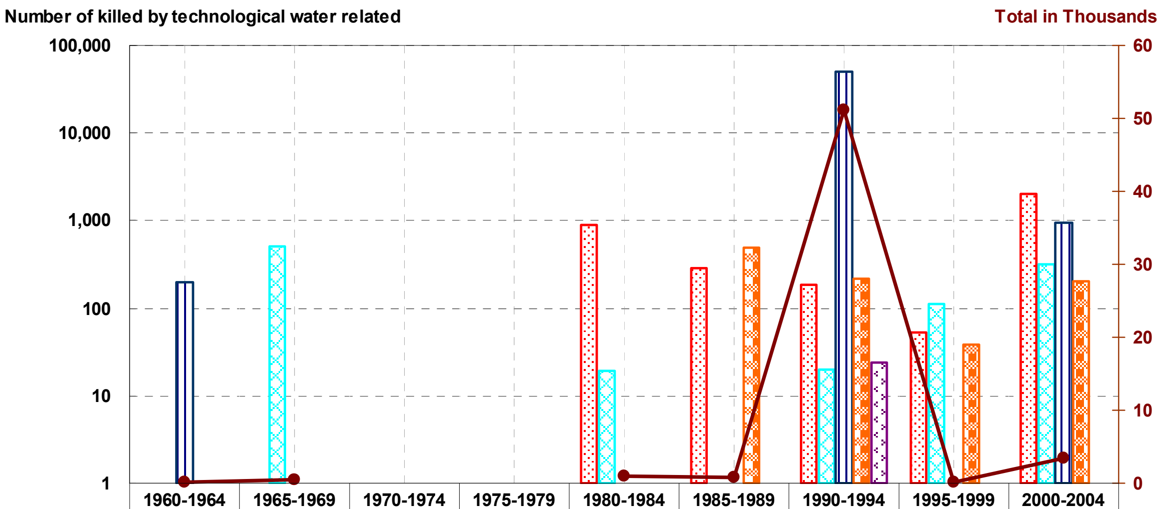
- **Technological water-related disasters (Figure 4.34):**

Technological water-related disasters attributed to water are all associated with transport accidents, mainly of marine type (i.e., out of the 770 disasters reported, 365 accidents were boat, ferry, or submarine accidents, etc.) Only 16 disasters out of the 365 known ones were attributed to bad weather conditions (such as storm, fog, etc.) the cause of other accidents were unknown. The largest disaster reported in terms of affected people is the 1992 Petrolier 'Katina' in Mozambique reported to affect over 50 thousand people. Figure 4.34 illustrates the trends of this type of disaster for each continent.

Total numbers of affected people by technological water-related disasters from 1960-2004

Rank	Continent	Affected people	%
1	Africa	51,832	97
2	Asia	3,467	6
3	Americas	971	2
4	Europe	956	2
5	Oceania	24	-
	Total	**57,250**	





	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004
Asia					907	290	188	53	2,029
Americas		500			19		20	112	320
Africa	200						50,692		940
Europe						498	219	38	201
Oceania							24		
Totals	200	500			926	788	51,143	203	3,490

Figure 4.34. Distribution of the number of affected people by technological water-related disaster by continent for each 5-year period from 1960 to 2004.

Chapter 5: Technical Aspects and Challenges Ahead

As proved from the results above water-related disasters are prevailing in time and commonly shared burden among all the continents. Reciprocally to the size of the continent's population, their negative impacts on society and economy are still exponentially increasing despite all national, regional and international efforts in disasters mitigation. Managers and scientists working in the field of natural disasters mitigation are convinced more than ever before that sustainable solution can only be sought under the umbrella of what we can generalize under the name of "multidisciplinary risk management science". Indeed, while water hazards are triggered by hydrometeorological phenomena (coupled with geological factors), the scales of their multifaceted impacts are resolved by the complex social and environmental conditions of the country and community afflicted by the disaster.

There are numbers of pragmatic issues for proper implementation of integrated multidisciplinary approach in water resources management. These issues are being stressed and discussed at many scientific and political gatherings and are mainly reflected as an integral part of the action plan of the 4th phase of the International Hydrological Program (IHP-VI Plan: 2002-2007). In water-related disasters further problematic issues are found within the risk management process and cycle. The major issue is the reliability of the risk quantification and assessment which we acknowledge to be among the most important steps in risk management and also the most difficult and prone to error regarding the diversity of the type of water-related disasters and concurrent impacts. The reliability of risk assessment does not only relay on the quality of reporting, but also on the methodology to monitor and assess disasters' impacts at the first stage. A direct problem resulting from such pragmatic assessment is at least of two folds, first, the uncertainties surrounding the accuracy of the numbers quantifying the impacts, second, the meaning behind the numbers resulting from the risk assessment upon which most mitigation strategies are built on. It is therefore extremely valuable to create a strong international platform for cooperation with primary focus on water-related disasters and related risk managemental issues. This body when created shall work to fill in the gap in this area and promote the development of standardized methodology for disasters impacts quantification (see Guha-Sapir & Below, 2002; Merabtene et al., 2004; and Wisner et al., 2004).

At the global scale and regardless of existing uncertainties and challenges ahead, there is an increasing consensus on the important role of risk management and its implementation in decision making to define safer and sustainable holistic strategies in natural disasters mitigation. This alone justifies the great importance of undertaking further vigilant quantification of disaster loss data at finer temporal and geographical scales than as reported herein. Among other great benefits behind such disaster quantification is to allow analysis of trends which in turn provides strong indicators for vulnerability and resiliency analysis as well as to assess the effectiveness of adopted policies in disasters mitigation.

As proven throughout the results of this technical analysis, there are numerous overwhelming difficulties underlying the assessment of disaster impacts. There is definitely urgent need to undertake a more in-depth survey and analysis in order to draw conclusive concepts for vulnerability analysis and water-related risk management in general. For instance, there is no clear evidence to fully support the largely acknowledge perspective that death toll from water-related disasters is decreasing, at least not for each continent and not for each type of water-related disaster. Our assessment draws the attention to the pragmatic aspect of data processing based on different time scales and analysis periods, which might often lead to controversial conclusions if the results are not handled and interpreted with extreme care. To further emphasis some of these technical issues, reference is made to figures 5.1 to 5.5 discussed hereafter.

Figure 5.1 depicts the number of affected people by the top 1000 disastrous natural events reported in EMDAT since 1900 to 2004. The figure reports that all the 11 types of natural disasters categorized in EMDAT had a clear impact share on world population despite the distinctive difference between the stressors and determinants susceptible to influence the scale and number of affected people. Among all water disasters, the figure largely endorses what we have stated earlier on the predominance in the numbers and impacts of hydrometeorological disasters such as flood, drought and windstorm over other natural disasters such as earthquake, extreme temperature (i.e. cold and heat waves), and volcano, etc. Flood, drought and windstorm accounted respectively for 35%, 27.6% and 24.1% of the total top 1000 disasters. For these three types of disasters, a notable aspect of the graph is the quasi-analogue form of the gradients of the trends of affected people (i.e., the top 1000 disasters events are plotted in a decreasing order and the time/year of occurrence of simultaneous events are different.) Technically, before drawing concrete conclusions on such interesting behaviors, it is important to recall the difference between the temporal and geographical spreading of the impacts of each type of disasters particularly of floods and droughts. A concurrent interesting example in Figure 5.1 is the trends of famine and earthquake disasters which are closely in the same range despite that earthquakes are mainly focal disasters (likely to affect any class of the community at a very localized scale) and famine disaster are widespread (likely to affect the whole nation and further impoverish the poor class). The most disastrous events in terms of killed people for the period from 1900 to 2004 were mainly driven by the extreme events reported in the early 1900s and are not reported herein (see Annex 4).

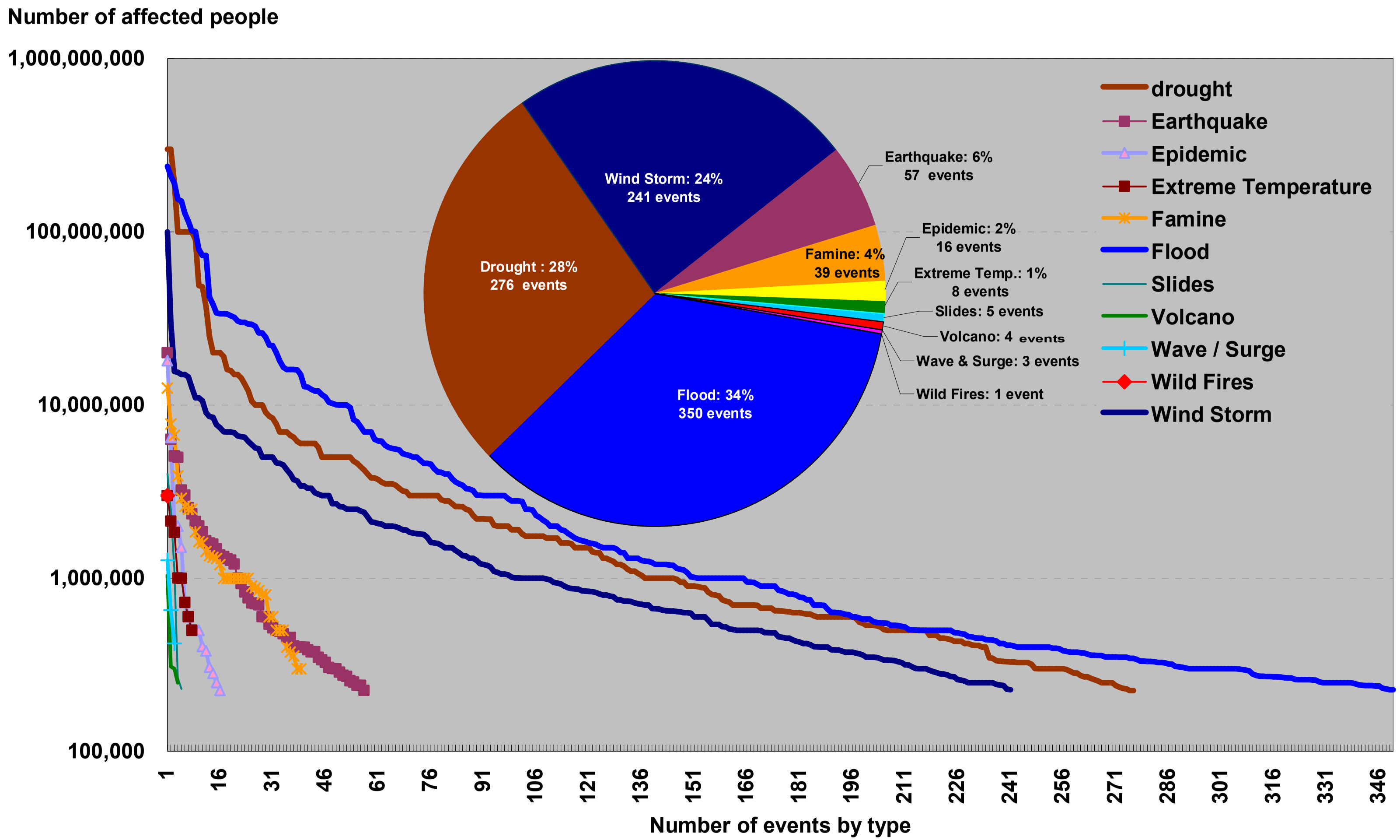


Figure 5.1. 1000 most disastrous events in terms of affected people: EMDAT from 1900 to 2004.

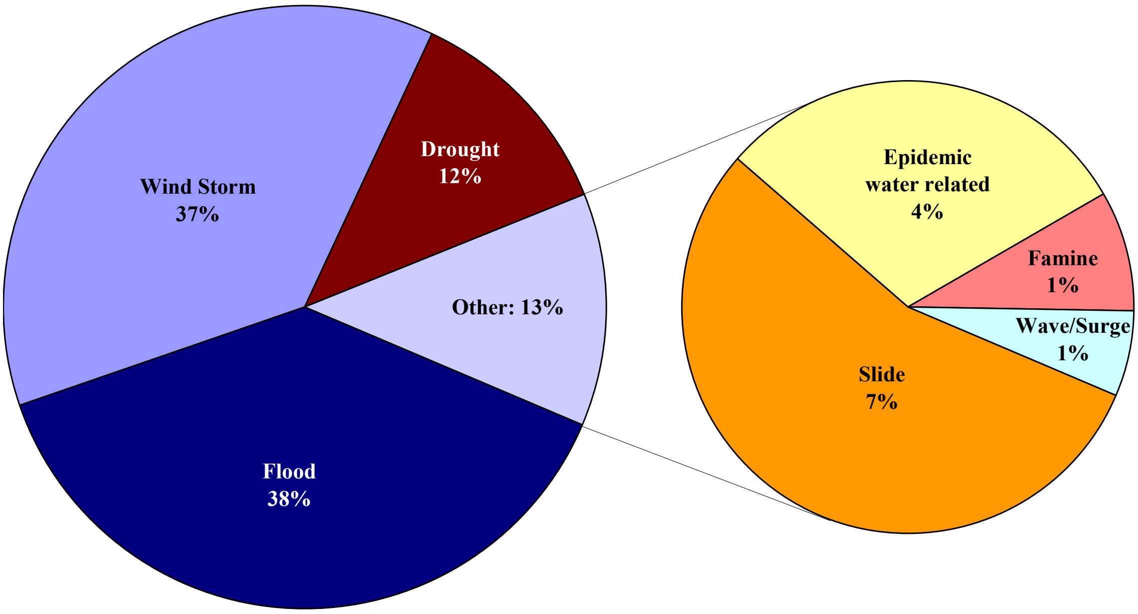


Figure 5.2.a. Distribution of numbers of events of water-related disasters per type: EMDAT 1960-2004.

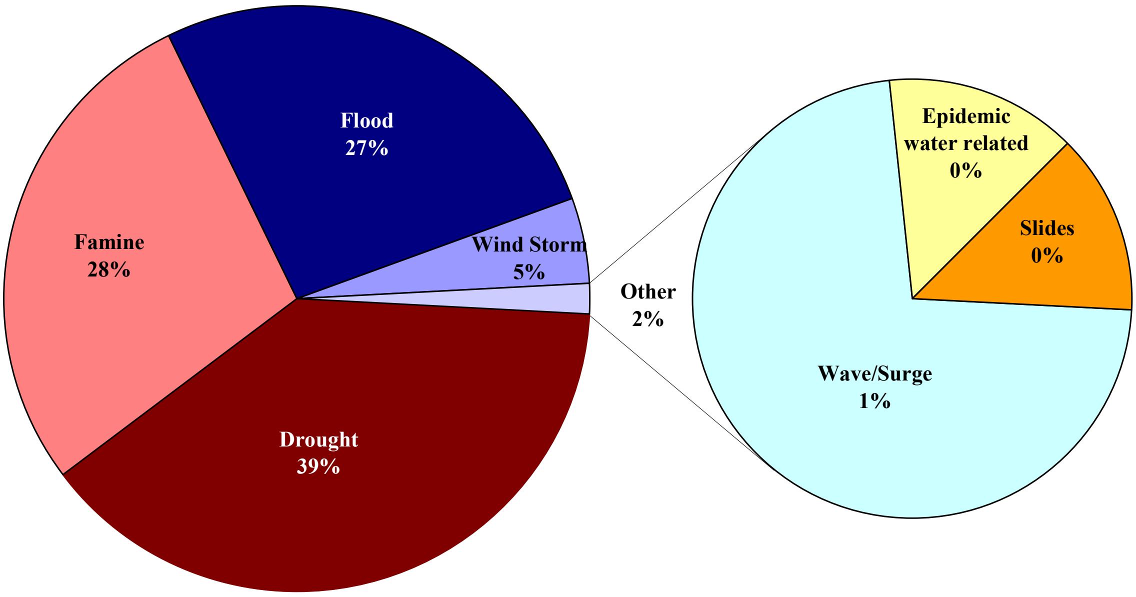


Figure 5.2.b. Ratios of numbers of killed people by type of water-related disasters: EMDAT 1960-2004.

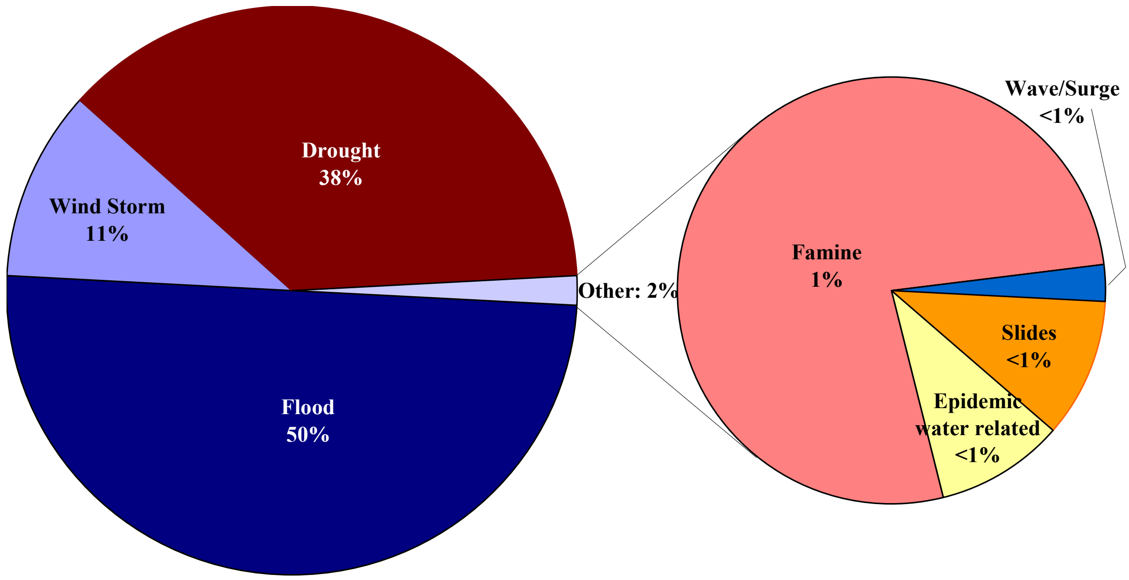


Figure 5.2.c. Ratios of numbers of affected people by type of water-related disasters: EMDAT 1960-2004.

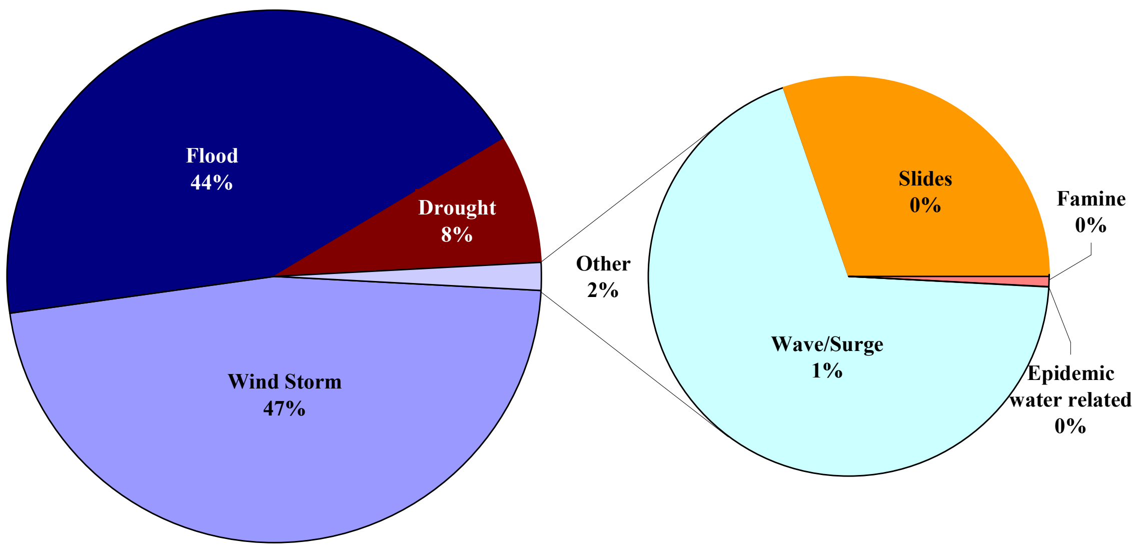


Figure 5.2.d. Ratios of added real economic damage by type of water-related disasters: EMDAT 1960-2004.

Table 5.1. Equivalent ratios between number of disasters and number of killed and affected people respectively: EMDAT 1960-2004 (technological water-related disasters not included)

Type of water related disaster	Ratio of the numbers of events (% of total)	Ratio of the numbers of killed people (% of total)	Ratio of the numbers of affected people (% of total)	Ratio of real economic damage (% of total)
Flood	38.32	26.84	50.00	43.64
Windstorm	37.35	4.67	10.90	46.96
Drought	11.73	39.00	37.53	7.86
Slide	6.93	0.21	0.16	0.47
Water Epidemic	3.81	0.23	0.15	0.00
Famine	1.10	27.90	1.22	0.01
Wave and surge	0.76	1.15	0.04	1.06

Figure 5.2 (plotted for the period 1960-2004) and concurrently Table 5.1 show the distribution of the ratio of the total numbers of events by type of water-related disaster (Figure 5.2.a) and the respective equivalent ratios in terms of total killed people (Figure 5.2.b), total affected people (Figure 5.2.c) and total economic damage (Figure 5.2.d) (i.e., economic damage is based on the real values reported without conversion to the referential year). Attention shall be drawn to the difference in the ratios when the same information is plotted for different periods (compare the ratios of Figure 5.1 to those of Figure 4.1.b, plotted for the period 1900-2004, and Figure 4.2.a, plotted for the period 1990-2004). In addition to what we have stated about the net improvement in the reporting mechanism in EMDAT, the three figures could be an indicator on the way the impacts of different types of disasters can evolve in time. In Figure 5.1 the total number of drought events for the period 1960 to 2004 accounted for 12% of the total disasters reported. Total numbers of killed and affected people were nearly 40% of the totals, respectively, whereas only 8% of the total economic damage was attributed to drought. At this stage no further analysis is conducted, but as mentioned earlier the death toll in China Republic and India and the number of affected people in India in particular are larger than those of the rest of the world by several digits. In contrast, the ratio of famine events accounted for only 1.1% of the total number of disasters. The result shows that famine killed 28% of the world total but affected only 1% of the world afflicted population by water-related disasters. Another interesting figure is the interrelation between the number of windstorm disasters and concurrent impacts (the total killed people 5%, the total affected people 11% and the total economic damage 47% of the global picture.) This later figure put clear emphasis on the importance to concurrently carry out an economic loss evaluation.

Undoubtedly, for us to have a complete picture behind these numbers a more in-depth event based analysis is required. Nevertheless, in order to put further clear emphasis on the complexity of such quality assessment of water-related disasters databases in particular, reference is made to figures 5.3 and 5.4. When producing figures 5.3 and 5.4 we have excluded all extreme values that were repeated over several years (with exactly the same numbers) such as the droughts in India or the famines in Korea Democratic Popular Republic. Such values are taken into consideration only once or twice at most depending on the decade of occurrence.

- Figure 5.3 looks at the database in terms of the top one hundred most disastrous events classified in reference to the largest numbers of killed people by water disasters since 1960 to 2004.
- Figure 5.4 looks at the database in terms of the top one hundred most disastrous events classified in reference to the largest numbers of affected people by water disasters since 1960 to 2004.

A classification as of Figure 5.3 shows that most devastating water disasters are drought, flood, windstorm and famine. For drought, the figure includes only 6 events with both social impacts (killed and affected people), however, the meaning behind these numbers is questionable. In other words, what does a drought event killing hundred thousands or one thousand or hundred people or even one person mean to us as water professionals? Are they killed by water shortage, epidemic disease such as HIV/AIDS or most likely by famine caused by droughts or others? If some deaths are attributed to famine then why are these data not reported as famine disasters? In other words for us to carry a reliable assessment of disasters a clear identification of the real root or cause of death is rudimentary. Though separating the real impact of drought from other factors is still a big challenge, attention is directed to the famine data in Figure 5.4 showing zero people killed by the largest famine disasters as well as to the famine data plotted in terms of largest killed people (see Figure 5.4) showing nearly zero affected people (save the North Korea disaster in 2002). Thus, even after isolating large extreme events there is still an important work to be carried out on event-basis to accurately identify the statistical trends of water-related disasters, especially if sought as indicators to compare between regions or countries.

For flood and windstorm a classification as in Figure 5.4 shows a more logical response in terms of social resiliency to water-related disaster. Nevertheless, clear data incompatibility is also found in reporting flood disasters. For instance, the flood events of 1970 in Bangladesh (10 million people affected), 1979 in India (26 million people affected), and 2002 in the China Rep. (20 million people affected) all reported zero killed people. In contrast Figure 5.4 (plotted in terms of the largest number of killed people) shows that 19 events out of the 100 most disastrous events under this classification counted numbers of zero affected people. These numbers clearly emphasize the extreme importance to verify these data with reference to the official statistics at the national level. This complex large diversity of interrelation between the numbers of killed people and affected people, especially under the classification shown in Figure 5.4, can be further investigated for wave/surge, famine, epidemic water-related, slide and windstorm. Needless to re-emphasis that the consistency of reported data can only be verified through a comprehensive comparative study with national disasters databases. However, we all recognize that for achieving this basic assessment goal there is a need for a strong political and scientific will to share data and open the national databases.

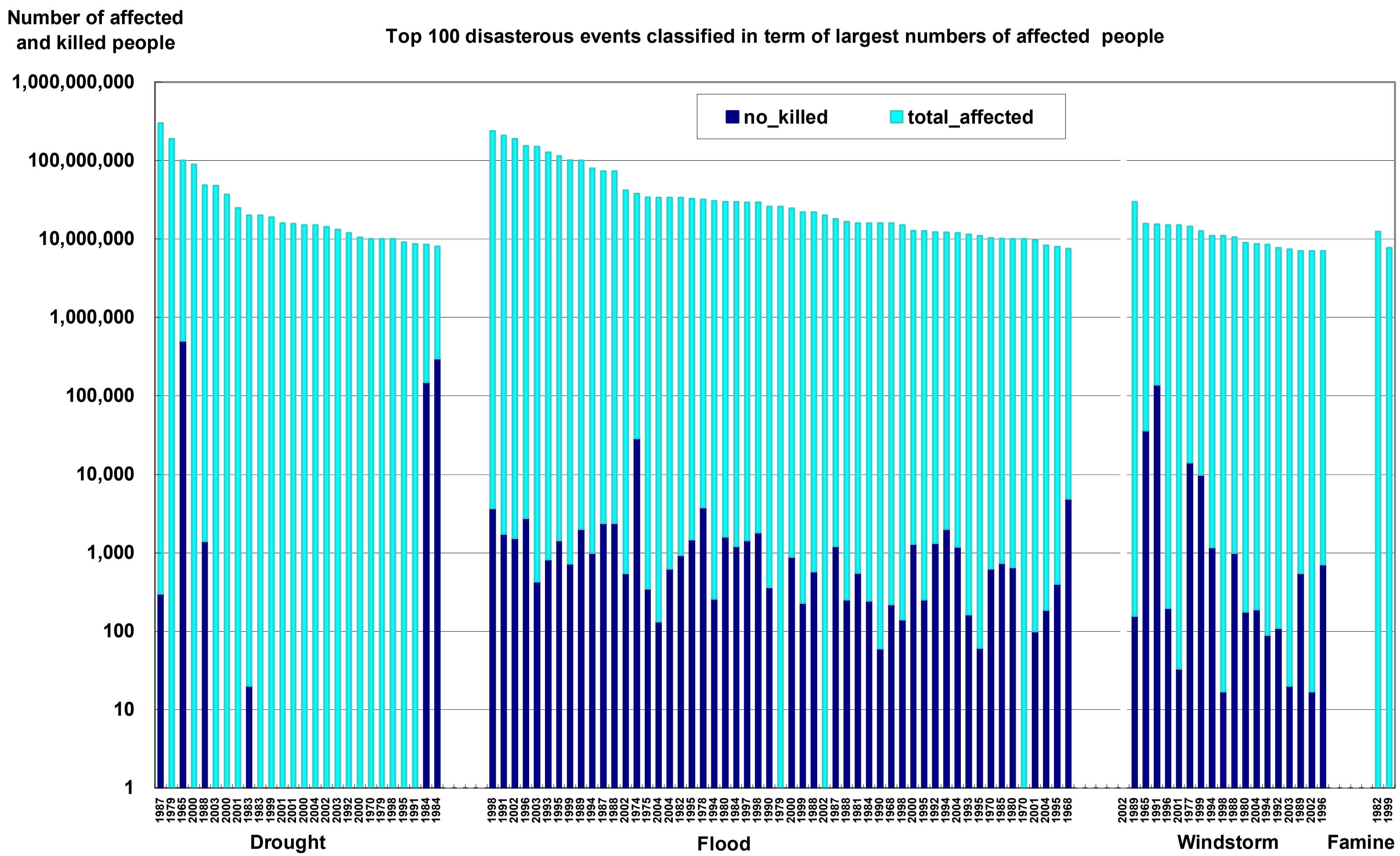


Figure 5.3. Extreme one hundred water-related disasters classified by largest number of affected people since 1960 to 2004.

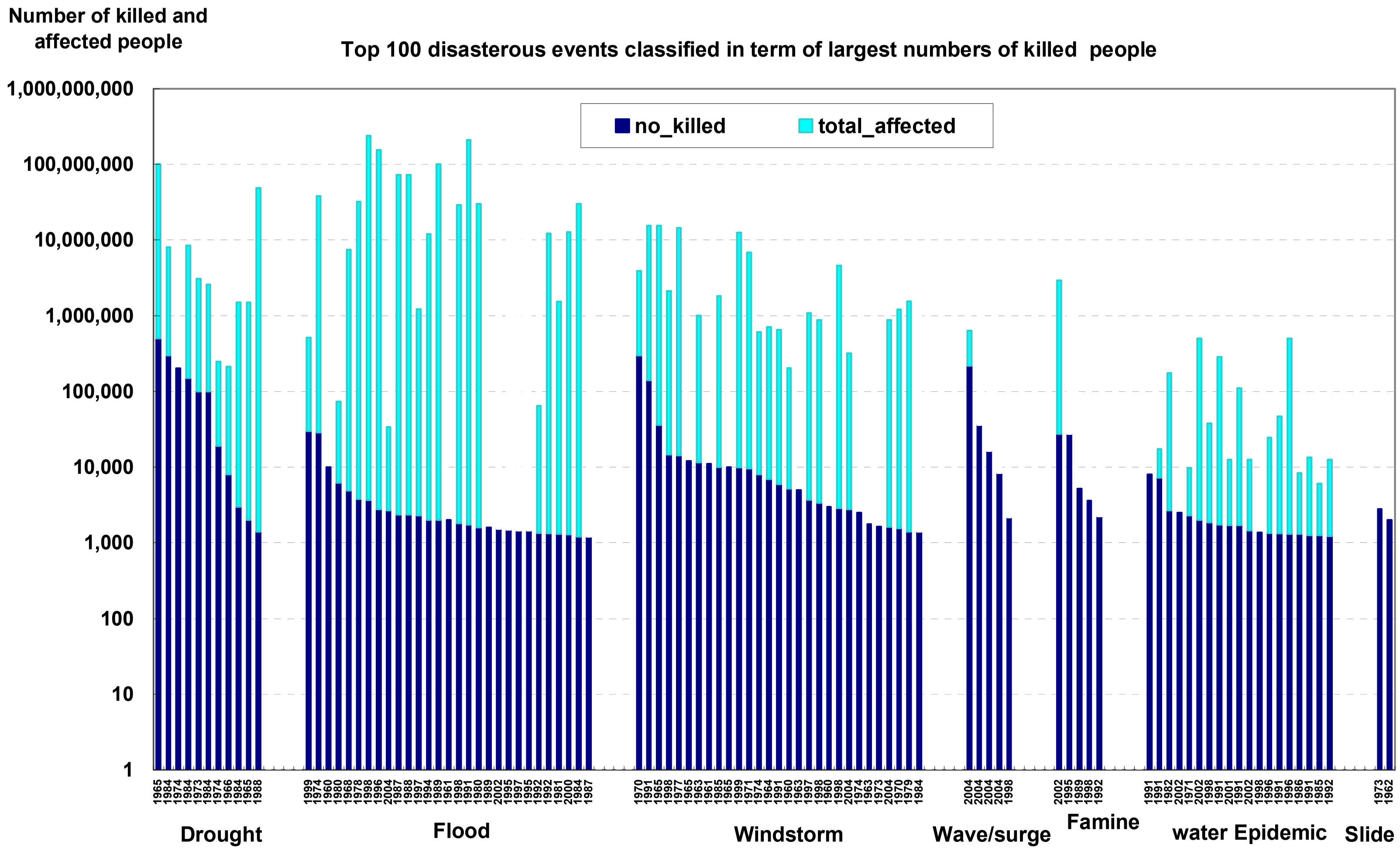
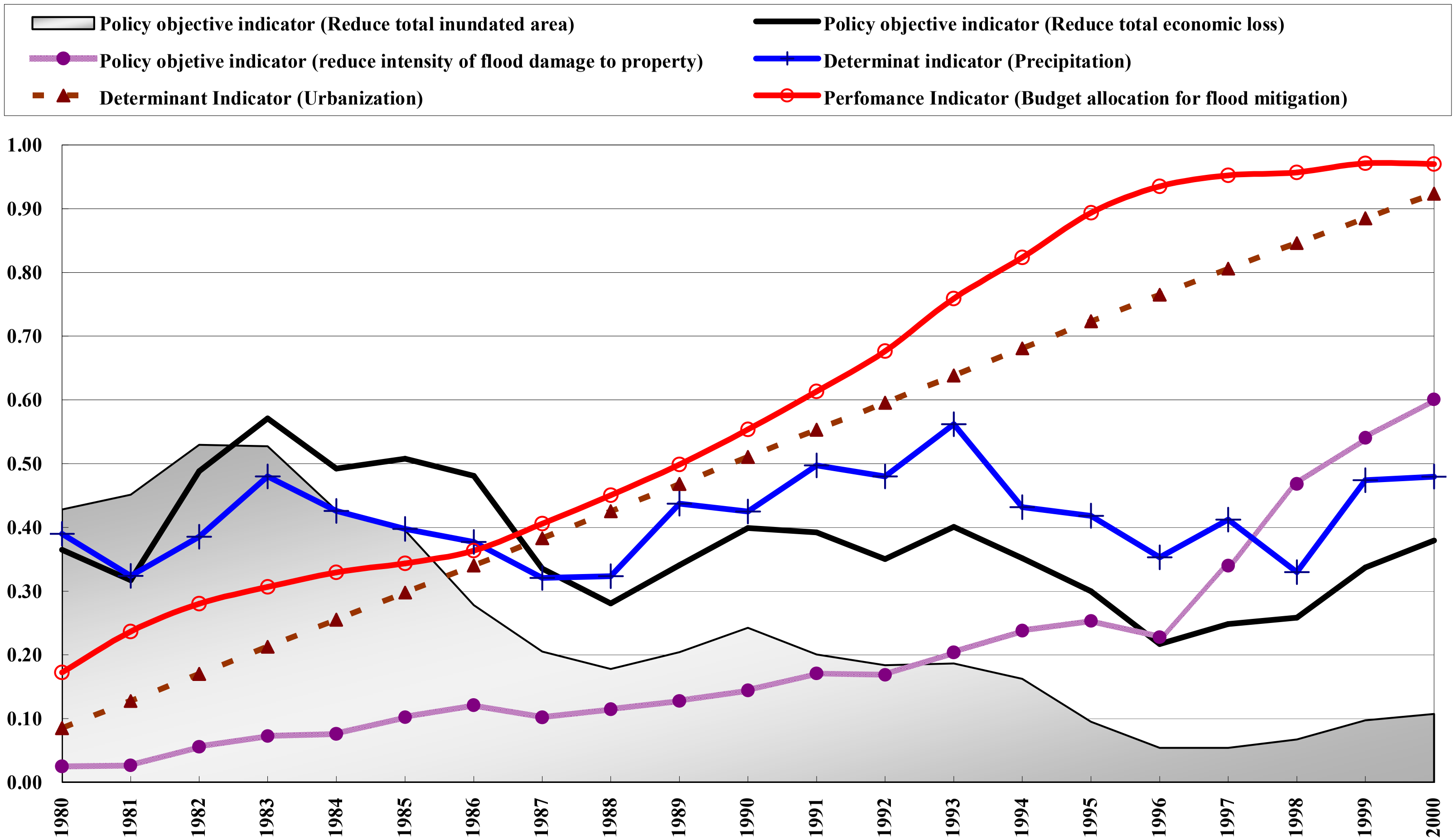


Figure 5.4. Extreme one hundred water-related disasters classified by largest number of killed people since 1960 to 2004.

The analysis above has brought to us a far clearer understanding of the complexity of water-related disaster quantification worldwide. The results show that the conclusions on the trends of death tolls and affected people by any type of water-related disasters should be questioned with even more vigor in the light of more rigorous scientific approach in data selection and data processing. For instance, while famine disasters are attracting many political and international attentions, there are still many events dropped from the database such as the famine disaster of 2002 in Malawi, described by Wisner 2004 as the worst disaster in the African modern history. It is believed that other water-related disasters are also undergoing such incomplete vision in reporting for many technical and political factors. A number of comparative studies between existent databases have put the light on some of these deficiencies (see Guha-Sapir (2002) and LA-RED (2002)), but very little was done to conduct a comparative study between these disasters databases and official national databases.

As mentioned earlier the goal behind such disaster data processing and analysis is to identify the means to build a reliable database with the quality to serve as base to first understand and quantify the vulnerability of people and property to water-related disasters and second to assess the effectiveness of adopted policies in disasters mitigation. Figure 5.5 introduces our case study to apply global indicators as a proof-of-concept implementation to assess 'policy effectiveness' toward the achievement of national and international goals in flood mitigation (i.e., MDGs in the first line). The case study uses the national disaster databases produced by different concerned agencies in Japan such as the Ministry of Land, Infrastructure and Transport (MLIT), the Japan Meteorological Agency, the Statistical Survey Department, the Statistics Bureau, and the Ministry of Public Management, Home Affairs, Posts and Telecommunications, to site only few.

The analysis focuses on flood disasters and reported socio-economic impacts. The data are analyzed and processed on a yearly basis for the period 1980 to 2000. Defining target indicators (e.g., reduce inundated area, reduce economic losses and reduce property damages), the modeling aims to explain the risk target to be reduced as functional relation of the stressors and determinants (also called indicators) identified to play a weighted role in influencing both the vulnerability and resiliency of the system (e.g., social and physical structure of the country or river basin) to positively respond to the mitigation actions. Despite a number of challenges to overcome, the methodology aims not only at evaluating the effectiveness or deficiency of applied policies but furthermore advises on the immediate and future actions necessary to be undertaken by decision makers in order to ensure progress toward the defined goals and mitigate risk from water hazards (see Merabtene et al. 2004).



Historical trends in standarized form of PWRI selected indicators: Japan Case Study, 5 years moving average.

Figure 5.5. Selected indicators for PWRI Flood Risk Index to assess policy effectiveness in flood mitigation.

Several ways of analysis are necessary in order to understand the interrelationships between all factors that determine the vulnerability and resiliency of a society to each type of water-related disasters. The analysis is even more complex if all playing factors including environmental and ecological stressors are integrated as meant by the philosophy of integrated water management. Figure 5.5 not only shows the effectiveness of decades of progress in flood mitigation in Japan but also brings about the complex interaction between flood risk determinants (such as hydrological and social conditions) and flood risk reduction actions (such as budget allocation for flood mitigation).

The figure also stresses the importance to deeply analyze the real cause of disasters. To this end we it is imperative to maintain a coherent database on every single water hazard along consistent information on water hazard/risk determinants and mitigation responses (from legislation to action). This is important because an integrated and well designed water-related disasters database can help us leverage the disaster information amassed from various sources and transform our data into a strategic decisions resource. In other words, creating a well-designed and standardized database will give us true understanding of the complex risk mechanism underlying each type of water-related disaster and will lead us to define more reflective and sustainable disaster mitigation strategies. From this objective point of view, it is clear that current disaster databases are not adequately organized or designed to allow undertaking comprehensive water hazard assessment, as of Figure 5.5 for flood, at the global and regional levels.

The assessment presented in this report recalls the challenges in delineating the assessment of the global and regional trends of water-related disasters and emerging need to sustain and promote similar eminent initiative such as the EMDAT of OFDA/CRED but with focus and study-oriented to water-related disasters. It is one of the goals of the future International Centre for Water Hazards and Risk Management under the auspices of UNESCO after its establishment to undertake such a systematic initiative to build a water hazard database. Nevertheless, we can not overemphasis that the accomplishment and success of such hardship mission requires synergic cooperation involving all concerned people and bodies to create a safer world from water-related disasters.

Appendix

Annex 1: National, Regional and International Disaster Databases
Annex 2: EMDAT Water-related Disaster Glossary
Annex 3: Processed Five-year data series of EMDAT data 1960-2004
Annex 4: Largest Disastrous Events: EMDAT data from 1900 to 2004

Annex 1: National, Regional and International Disaster Databases

- **DesInventar**: DesInventar is a conceptual and methodological development about disasters of any magnitude and about local, regional and national surrounding diversity in Latin-America. It is an inventory system, a methodology to register data about characteristics and effects of diverse types of disasters, with special interest in disasters that are invisible from global or national scales. The inventory allows to watch accumulated data of these invisible disasters at a global or national scale. DesInventar disaster database in managed by the Social Studies Network for Disaster Prevention in LatinAmerica (LA RED), Further details are found at http://www.desinventar.org/desinventar.html.

- **ADRC** Natural Disaster Data Book: The Asian Disaster Reduction Center (ADRC) maintains a Disaster information database and publishes a yearly analytical review under the title "Natural Disaster Data Book". The disasters entries in the data book are enhanced by the use of the Global Identification Number (GLIDE Number). The GLIDE initiative of ADRC was shared and promoted by the Center for Research on the Epidemiology of Disasters (CRED), UCL University, Belgium, OCHA/ReliefWeb, OCHA/FSCC, ISDR, UNDP, WMO, IFRC, OFDA-USAID, FAO, LA-RED and The Word Bank (Araki and Murata 2002 and 2003). Further information about GLIDE initiative can be found at www.glidenumber.net.

- **Relief Web**: "ReliefWeb is the world's leading on-line gateway to information (documents and maps) on humanitarian emergencies and disasters. An independent vehicle of information, designed specifically to assist the international humanitarian community in effective delivery of emergency assistance, it provides timely, reliable and relevant information as events unfold, while emphasizing the coverage of "forgotten emergencies" at the same time.
ReliefWeb was launched in October 1996 and is administered by the UN Office for the Coordination of Humanitarian Affairs (OCHA)." For further information on how disaster information is handled by ReliefWeb see http://www.reliefweb.int.

- **NatCat of Munich Re Group**: "NatCatSERVICE® is a product that Munich Re launched in 1974. NatCatSERVICE® is an information and service package devoted to natural catastrophes. At its centre is a comprehensive database of loss events which can be used to perform complex analyses. It contains more than 20,000 entries on material and human losses caused by natural catastrophes worldwide. This data represents an important resource for the insurance sector and international research institutions. Insurers around the world can access details and trends concerning the various types of loss event." (Munich Re Group**,** 2003).

- **Sigma of Swiss Re:** "Swiss Re approached their database in a similar fashion to Munich Re. Swiss Re devoted somewhat less resources to their database than Munich Re but used these slightly differently by focusing on a number of annual publications. The publications provide international insurance markets with analyses of market trends and forecasts and summaries of prevailing premium/loss volumes. The most recognized of these publications was the annual Sigma Report of global disaster losses produced in 7 languages. Whilst, every effort is made to ensure consistency and reliability of data, Sigma does not claim to be fully comprehensive. In a brief and limited data comparison between Swiss Re and CRED, approximately 40% of entries were found to be identical to CRED's reports." (ProVention 2001).

- The Natural Disaster Reference Database (NDRD): NDRD is a bibliographic database on research, programs, and results which relate to the use of satellite remote sensing for disaster mitigation. The NDRD was compiled and abstracted from articles published from 1981 though January 2000. Major sources for the contents of this database were the NASA RECON and ISI Current Contents databases. This database focuses on the nexus of hazards and satellite remote sensing as well as models and process studies through which these can be brought together. Although the NDRD is no longer updated, it remains on-line as a useful resource for disaster researchers worldwide and as a legacy web site of the Earth Sciences Directorate, NASA Goddard Space Flight Center located in Greenbelt, Maryland, USA. (for further details see http://ndrd.gsfc.nasa.gov).

Annex 2: EMDAT Water-related Disaster Glossary

Definitions are from: International Agreed Glossary of Basic Terms Related to Disaster Management (1992) UN-DHA, IDNDR, Geneva, 83 pages. For non water-related Glossary visit EMDAT web page at http://www.EMDAT.net.

- **Avalanche**: Rapid and sudden sliding and flowage of masses of usually unsorted mixtures of snow/ice/rock material (in EMDAT, «avalanche» is a disaster subset of disaster type «slide»).
- **Collapse**: Accident involving the collapse of building or structure. Can either involve industrial structures (in EMDAT referred to as «Ind:Collapse» and forms a disaster subset of disaster type «industrial accident») or domestic / non-industrial structures (in EMDAT referred to as «Misc: Collapse» and forms a disaster subset of disaster type «miscellaneous accident»).
- **Crop failure**: Abnormal reductions in crop yield such that is insufficient to meet the nutritional or economic needs of the community (in EMDAT, «crop failure» is a disaster subset of disaster type «famine»).
- **Cyclone**: Large-scale closed circulation system in the atmosphere above the Indian Ocean and South Pacific with low barometric pressure and strong winds that rotate clockwise. Maximum wind speed of 64 knots or more [See «hurricane» for the western Atlantic and eastern Pacific and «typhoon» for the western Pacific]. (in EMDAT, « cyclone » is a disaster subset of disaster type «wind storm»).
- **Drought**: Period of deficiency of moisture in the soil such that there is inadequate water required for plants, animals and human beings.
- **El Niño** («little child» in Spanish): Anormalous warming of ocean water resulting from the oscillation of current in the South Pacific, usually accompanied by heavy rainfall in the coastal region of Peru and Chile, and reduction of rainfall in equatorial Africa and Australia.
- **Epidemic**: Either an unusual increase in the number of cases of an infectious disease, which already exists in the region or population concerned; or the appearance of an infection previously absent from a region (in EMDAT the epidemic disease in included as a disaster subset).
- **Famine**: Catastrophic food shortage affecting large numbers of people due to climatic, environmental and socio-economic reasons (in EMDAT, famine can have four disaster subsets: «crop failure», «food shortage» and «drought»).
- **Flood**: Significant rise of water level in a stream, lake, reservoir or coastal region.

- **Food shortage**: Lack of alimentation bases (in EMDAT, «food shortage» is a disaster subset of disaster type «famine»).
- **Hazard**: Threatening event, or probability of occurrence of a potentially damaging phenomenon within a given time period and area.
- **Hurricane**: disaster subset of disaster type «wind storm»Large-scale closed circulation system in the atmosphere above the western Atlantic with low barometric pressure and strong winds that rotate clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. Maximum wind speed of 64 knots or more.
- **La Niña** (« little girl » in Spanish): It is essentially the opposite of El Niño. The ocean becomes much cooler than normal. Although, La Niña is not as well understood as El Niño, it is thought to occur due to an increase in the strength of the trade winds. This increases the amount of cooler water that upwells toward the West Coast of South American and reduces water temperatures. (Environnement Canada).
- **Landslide**: In general, all varieties of slope movement, under the influence of gravity. More strictly refers to down-slope movement of rock and/or earth masses along one or several slide surfaces (in EMDAT, « landslide » is a disaster subset of disaster type « slide »).
- **Slide**: Disaster type term used in EMDAT comprising the two disaster subsets «avalanche» and «landslide».
- **Storm**: Wind with a speed between 48 and 55 knots; (in EMDAT, «storm» is a disaster subset of the disaster type «wind storm»).
- **Tidal wave**: Abrupt rise of tidal water (caused by atmospheric activities) moving rapidly inland from the mouth of an estuary or from the coast (in EMDAT, « tidal wave » is a disaster subset of the disaster type «wave/surge»)(OFDA).
- **Tornado**: Violently rotating storm diameter; the most violent weather phenomenon. It is produced in a very severe thunderstorm and appears as a funnel cloud extending from the base of a cumulonimbus to the ground (in EMDAT, « tornado » is a disaster subset of the disaster type « wind storm »).
- **Tropical storm**: Generic term for a non-frontal synoptic scale cyclone originating over tropical or sub-tropical waters with organised convection and definite cyclonic surface wind circulation (in EMDAT, « tropical storm » is a disaster subset of the disaster type « wind storm »).
- **Tsunami** (« wave in the port » in Japanese): Series of large waves generated by sudden displacement of seawater (caused by earthquake, volcanic eruption or submarine landslide); capable of propagation over large distances and causing a

destructive surge on reaching land. The Japanese term for this phenomenon, which is observed mainly in the Pacific, has been adopted for general usage (in EMDAT, « tsunami » is a disaster subset of the disaster type « wave/surge »).

- **Typhoon**: Large-scale closed circulation system in the atmosphere above the western Pacific with low barometric pressure and strong winds that rotate clockwise in the southern hemisphere and counter-clockwise in the northern hemisphere. Maximum wind speed of 64 knots or more. (in EMDAT, « typhoon » is a disaster subset of disaster type « wind storm »).
- **Wave/surge**: Disaster type term used in EMDAT comprising the two disaster subsets « tsunami » and « tidal wave ».
- **Wind storm**: Disaster type term comprises the following disaster subsets cyclone, hurricane, storm, tornado, tropical storm, typhoon, winter storm.
- **Winter storm**: Snow (blizzard), ice or sleet storm; (in EMDAT, « winter storm » is a disaster subset of the disaster type « wind storm »).

Other General Related Glossary to EMDAT:

- **Disaster**: Situation or event, which overwhelms local capacity, necessitating a request to national or international level for external assistance (definition considered in EMDAT); An unforeseen and often sudden event that causes great damage, destruction and human suffering. Though often caused by nature, disasters can have human origins. Wars and civil disturbances that destroy homelands and displace people are included among the causes of disasters. Other causes can be: building collapse, blizzard, drought, epidemic, earthquake, explosion, fire, flood, hazardous material or transportation incident (such as a chemical spill), hurricane, nuclear incident, tornado, or volcano (Disaster Relief).
- **Emergency**: Sudden and usually unforeseen event that calls for immediate measures to minimize its adverse consequences.
- **Hazard**: Threatening event, or probability of occurrence of a potentially damaging phenomenon within a given time period and area.
- **Risk**: Expected losses (of lives, persons injured, property damaged and economic activity disrupted) due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability.
- **Vulnerability**: Degree of loss (from 0% to 100%) resulting from a potential damaging phenomenon.

Annex 3: Processed Five-year data series of EMDAT data 1960-2004

- The table hereafter reports the EMDAT water-related disasters database used.
- The database is categorized by:
  - Events: Flood, Windstorm, Slide, Wave & surge, Drought, Famine, Water-related epidemic, and Water-related technologic disasters (traffic accident in particular); and by
  - Continent: Africa, Asia, Americas, Europe, and Oceania
- Each field of data reports the accumulated value over five year period of successive data.
- From the 42 fields originally available in EMDAT the four related to this project are reported are number of events, dead people, affected people and economic damage.
- Empty field: refers that none data were reported for the concerned 5 years period

Tables Legend:

- **no_Disasters**: Total of number of water-related disasters for the 5 year period of data;
- **no_Killed**: Total of number of people killed within the 5 year period of data;
- **Total_Affected**: Total affected people (including injured and homeless);
- **Damage_US$:** Actual economic damage in US$ within the 5 year period of data;

Flood:

Africa

Period \ Event	Flood			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	6	3237	0	0
1960-1964	10	534	130310	3000
1965-1969	14	809	736731	415370
1970-1974	13	705	2974684	79250
1975-1979	29	623	1624842	172200
1980-1984	19	460	1467719	92406
1985-1989	46	1238	6010913	842905
1990-1994	42	2049	2361934	438829
1995-1999	103	5208	11887220	225895
2000-2004	172	3955	8820479	1117078
Total (1960-2002)	448	15581	36014832	3386933
Total (1900 to 2004)	454	18818	36014832	3386933

Asia

Period \ Event	Flood			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	65	6579132	58360534	1450000
1960-1964	30	15599	3317421	6000
1965-1969	49	10279	34650437	629811
1970-1974	36	35426	70892281	1755357
1975-1979	68	9309	119539124	2095521
1980-1984	110	21640	161328823	5731010
1985-1989	117	23083	344149344	18191764
1990-1994	157	20195	567632267	33641501
1995-1999	166	27882	841000440	79089067
2000-2004	261	16941	621308929	31178343
Total (1960-2002)	994	180354	2763819066	172318374
Total (1900-2004)	1059	6759486	2822179600	173768374

Americas

Period \ Event	Flood			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	29	45678	109000	3162230
1960-1964	9	1195	120000	820500
1965-1969	34	2782	1757747	626978
1970-1974	41	2195	6669785	1237679
1975-1979	41	1144	3535740	789900
1980-1984	66	4228	13184145	7659200
1985-1989	97	3068	13714920	5038190
1990-1994	102	1844	3182908	19305370
1995-1999	94	32559	5593659	13847287
2000-2004	170	5209	3485860	4374620
Total (1960-2002)	654	54224	51244764	53699724
Total (1900 to 2004)	683	99902	51353764	56861954

Europe

Period \ Event	Flood			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	24	4280	306350	670000
1960-1964	4	495	243000	142600
1965-1969	6	896	196200	2350000
1970-1974	7	1085	1541005	1273300
1975-1979	17	229	1086870	830100
1980-1984	32	350	828247	5602500
1985-1989	22	216	34580	3414800
1990-1994	42	620	1520147	31795700
1995-1999	65	814	3019596	12230650
2000-2004	132	601	2447298	28074297
Total (1960-2002)	327	5306	10916943	85713947
Total (1900 to 2004)	351	9586	11223293	86383947

Oceania

Period \ Event	Flood			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	2	91	0	0
1960-1964	1	1	18000	1100
1965-1969				
1970-1974	3	53	12000	96972
1975-1979	10	7	12975	93080
1980-1984	11	94	25095	234415
1985-1989	18	68	219912	173233
1990-1994	9	13	170935	280800
1995-1999	13	11	65251	554528
2000-2004	22	22	27991	717483
Total (1960-2002)	87	269	552159	2151611
Total (1900 to 2004)	89	360	552159	2151611

Windstorm:

Africa

Period \ Event	Wind Storm			
	no_Disasters	**no_Killed**	**Total_Affected**	**Damage_US$**
1900-1959	5	833	0	0
1960-1964	1	42	0	0
1965-1969	4	110	141579	13300
1970-1974	3	163	2545072	23820
1975-1979	14	252	1628592	774600
1980-1984	20	704	1910950	1140250
1985-1989	17	384	258444	281961
1990-1994	16	554	3324048	543565
1995-1999	21	563	849871	606000
2000-2004	48	822	3043099	350222
Total (1960-2002)	144	3594	13701655	3733718
Total (1900 to 2004)	149	4427	13701655	3733718

Asia

Period \ Event	Wind Storm			
	no_Disasters	**no_Killed**	**Total_Affected**	**Damage_US$**
1900-1959	126	410733	9684110	1280000
1960-1964	45	44121	9477059	245050
1965-1969	50	65867	19746665	267481
1970-1974	64	323254	21303460	891489
1975-1979	82	21077	23574046	3153838
1980-1984	108	12631	38240203	2448374
1985-1989	122	22327	91342961	5659246
1990-1994	181	157090	106438734	29030494
1995-1999	124	27457	89201795	21037554
2000-2004	194	6512	162968469	37691474
Total (1960-2002)	970	680336	562293392	100425000
Total (1900 to 2004)	1096	1091069	571977502	101705000

Americas

Period \ Event	Wind Storm			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	114	37875	383820	3899000
1960-1964	37	9185	91868	2297390
1965-1969	44	3149	652508	3718350
1970-1974	27	9161	922706	4331580
1975-1979	36	2984	2311483	3893950
1980-1984	64	3603	1474004	10908655
1985-1989	101	1478	4127618	13887391
1990-1994	119	2053	2937112	50501525
1995-1999	146	21382	11241455	52671596
2000-2004	153	3870	13140861	43915942
Total (1960-2002)	727	56865	36899615	186126379
Total (1900 to 2004)	841	94740	37283435	190025379

Europe

Period \ Event	Wind Storm			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	10	4300	0	80000
1960-1964	3	390	12000	602200
1965-1969	8	85	3900	53600
1970-1974	13	187	5200	980200
1975-1979	10	83	19	1301000
1980-1984	38	517	71962	3096100
1985-1989	26	172	0	5222600
1990-1994	39	457	1022071	16497300
1995-1999	30	447	3793421	13524741
2000-2004	63	271	2827697	1075198
Total (1960-2002)	230	2609	7736270	42352939
Total (1900 to 2004)	240	6909	7736270	42432939

Oceania

Period \ Event	Wind Storm			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	20	538	2400	4450
1960-1964	4	261	12000	250541
1965-1969	15	168	107204	3838
1970-1974	15	173	174090	1311411
1975-1979	27	85	75005	1458504
1980-1984	29	46	435660	289127
1985-1989	31	250	461166	850367
1990-1994	35	126	3481917	2545173
1995-1999	26	146	1096504	1907995
2000-2004	41	103	162140	580900
Total (1960-2002)	223	1358	6005686	9197856
Total (1900 to 2004)	243	1896	6008086	9202306

Slides:

Africa

Event / Period	Slides			
	no_Disasters	**no_Killed**	**Total_Affected**	**Damage_US$**
1900-1959				
1960-1964				
1965-1969	2	308	1436	0
1970-1974				
1975-1979				
1980-1984	2	47	12416	0
1985-1989	3	31	1648	0
1990-1994	4	84	1025	0
1995-1999	3	141	2500	0
2000-2004	8	110	715	0
Total (1960-2002)	22	721	19740	0
Total (1900 to 2004)	22	721	19740	0

Asia

Event / Period	Slides			
	no_Disasters	**no_Killed**	**Total_Affected**	**Damage_US$**
1900-1959	11	1978	0	0
1960-1964	4	414	0	0
1965-1969	2	1064	0	0
1970-1974	9	513	1113	0
1975-1979	10	738	80125	100000
1980-1984	16	1227	3150	0
1985-1989	29	1923	2571402	1341
1990-1994	32	1788	215196	302590
1995-1999	46	3254	1328503	4500
2000-2004	66	2943	856837	125798
Total (1960-2002)	214	13864	5056326	534229
Total (1900 to 2004)	225	15842	5056326	534229

Americas

Period \ Event	Slides			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	18	6523	2069	0
1960-1964	3	2071	0	200000
1965-1969	8	983	4000022	27
1970-1974	17	5709	16028	21700
1975-1979	4	103	116	0
1980-1984	9	688	40	3000
1985-1989	22	1769	119302	800
1990-1994	16	972	327849	915400
1995-1999	22	1051	46757	0
2000-2004	22	691	156982	86000
Total (1960-2002)	123	14037	4667096	1226927
Total (1900 to 2004)	141	20560	4669165	1226927

Europe

Period \ Event	Slides			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	8	12528	380	20000
1960-1964	2	1334	0	0
1965-1969	4	261	22	0
1970-1974	6	183	85	0
1975-1979	6	120	50	11000
1980-1984	10	133	7035	700000
1985-1989	10	351	16841	950000
1990-1994	10	832	2834	2600
1995-1999	12	234	11278	22089
2000-2004	7	182	3011	0
Total (1960-2002)	67	3630	41156	1685689
Total (1900 to 2004)	75	16158	41536	1705689

Oceania

Period \ Event	Slides			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969				
1970-1974	1	100	0	0
1975-1979	2	13	600	2466
1980-1984	0	0	0	0
1985-1989	3	87	4000	0
1990-1994	1	200	5000	0
1995-1999	5	79	620	0
2000-2004	3	49	795	0
Total (1960-2002)	15	528	11015	2466
Total (1900 to 2004)	15	528	11015	2466

Wave and Surge:

Africa

Period \ Event	Wave / Surge			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969	1	0	2000	50
1970-1974				
1975-1979				
1980-1984				
1985-1989				
1990-1994				
1995-1999				
2000-2004	4	164	54478	30000
Total (1960-2002)	5	164	56478	30050
Total (1900 to 2004)	5	164	56478	30050

Asia

Period \ Event	Wave / Surge			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	7	7319	0	0
1960-1964	2	170	0	50000
1965-1969	2	264	97	0
1970-1974				
1975-1979	1	539	23	0
1980-1984	2	0	818	2330
1985-1989	1	11	2000	0
1990-1994	3	100		
1995-1999	4	420	29200	267
2000-2004	11	280882	2459791	7765200
Total (1960-2002)	26	282386	2491929	7817797
Total (1900 to 2004)	33	289705	2491929	7817797

Americas

Event / Period	Wave / Surge			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	4	312	0	900
1960-1964	1	61	0	0
1965-1969				
1970-1974				
1975-1979				
1980-1984				
1985-1989				
1990-1994				
1995-1999	2	15	1124	0
2000-2004	1	0	1720	0
Total (1960-2002)	4	76	2844	0
Total (1900 to 2004)	8	388	2844	900

Europe

Event / Period	Wave / Surge			
	no_Killed	Total_Affected	Damage_US$	no_Disasters
1900-1959	1	2300	0	0
1960-1964				
1965-1969				
1970-1974				
1975-1979	1	11	2	0
1980-1984				
1985-1989				
1990-1994				
1995-1999				
2000-2004				
Total (1960-2002)	1	11	2	0
Total (1900 to 2004)	2	2311	2	0

Oceania

Event / Period	Wave / Surge			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	2	61	0	0
1960-1964				
1965-1969				
1970-1974				
1975-1979	1	200	0	0
1980-1984				
1985-1989				
1990-1994				
1995-1999	1	2182	9867	0
2000-2004				
Total (1960-2002)	2	2382	9867	0
Total (1900 to 2004)	4	2443	9867	0

Drought:

Africa

Period \ Event	Drought			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	96	170000	32000	0
1960-1964	2	50	705000	0
1965-1969	25	2000	4118483	22500
1970-1974	47	319000	12506595	1108400
1975-1979	32	0	11780400	401500
1980-1984	90	553500	65260840	2501434
1985-1989	33	1017	28027000	146320
1990-1994	40	0	71575007	0
1995-1999	32	12	20586349	291939
2000-2004	65	895	102583908	0
Total (1960-2002)	366	876474	317143582	4472093
Total (1900 to 2004)	462	1046474	317175582	4472093

Asia

Period \ Event	Drought			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	5	6250000	20000000	0
1960-1964	5	0	1291000	0
1965-1969	10	1508000	104957944	127318
1970-1974	12	0	207875000	223500
1975-1979	17	81	209772885	201200
1980-1984	17	510	227502000	0
1985-1989	15	1894	357737000	942887
1990-1994	12	0	28746385	120200
1995-1999	19	680	46049000	3106325
2000-2004	53	243	586149800	10089546
Total (1960-2002)	160	1511408	1770081014	14810976
Total (1900 to 2004)	165	7761408	1790081014	14810976

Americas

Period \ Event	Drought			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	20	0	250000	0
1960-1964	3	0	613400	0
1965-1969	7	0	1054821	71500
1970-1974	5	0	10837000	62100
1975-1979	7	0	5450000	3550000
1980-1984	19	20	23992049	3319000
1985-1989	11	0	823000	1559400
1990-1994	9	0	3713160	1981000
1995-1999	15	0	12298200	2459000
2000-2004	32	54	2932400	505539
Total (1960-2002)	108	74	61714030	13507539
Total (1900 to 2004)	128	74	61964030	13507539

Europe

Period \ Event	Drought			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	1	1200000	5000000	0
1960-1964				
1965-1969				
1970-1974				
1975-1979	1	0	0	0
1980-1984	7	0	0	3055000
1985-1989				
1990-1994	8	0	3200000	2188600
1995-1999	4	0	6000000	7700000
2000-2004	9	0	1062575	1368000
Total (1960-2002)	29	0	10262575	14311600
Total (1900 to 2004)	30	1200000	15262575	14311600

Oceania

Period \ Event	Drought			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969	1	600	0	0
1970-1974				
1975-1979	4	0	0	0
1980-1984	4	0	151000	6030000
1985-1989				
1990-1994	4	0	5250000	3623000
1995-1999	8	88	2832635	1053000
2000-2004	1	0	0	300000
Total (1960-2002)	22	688	8233635	11006000
Total (1900 to 2004)	22	688	8233635	11006000

Famine:

Africa

Period \ Event	Famine			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	1	26000	0	0
1960-1964				
1965-1969				
1970-1974				
1975-1979	2	0	300000	0
1980-1984	3	15	13123000	0
1985-1989	9	5437	8937267	0
1990-1994	11	2443	15203900	0
1995-1999	17	3644	12339134	89000
2000-2004	5	0	1080000	0
Total (1960-2002)	47	11539	50983301	89000
Total (1900 to 2004)	48	37539	50983301	89000

Asia

Period \ Event	Famine			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964	1	0	300000	0
1965-1969				
1970-1974				
1975-1979				
1980-1984				
1985-1989				
1990-1994	5	760	1812000	4399
1995-1999	11	137500	11988000	0
2000-2004	3	82500	4900000	0
Total (1960-2002)	20	220760	19000000	4399
Total (1900 to 2004)	20	220760	19000000	4399

Americas

Period \ Event	Famine			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969	1	0	0	50
1970-1974				
1975-1979				
1980-1984				
1985-1989				
1990-1994	1	0	1000000	0
1995-1999	1	0	0	0
2000-2004	1	0	3000	0
Total (1960-2002)	4	0	1003000	50
Total (1900 to 2004)	4	0	1003000	50

Europe

Period \ Event	Famine			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	1	5000000	0	0
1960-1964				
1965-1969				
1970-1974				
1975-1979				
1980-1984				
1985-1989				
1990-1994				
1995-1999	1	0	10000	0
2000-2004				
Total (1960-2002)	1	0	10000	0
Total (1900-2004)	3	10000000	10000	0

Oceania

Period \ Event	Famine			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969				
1970-1974	1	0	0	0
1975-1979				
1980-1984				
1985-1989				
1990-1994				
1995-1999				
2000-2004				
Total (1960-2002)	1	0	0	0
Total (1900 to 2004)	1	0	0	0

Epidemic water-related:

Africa

Event / Period	Epidemic Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	1	10276	0	0
1960-1964				
1965-1969	1	0	0	0
1970-1974	4	2932	13476	0
1975-1979	7	576	16386	0
1980-1984	7	1687	12376	0
1985-1989	22	6422	62490	4692
1990-1994	23	14618	6813919	0
1995-1999	83	15365	1056966	0
2000-2004	111	6218	1003553	38
Total (1960-2002)	258	47818	8979166	4730
Total (1900 to 2004)	259	58094	8979166	4730

Asia

Event / Period	Epidemic Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	2	800000	0	0
1960-1964	2	598	10848	0
1965-1969	5	466	205118	0
1970-1974				
1975-1979	21	1512	69371	0
1980-1984	10	5324	178375	0
1985-1989	14	2778	1169700	0
1990-1994	22	7827	2137951	0
1995-1999	40	3783	465221	0
2000-2004	30	1304	227214	0
Total (1960-2002)	144	23592	4463798	0
Total (1900 to 2004)	2900	7851533	7964553444	508187423

Americas

Period \ Event	Epidemic Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	2	46	0	0
1960-1964	1	0	2724	0
1965-1969				
1970-1974				
1975-1979	3	0	407	0
1980-1984	1	300	0	0
1985-1989	3	37	34892	0
1990-1994	22	12721	400435	0
1995-1999	24	194	459779	0
2000-2004	8	82	207695	0
Total (1960-2002)	62	13334	1105932	0
Total (1900 to 2004)	64	13380	1105932	0

Europe

Period \ Event	Epidemic Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	1	0	18000000	0
1960-1964				
1965-1969				
1970-1974	1	0	0	0
1975-1979	2	0	100000	0
1980-1984	1	26	16	0
1985-1989	2	45	294	0
1990-1994	2	91	1333	0
1995-1999	3	18	554	0
2000-2004	5	0	1106	0
Total (1960-2002)	16	180	103303	0
Total (1900 to 2004)	17	180	18103303	0

Oceania

Period \ Event	Epidemic Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969				
1970-1974				
1975-1979	1	17	352	0
1980-1984				
1985-1989				
1990-1994	1	7	1200	0
1995-1999				
2000-2004	3	25	4086	0
Total (1960-2002)	5	49	5638	0
Total (1900 to 2004)	5	49	5638	0

Technologic water-related:

Africa

Event / Period	Technological Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964	1	0	200	0
1965-1969	1	100	0	0
1970-1974				
1975-1979				
1980-1984	6	596	0	0
1985-1989	14	1495	0	0
1990-1994	34	3033	50692	0
1995-1999	38	3893	0	0
2000-2004	87	5048	940	0
Total (1960-2002)	181	14165	51832	0
Total (1900 to 2004)	181	14165	51832	0

Asia

Event / Period	Technological Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	7	6146	0	0
1960-1964				
1965-1969	1	39	0	0
1970-1974	3	360	0	0
1975-1979	2	700	0	0
1980-1984	17	2553	907	0
1985-1989	100	14076	290	0
1990-1994	95	5929	188	0
1995-1999	77	4806	53	0
2000-2004	87	6117	2029	0
Total (1960-2002)	382	34580	3467	0
Total (1900 to 2004)	3143	7068667	7960093113	508187423

Americas

Period / Event	Technological Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	12	5564	16600	0
1960-1964				
1965-1969	1	90	500	0
1970-1974	1	30	0	0
1975-1979	2	43	0	0
1980-1984	4	644	19	0
1985-1989	21	1021	0	0
1990-1994	18	3080	20	0
1995-1999	20	1042	112	0
2000-2004	25	597	320	0
Total (1960-2002)	92	6547	971	0
Total (1900 to 2004)	104	12111	17571	0

Europe

Period / Event	Technological Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959	4	2563	2200	0
1960-1964	1	13	0	0
1965-1969	1	39	0	0
1970-1974	2	81	0	0
1975-1979	1	50	0	0
1980-1984	1	400	0	0
1985-1989	11	1017	498	0
1990-1994	18	1575	219	0
1995-1999	12	609	38	0
2000-2004	33	944	201	0
Total (1960-2002)	80	4728	956	0
Total (1900 to 2004)	84	7291	3156	0

Oceania

Period / Event	Technological Water-related			
	no_Disasters	no_Killed	Total_Affected	Damage_US$
1900-1959				
1960-1964				
1965-1969				
1970-1974				
1975-1979				
1980-1984				
1985-1989				
1990-1994	3	86	24	0
1995-1999				
2000-2004	2	181	0	0
Total (1960-2002)	5	267	24	0
Total (1900 to 2004)	5	267	24	0

Annex 4: Largest Disastrous Events: EMDAT data from 1900 to 2004

A: Top 100 disastrous events in terms of killed people

year	dis_type	dis_subset	country_name	no_killed	total_affected
1932	Famine	Food shortage	Soviet Union	5,000,000	0
1931	Flood	Flood	China P Rep	3,700,000	28,500,000
1928	Drought	Drought	China P Rep	3,000,000	0
1917	Epidemic	Unknown	Soviet Union	2,500,000	0
1959	Flood	Flood	China P Rep	2,000,000	0
1920	Epidemic	Plague	India	2,000,000	0
1943	Famine	Food shortage	Bangladesh	1,900,000	0
1909	Epidemic	Plague	China P Rep	1,500,000	0
1942	Drought	Drought	India	1,500,000	0
1907	Epidemic	Plague	India	1,300,000	0
1900	Drought	Drought	India	1,250,000	0
1921	Drought	Drought	Soviet Union	1,200,000	5,000,000
1939	Flood	Flood	China P Rep	500,000	0
1920	Epidemic	Diarrhoeal/Enteric	India	500,000	0
1920	Drought	Drought	China P Rep	500,000	20,000,000
1965	Drought	Drought	India	500,000	100,000,000
1966	Drought	Drought	India	500,000	0
1967	Drought	Drought	India	500,000	0
1926	Epidemic	Small pox	India	423,000	0
1918	Epidemic	Respiratory	Bangladesh	393,000	0
1970	Wind Storm	Cyclone	Bangladesh	300,000	3,648,000
1924	Epidemic	Diarrhoeal/Enteric	India	300,000	0
1984	Drought	Drought	Ethiopia	300,000	7,750,000
1901	Epidemic	Unknown	Uganda	200,000	0
1974	Drought	Drought	Ethiopia	200,000	0
1984	Drought	Drought	Sudan	150,000	8,400,000
1935	Flood	Flood	China P Rep	142,000	10,030,000
1991	Wind Storm	Cyclone	Bangladesh	138,866	15,438,849
1922	Wind Storm	Typhoon	China P Rep	100,000	0
1911	Flood	Flood	China P Rep	100,000	0
1923	Epidemic	Meningitis	Niger	100,000	0
1973	Drought	Drought	Ethiopia	100,000	3,000,000
1984	Drought	Drought	Mozambique	100,000	2,466,000
1942	Wind Storm	Cyclone	Bangladesh	61,000	0
1935	Wind Storm	Cyclone	India	60,000	0
1910	Epidemic	Plague	China P Rep	60,000	0
1949	Flood	Flood	China P Rep	57,000	0
1912	Wind Storm	Typhoon	China P Rep	50,000	0
1918	Epidemic	Respiratory	Canada	50,000	2,000,000
1942	Wind Storm	Cyclone	India	40,000	0

year	dis_type	dis_subset	country_name	no_killed	total_affected
1949	Flood	Flood	Guatemala	40,000	0
1965	Wind Storm	Cyclone	Bangladesh	36,000	15,600,000
1954	Flood	Flood	China P Rep	30,000	0
1999	Flood	Flood	Venezuela	30,000	483,635
1946	Drought	Drought	Cape Verde Is	30,000	0
1974	Flood	Flood	Bangladesh	28,700	38,000,000
1995	Famine	Food shortage	Korea Dem P Rep	27,500	1,000,000
1996	Famine	Food shortage	Korea Dem P Rep	27,500	1,000,000
1997	Famine	Food shortage	Korea Dem P Rep	27,500	1,000,000
1998	Famine	Food shortage	Korea Dem P Rep	27,500	1,000,000
1999	Famine	Food shortage	Korea Dem P Rep	27,500	1,000,000
1931	Famine	Food shortage	Niger	26,000	0
1920	Drought	Drought	Cape Verde Is	24,000	0
1910	Drought	Drought	Niger	21,250	8,000
1911	Drought	Drought	Niger	21,250	8,000
1912	Drought	Drought	Niger	21,250	8,000
1913	Drought	Drought	Niger	21,250	8,000
1974	Drought	Drought	Somalia	19,000	230,000
1933	Flood	Flood	China P Rep	18,000	3,600,000
1998	Wind Storm	Hurricane	Honduras	14,600	2,112,000
1977	Wind Storm	Cyclone	India	14,204	14,469,800
1965	Wind Storm	Cyclone	Bangladesh	12,047	0
1949	Slides	Landslide	Soviet Union	12,000	0
1963	Wind Storm	Cyclone	Bangladesh	11,500	1,000,000
1937	Wind Storm	Typhoon	Hong Kong (China)	11,000	0
1961	Wind Storm	Cyclone	Bangladesh	11,000	0
1900	Drought	Drought	Cape Verde Is	11,000	0
1947	Epidemic	Diarrhoeal/Enteric	Egypt	10,276	0
1906	Wind Storm	Typhoon	Hong Kong (China)	10,000	0
1965	Wind Storm	Cyclone	Pakistan	10,000	0
1985	Wind Storm	Cyclone	Bangladesh	10,000	1,810,000
1960	Flood	Flood	Bangladesh	10,000	0
1999	Wind Storm	Cyclone	India	9,843	12,628,312
1971	Wind Storm	Cyclone	India	9,658	6,900,000
1974	Wind Storm	Hurricane	Honduras	8,000	600,000
1991	Epidemic	Diarrhoeal/Enteric	Peru	8,000	0
1966	Drought	Drought	Indonesia	8,000	204,000
1988	Epidemic	Meningitis	Ethiopia	7,385	41,139
1991	Epidemic	Diarrhoeal/Enteric	Nigeria	7,289	10,000
1964	Wind Storm	Typhoon	Viet Nam	7,000	700,000
1918	Epidemic	Respiratory	New Zealand	6,700	0
1980	Flood	Flood	China P Rep	6,200	67,000
1900	Wind Storm	Hurricane	United States	6,000	0
1991	Wind Storm	Typhoon	Philippines	5,956	647,254
1989	Famine	Food shortage	Mozambique	5,200	0

year	dis_type	dis_subset	country_name	no_killed	total_affected
1960	Wind Storm	Cyclone	Bangladesh	5,149	200,000
1959	Wind Storm	Typhoon	Japan	5,098	1,500,000
1927	Wind Storm	Typhoon	China P Rep	5,000	0
1941	Wind Storm	Cyclone	Bangladesh	5,000	0
1943	Wind Storm	Cyclone	India	5,000	0
1963	Wind Storm	Hurricane	Haiti	5,000	0
1941	Slides	Landslide	Peru	5,000	0
1968	Flood	Flood	India	4,892	7,500,000
1951	Flood	Flood	China P Rep	4,800	0
1996	Epidemic	Meningitis	Burkina Faso	4,071	40,506
1917	Wind Storm	Typhoon	Japan	4,000	0
1952	Wind Storm	Storm	United Kingdom	4,000	0
1940	Drought	Drought	Cape Verde Is	4,000	0
1941	Drought	Drought	Cape Verde Is	4,000	0
1942	Drought	Drought	Cape Verde Is	4,000	0

B: Top 100 disastrous events in terms of affected people

year	dis_type	dis_subset	country_name	no_killed	total_affected
1987	Drought	Drought	India	300	300,000,000
1998	Flood	Flood	China P Rep	3,656	238,973,000
1991	Flood	Flood	China P Rep	1,729	210,232,227
1979	Drought	Drought	India	0	190,000,000
1996	Flood	Flood	China P Rep	2,775	154,634,000
1993	Flood	Flood	India	827	128,000,000
1995	Flood	Flood	China P Rep	1,437	114,470,249
1999	Flood	Flood	China P Rep	725	101,024,000
1989	Flood	Flood	China P Rep	2,000	100,010,000
1965	Drought	Drought	India	500,000	100,000,000
1972	Drought	Drought	India	0	100,000,000
1973	Drought	Drought	India	0	100,000,000
1982	Drought	Drought	India	0	100,000,000
1983	Drought	Drought	India	0	100,000,000
1994	Flood	Flood	China P Rep	1,001	78,974,400
1987	Flood	Flood	Bangladesh	2,379	73,000,000
1988	Flood	Flood	Bangladesh	2,379	73,000,000
1988	Drought	Drought	China P Rep	1,400	49,000,000
1974	Flood	Flood	Bangladesh	28,700	38,000,000
1975	Flood	Flood	India	350	34,000,000
1982	Flood	Flood	India	932	33,500,000
1995	Flood	Flood	India	1,479	32,704,000
1978	Flood	Flood	India	3,800	32,000,000
1994	Flood	Flood	China P Rep	258	30,547,665
1989	Wind Storm	Storm	China P Rep	157	30,007,500

year	dis_type	dis_subset	country_name	no_killed	total_affected
1980	Flood	Flood	India	1,600	30,000,023
1984	Flood	Flood	Bangladesh	1,200	30,000,000
1997	Flood	Flood	India	1,442	29,259,000
1998	Flood	Flood	India	1,811	29,227,200
1931	Flood	Flood	China P Rep	3,700,000	28,500,000
1990	Flood	Flood	China P Rep	363	26,130,805
1979	Flood	Flood	India	0	26,000,000
1999	Flood	Flood	India	229	22,120,000
1988	Flood	Flood	China P Rep	577	22,000,200
1920	Drought	Drought	China P Rep	500,000	20,000,000
1983	Drought	Drought	Brazil	20	20,000,000
1983	Drought	Drought	Bangladesh	0	20,000,000
1999	Drought	Drought	China P Rep	0	19,000,000
1987	Flood	Flood	India	1,200	18,000,000
1923	Epidemic	Malaria	Soviet Union	0	18,000,000
1988	Flood	Flood	India	250	16,500,000
1981	Flood	Flood	India	553	16,000,000
1984	Flood	Flood	India	245	16,000,000
1990	Flood	Flood	China P Rep	60	16,000,000
1968	Flood	Flood	Bangladesh	221	15,889,616
1965	Wind Storm	Cyclone	Bangladesh	36,000	15,600,000
1991	Wind Storm	Cyclone	Bangladesh	138,866	15,438,849
1996	Wind Storm	Typhoon	China P Rep	197	15,005,000
1998	Flood	Flood	Bangladesh	140	15,000,050
1977	Wind Storm	Cyclone	India	14,204	14,469,800
1995	Flood	Flood	Bangladesh	250	12,656,006
1999	Wind Storm	Cyclone	India	9,843	12,628,312
1982	Famine	Drought	Ghana	0	12,500,000
1992	Flood	Flood	Pakistan	1,334	12,324,024
1994	Flood	Flood	India	2,001	12,060,050
1992	Drought	Drought	China P Rep	0	12,000,000
1993	Flood	Flood	Bangladesh	162	11,469,537
1995	Flood	Flood	China P Rep	61	11,100,162
1994	Wind Storm	Typhoon	China P Rep	1,174	11,001,800
1998	Wind Storm	Storm	China P Rep	17	11,000,038
1988	Wind Storm	Cyclone	Bangladesh	1,000	10,568,860
1970	Flood	Flood	India	627	10,351,000
1985	Flood	Flood	India	741	10,225,000
1935	Flood	Flood	China P Rep	142,000	10,030,000
1980	Flood	Flood	Bangladesh	655	10,000,000
1950	Flood	Flood	China P Rep	500	10,000,000
1970	Flood	Flood	Bangladesh	0	10,000,000
1970	Drought	Drought	Brazil	0	10,000,000
1979	Drought	Drought	India	0	10,000,000
1998	Drought	Drought	Brazil	0	10,000,000

year	dis_type	dis_subset	country_name	no_killed	total_affected
1995	Drought	Drought	China P Rep	0	9,060,000
1980	Wind Storm	Typhoon	Viet Nam	176	9,027,174
1991	Drought	Drought	Sudan	0	8,600,000
1994	Wind Storm	Typhoon	China P Rep	90	8,488,684
1984	Drought	Drought	Sudan	150,000	8,400,000
1995	Flood	Flood	Bangladesh	400	8,000,000
1999	Famine	Crop failure	Ethiopia	0	7,767,594
1984	Drought	Drought	Ethiopia	300,000	7,750,000
1992	Wind Storm	Storm	China P Rep	109	7,700,000
1968	Flood	Flood	India	4,892	7,500,000
1989	Wind Storm	Typhoon	China P Rep	550	7,002,696
1996	Wind Storm	Cyclone	India	708	7,000,000
1986	Flood	Flood	China P Rep	233	7,000,000
1997	Flood	Flood	China P Rep	164	7,000,000
1983	Drought	Drought	Ethiopia	0	7,000,000
1987	Drought	Drought	Ethiopia	0	7,000,000
1993	Drought	Drought	Malawi	0	7,000,000
1971	Wind Storm	Cyclone	India	9,658	6,900,000
1993	Famine	Food shortage	Ethiopia	0	6,700,000
1994	Drought	Drought	China P Rep	0	6,690,000
1980	Wind Storm	Typhoon	Viet Nam	132	6,624,710
1991	Wind Storm	Typhoon	Philippines	754	6,547,592
1994	Epidemic	Malaria	Kenya	1,000	6,500,000
1990	Wind Storm	Cyclone	India	957	6,500,000
1990	Drought	Drought	Ethiopia	0	6,500,000
1992	Flood	Flood	Pakistan	221	6,184,418
1996	Flood	Flood	Bangladesh	33	6,163,319
1991	Drought	Drought	Ethiopia	0	6,160,000
1990	Wind Storm	Typhoon	Philippines	748	6,159,869
1978	Drought	Drought	China P Rep	0	6,000,000

References

1) Amjad Bhatti, (1999): "International Decade for Natural Disaster Reduction; Relevance to South Asia", IDNDR Program Forum, WMO Geneva, 4-9 July 1999.
2) Arakida M. and Murata M. (2003): "Disaster informational common means with high promptness and reliability: The GLobal unique disaster IDEntifier number (GLIDE)" in Japanese, Asia Disaster Reduction Center publication.
3) DesInventar, (2005): "Disaster inventory system for Latin America", Social Studies Network for Disaster Prevention in LatinAmerica (LA RED), http://www.desinventar.org. or http://www.desenredando.org.
4) EMDAT, (2005): "The OFDA/CRED international disaster database", University Catholic Louvain- Brussels, Belgium, http://www.EMDAT.net.
5) Economic History, (2005): "What is its relative value in US dollars", http://eh.net/hmit/compare/.
6) Guha-Sapir D., Hargitt D., and Hoyois P., (2004): "Thirty years of natural disasters 1974-2003: The Numbers", Centre for Research on the Epidemiology of Disasters, UCL Press, pp 76.
7) Guha-Sapir D., and Below R., (2002): "The quality and accuracy of disaster data A comparative analysis of there global sets", http://www.proventionconsortuim.org/files/sapir.pdf.
8) Hoyois P., and Guha-Sapir D., (2004): "Disasters caused by flood : Preliminary data for a 30 year assessment of their occurrence and human impact", International workshop organised by the Tyndall Centre for Climate Change Research, University of East Anglia, Norwich,18th to 20th July 2004.
9) ISDR, (2004): "Living with risk: A global review of disasters reduction initiatives", United Nations Publication, Geneva 2004, pp. 429.
10) LA-RED, (2002): "Comparative analysis of disaster databases", (LA RED-OSSO- UNDP) Final report of the Inter-Agency Task Force (IATF) of ISDR on Risk, http://www.unisdr.org/unisdr/eng/task%20force/working%20groups/wg3/Comparative%20Analysis%20of%20Disaster%20Database.pdf.
11) Merabtene T., Yoshitani J., and Kuribayashi D., (2004.a): "Managing Flood and Water-related Risks: A challenge for the future", Paper presented at the special Session (JS6) on - Basin-wide Policy Scenarios to Secure Sustainability Against Population Explosion: Strategy to Cope with Water Variability in Monsoon-Asia Region-, AOGS 2004 Joint 1st Annual Meeting & 2nd APHW Conference, Singapore 2004.

12) Merabtene T., Yoshitani J., and Kuribayashi D., (2004.b): "Report on the PWRI International Workshop on Water Hazard and Risk Management", Public Works Research Institute, 20-22 January 2004, http://www.unesco.pwri.go.jp/ja/publication/report/jan_20_22_2004_ws/index.htm.
13) Munich Re Group**,** (2003)**:** **"**NatCat Service: A guide to the Munich Re database for natural catastrophes", www.munichre.com/publications/302-03901_en.pdf
14) ProVention , (2001): "ProVention Consortium Disaster Database Working Group Meeting, February 5, 2001", www.proventionconsortium.org/files/disastersdb_020501/proceedings_db.pdf.
15) Reliefweb (2000): "Action against hunger withdraws from N. Korea", http://www.reliefweb.int/rw/rwb.nsf/AllDocsByUNID/f64f8a57c500b81d852568ac005a634d.
16) UNDP, (2004): "A Global report: Reducing Disaster Risk: A challenge for development", United Nations Development Programme, pp.149.
17) WCDR, (2005): "Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters", World Conference on Disaster Reduction, 18-22 January 2005, Kobe, Hyogo, Japan, www.unisdr.org/wcdr.
18) WHO, (2005), World Health Organization, http://www.who.int/en/
19) Wisner B., Blaikie P., Terry C., and Davis I., (2004): "At Risk, Natural Hazards, People's Vulnerability, and Disasters", Routledge, 2nd Edition.
20) WWAP, (2003) "Water for People Water for life", the United Nations World Water Development Report, World Water Assessment Programme (WWAP), UESCO Publishing/Berghahn Books, p.576.