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Technical Report on the Trends of Global Water-related Disasters

- a revised and updated version of 2005 report -

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Disaster Prevention Team
International Centre for Water Hazard and Risk Management under the auspices of UNESCO
Public Works Research Institute

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Synopsis:

This report is designed and aimed to develop an understanding of water-related disasters and their impacts hoping that the scientists, engineers and policy-makers join hand to fight water-related disaster leading to prosperous future of each nation. The results presented in this report allow the reader to evaluate the current state of the global and regional trends of water-related disasters. The outcome of the report emphasizes on the numbers of emerging issues and challenges for concrete evaluation of the social and economic vulnerabilities to water related disasters. This is an update of the Technical Memorandum No. 3985 of PWRI published October 2005. This revised version emphasizes the water-related disaster trends since 1980 to 2006 using EM-DAT data base.

Keywords: water-related disaster, risk management, disaster trends, policy-makers, flood, windstorm, landslides, drought, epidemics, EM-DAT

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Preface

Water-related disasters (floods, droughts, landslides, debris flow, water related epidemic and so on) are ever increasing in numbers resulting an escalation on the loss of human lives and property. United Nations University Institute for Environment and Human Security (UNU-EHS) warns that unless preventative efforts are stepped up the number of vulnerable people to water-related disaster worldwide is expected to mushroom to 2 billion by 2050 due to climate change, deforestation, rising sea levels and population growth in flood-prone lands (Bogardi, 2004).

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. This is a call for the search of innovative and holistic strategies for water-related disasters mitigation and risk management. 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 making processes has become increasingly evident to many governmental and international agencies engaged in disaster management at both proactive and reactive stages.

The technical report of 2005 presents the global and regional trends of water-related disasters and their social impacts which was initiated as one of the contributions of the Public Works Research Institute (PWRI) to support the United Nations World Water Assessment Programme (UN-WWAP) hosted by UNESCO. Our contribution to this collective effort is to contribute to World Water Development Report hand in hand with the World Meteorological Organization (WMO) and the United Nations International Strategy for Disaster Reduction (UN-ISDR) and other organizations. This revised version also aims to contribute to UN-WWAP besides the following objectives.

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 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.*

Understanding the disaster trends rationalizes decision-making for preparedness and provides an objective base for vulnerability assessment and priority setting as well. We analyzed data into a set of three years thinking that the revision of the report would be more frequent and useful to readers; and present the water-related disaster trends from 1980 to 2006 in this volume hoping that the decision makers, researchers, other professionals involved in the water-related disaster management and the lay men irrespective of their background benefit from this report.

Acknowledgments

ICHARM hosted by PWRI is indebted to 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) accessible free of charge. The data from EMDAT are analyzed and presented in this report.

We also thank MLIT, UNESCO, WMO, UN-ISDR, UNEP, UNDP, ADRC, LA RED and the ReliefWeb. We acknowledge the contribution of many other national and regional organizations, centers, universities, research institutions and governmental organizations and NGOs to make this publication a success.

Abbreviations

ADRC	Asian Disaster Reduction Center
CRED	Centre for Research on Epidemiology of Disasters
EMDAT	Emergency Disasters Database
GLIDE	GLobal IDEntifier number
ICHARM	International Centre for Water Hazard and Risk Management under the auspices of UNESCO
IDNDR	International Decade for Natural Disaster Reduction
LA RED	Network for Social Studies on Disaster Prevention in Latin America
MLIT	Ministry of Land, Infrastructure and Transport
OCHA	Office for Coordination of Humanitarian Affairs
OFDA	Office of Foreign Disaster Assistance
UN-DHA	United Nations Department of Humanitarian Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-ISDR	United Nations International Strategy for Disaster Reduction
UNU	United Nations University
UNU-EHS	UNU Institute for Environment and Human Security
UN-WWAP	United Nations World Water Assessment Programme
USAID/OFDA	The US National Oceanic and Atmospheric Administration and the US Federal Emergency Management Agency
WFP	World Food Program
WHO	World Health Organization
WMO	World Meteorological Organization
WWAP	World Water Assessment Programme
WWDR 2	Second World Water Development Report
WWDR 3	Third World Water Development Report

Chapter 1: Background and Objectives

Introduction

Natural disasters taking not only lives everyday somewhere in the world but also cause millions of dollar worth of property damages every year. They are continuously increasing in most regions of the world along with the global population explosion. Therefore, there is an indispensable need and obligation for the governments and the international communities to tackle the natural disaster to develop each nation and improve the living standard and livelihood of people. Thus, the demand for the close scrutiny of the past natural disaster trends to predict future ones arise leading to better development planning, efficient and optimal budget utilization to bring development in nations, satisfaction to the citizens and peace to the world. Among all observed natural and anthropogenic adversities, water-related disasters are undoubtedly most recurrent and pose major impediments against achieving human security and sustainable socio-economic development. Natural variation in the climate as well as atmospheric oscillations (e.g. North Atlantic Oscillation, El Nino, etc), lack of appropriate political system, planning, mitigation and management practices in water hazard areas coupled with the population explosion and concentration have skyrocketed the fatalities in past decade (**Figure 1**).

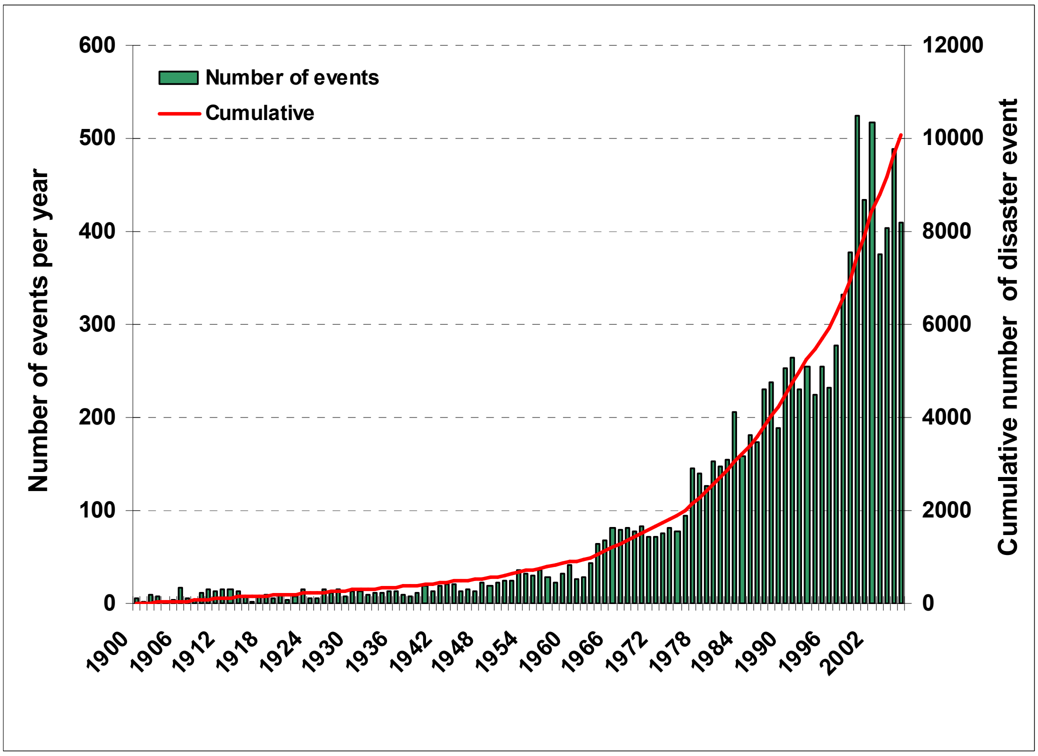

Figure 1 Number of natural disaster events since 1900 to 2006

For instance, from 2004 to 2006, 1,047 water-related disasters with more than 272,000 fatalities and 429 million victims were reported by Emergency Events Database (EMDAT), developed by the WHO Centre for Research on the Epidemiology of Disasters (CRED) of the University of Louvain in Belgium. The so called economic migrant concentration to coastal cities, fertile floodplains and deltas are some of the factors that have increased the risk and vulnerability to water-related disasters, not to mention the geophysical changes brought about by natural abnormalities such as climate change.

The lack of up to date management strategies to tackle water-related disasters and risks, the victims and fatalities are escalating especially in economically poor regions thus stagnating the socio-economic development. Consequently the situation demanded the concern of the governments and responsible institutions to formulate policies that place water-related disaster and risk management as elements of integrated water resources management. The World Conference on Disaster Reduction came into being and was held in Kobe, Hyogo, Japan, from 18 to 22 January, 2005 with aim of "*the sustainable reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries*". During this conference it was resolved that "*the 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*". 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 has recognized 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.

The goal is to formulate a globally applicable water-related disaster risk index to assess the effectiveness of flood mitigation policies leading to a decision making 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 third edition of the World Water Development Report (WWDR 3), UNESCO Secretariat of the World Water Assessment Programme (WWAP).

The report presents the assessment of the trends of different type of water-related disasters at regional and global scales. Database used here is derived from EMDAT. *This report is aimed at highlighting a broad spectrum of the impacts of natural disasters triggered by hydrometeorological events, specifically, understanding the relationship between the increasing trends of each individual type of water-related disasters and their social impacts (i.e., the number of fatalities and victims, and economic loss).* Concurrently developing our understanding of global requirements and challenges to build standardized global indicators to assist the identification of underlying risks from water-related disasters and to evaluate the effectiveness of adopted policies in water hazard mitigation is indispensable.

International Centre for Water Hazards and Risk Management (ICHARM), under the auspices of UNESCO, is to undertake a systematic initiative to build a comprehensive water hazard database which 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. Synergic cooperation from all concerned parties to create a safer world from water-related disasters is always welcome.

Methodology

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 government strategic goals in disaster mitigation, international databases are mainly developed and maintained to develop institutions and international standards to help achieving global goals.

EMDAT is a global database maintained since 1988 by the World Health Organization (WHO) Collaborating Centre for Research on the Epidemiology of Disasters (CRED) at the University of Louvain, Belgium. 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). The database came in to being in response 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 a strong base for vulnerability assessment and priority setting (EMDAT, 2005).

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:

United Nation Agencies;
Non governmental institutions;
Research institutes;
Insurance companies;
Humanitarian and disaster agencies;
Specialized agencies;
Government agencies; and
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 of 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 victims are unavailable, informed proxies are used to develop estimates (ProVention, 2001).

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 database 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 1**.

Table 1 Outline of data entry criteria into disaster database categorized according to leading organizations

Relief Web	ADRC	DesInveter (LARED)	NatCat (MunichRe)	Sigma (SwissRe)	EM-DAT
Declaration of state of emergency; and/or Based 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	>=10 death; or >=100 affected; or Declaration of a state of emergency; or Call for international assistance.

(Please see Technical Memorandum of PWRI No 3985 for more details)

As EMDAT is regularly updated and validated, it is important to note that the results and figures processed in this report are based on the disasters data last downloaded on

11 March 2007. The fields of data processed are limited to the social impacts of water-related disasters, namely: temporal trends of the number of fatalities and the total number of victims in each of the five continents (Africa, Asia, Americas, Europe and Oceania). Hereafter, the word "water-related disasters" refers to the following six categories:

Flood:	Costal and lake flood, plain flood, valley flood and flash flood
Windstorm:	Typhoon, hurricane, cyclone, tornado, tropical storm, winter storm and storm
Wave & surge:	Tidal wave and tsunami
Slides:	Landslide, avalanche, mudflow and rockfall
Drought:	
Epidemic:	Water-related epidemics are selected based on the WHO definitions

Chapter 2: Global Disasters

2.1 Natural disaster trends

Water-related disasters risk management is complex since it involves multifaceted parameters such as people, environment, land and water. Water-related disasters are triggered by hydro-meteorological phenomena yet hard to accurately forecast, the negative impact on people and property is very sensitive to the static and dynamic states of the surrounding environment and 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 indicators is a complex evolutionary process that is still ill defined for the various types of water-related disasters triggered by natural and/or human-made factors with diverse direct and indirect social and economic impacts (i.e. also vulnerability). Combination of structural and non-structural measures to alleviate disasters impact in sustainable manner through the study and understanding of the disaster trends in the past leading to the ability to prognosticate the future disasters to certain accuracy should be in place. Construction and achievement of a sustainable disaster mitigation policy requires balanced and high-quality disaster database framed to respond to the challenges imposed by water-related disasters.

The recorded number of disasters in the world until March 2007 according to EMDAT is 16,301 events which affected 6,276 million people with more than 37,580 thousand fatalities and the estimated damage is more than US$ 1,349 billion. Disasters triggered by hydrometeorological events outnumber the total of all other disasters combined making them the most frequent ones with wider impact on human beings. **Table 2** presents total recorded statistics of the disaster types since 1900 until 2006 and after the turn of the century (**Table 3**).

Table 2 Category wise frequencies of natural disasters since 1900 to 2006

1900-2004 & 2005-2006	Number of disasters	(%)	Number of killed	(%)	Total affected	(%)	Real damage (1000 USD)	(%)
Flood	3,050	29.8	6,899,095	18.5	3,027,693,701	48.3	342,968,287	25.9
Wind Storm	2,758	26.9	1,208,408	3.2	752,843,507	12.0	536,432,227	40.5
Earthquake	1,025	10.0	1,963,172	5.3	104,038,367	1.7	317,580,870	24.0
Epidemic	1,035	10.1	9,528,995	25.6	40,156,618	0.6	4,737	0.0
Drought	836	8.2	10,008,805	26.8	2,239,624,826	35.7	61,262,901	4.6
Slides	508	5.0	55,980	0.2	10,205,768	0.2	3,487,457	0.3
Wild Fire	312	3.0	2,710	0.0	4,019,267	0.1	29,574,293	2.2
Extreme Temperature	322	3.1	69,138	0.2	11,466,747	0.2	21,843,847	1.6
Volcano	193	1.9	95,917	0.3	4,907,517	0.1	3,842,646	0.3
Insect Infection	83	0.8	0	0.0	2,200	0.0	230,125	0.0
Famine	76	0.7	7,158,299	19.2	70,996,301	1.1	93,449	0.0
Wave/Surge	52	0.5	295,813	0.8	2,596,663	0.0	7,850,747	0.6
Total of Natural Disasters	10,250	100.0	37,286,332	100.0	6,268,551,482	100.0	1,325,171,586	100.0
Technological	6,051	37.1	293,947	0.8	7,692,699	0.1	24,632,200	1.8
Total	16,301	100.0	37,580,279	100.0	6,276,244,181	100.0	1,349,803,786	100.0

Table 3 Category wise natural disaster occurrences since 2000 to 2006

2000-2006	Number of disasters	(%)	Number of killed	(%)	Total affected	(%)	Real damage (1000 USD)	(%)
Flood	1,184	37.5	36,440	6.9	668,205,954	41.1	97,552,394	19.7
Wind Storm	701	22.2	20,969	4.0	299,911,358	18.4	299,911,358	60.7
Earthquake	208	6.6	135,828	25.8	25,693,217	1.6	54,918,938	11.1
Epidemic	459	14.6	39,167	7.4	3,368,371	0.2	0	0.0
Drought	124	3.9	996	0.2	619,210,069	38.1	16,859,958	3.4
Slides	137	4.3	6,124	1.2	2,183,305	0.1	288,707	0.1
Wild Fire	108	3.4	207	0.0	283,283	0.0	7,645,513	1.5
Extreme Temperature	157	5.0	58,860	11.2	4,388,321	0.3	9,039,297	1.8
Volcano	42	1.3	210	0.0	1,261,058	0.1	176,067	0.0
Insect Infection	16	0.5	0	0.0	0	0.0	120,000	0.0
Famine	1	0.0	0	0.0	3,000	0.0	0	0.0
Wave/Surge	17	0.5	227,238	43.2	2,486,330	0.2	7,712,800	1.6
Total of Natural Disasters	3,154	100.0	526,039	100.0	1,626,994,266	100.0	494,225,032	100.0
Technological	2,409	43.3	75556	12.6	1318703	0.1	12192623	2.4
Total	5,563	100.0	601,595	100.0	1,628,312,969	100.0	506,417,655	100.0

It is noteworthy that the water-related disasters were the most frequent in the past century particularly the floods with more than one thousand out of three thousand floods were recorded in 21st century, and the technological disasters also increased in parallel to development. The most physically damaging disaster as our data suggests is earthquake. A closer look at the impact of each type of natural disasters, the table reveals a complex inter-relation between the number fatalities and victims by each type of water-related disasters. For instance, during the period from 1900 to 2006, flood accounted for more than 37 % of the total number of natural disasters claiming more than 6% of the total casualties and more than 41% of the total affected people. Coupling flood and windstorm events from 1900 to 2006 add up to more than 59% of the total numbers of disasters with more than 10% fatalities and affecting more than 59% of all the natural disaster victims. Furthermore, the most hazardous one thousand disasters since 1900 to 2006 show that about 90% are water-related disasters (**Figure 2)** but the comparative national budget for the water-related disaster mitigation is proportionately low. It is important to understand not only the disasters are increasing but also the population living in disaster prone area is increasing too as a result of so called economic migration, for example, most cities in Asia are located in disaster prone area with huge population (**Figure 3**) and the statistics shows that more than 71% of natural disaster fatalities occur in Asia of which more than 83% are flood-related (**Figure 4**).

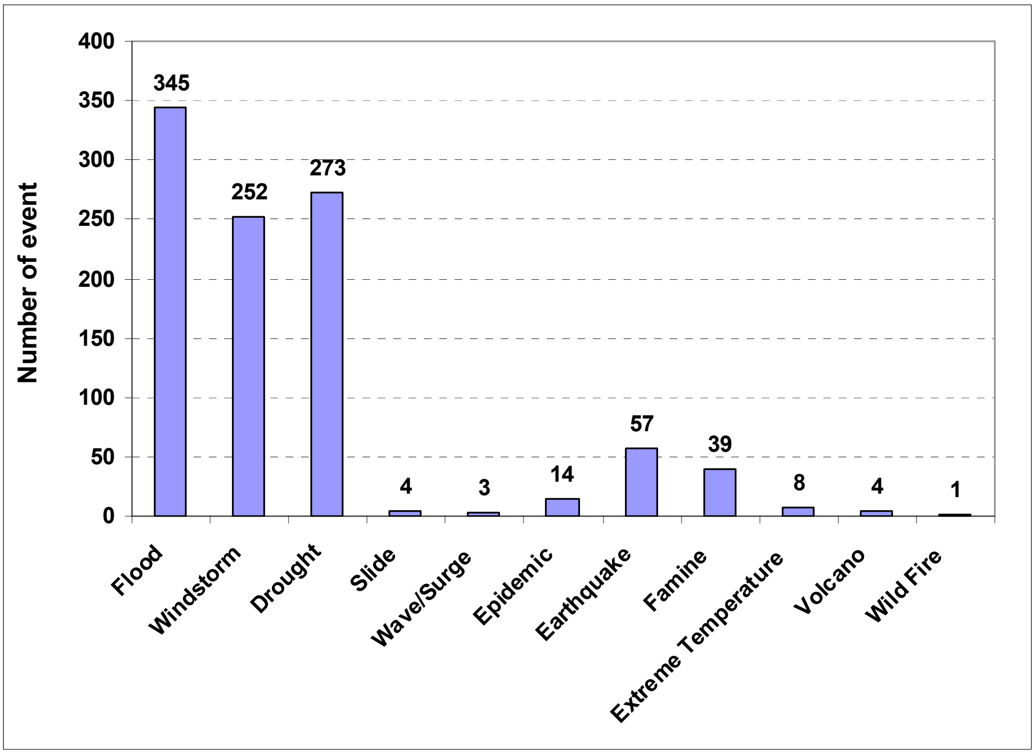

Figure 2 One thousand most disastrous different disaster events since 1900 to 2006

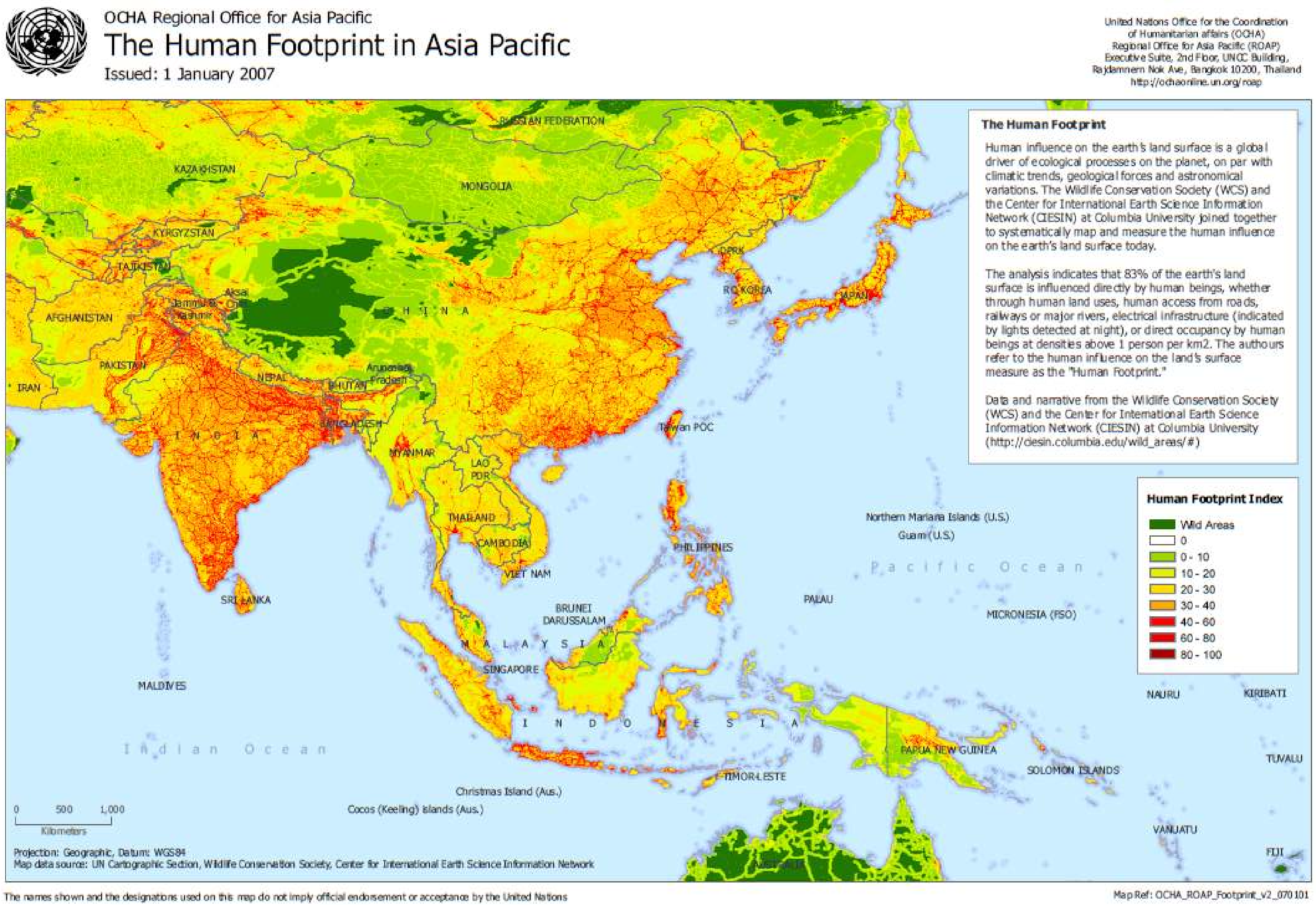

Figure 3 Population distribution in Asia Pacific

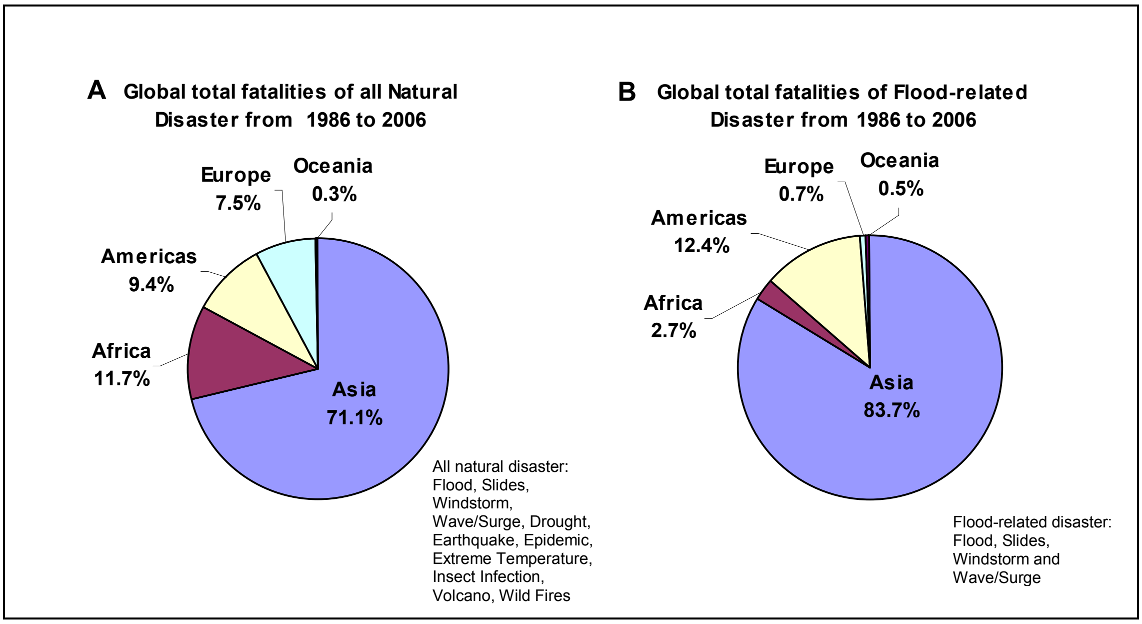

Figure 4 Global total fatalities of natural and flood-related disaster

The examination of the dissimilarities underlying the effects related to the trend of disasters and their respective impacts shows the complexity of disaster risk assessment and management. The global data such as EMDAT can help understand the world status vis-à-vis the impacts of water-related disasters. Further data collection and analysis based on disasters type is a perquisite to draw concrete conclusions on the efficiency of current international policies, actions, efforts and practices to mitigate water-related hazards.

There is a continuous increasing trend of the total number of disaster from decade to decade and the economic damage (**Figure 5** and **Figure 6**). 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 have become more frequent. Historical examples are the flood of July 1931 in China, which claimed the life of nearly 4 million people, and the Sumatra earthquake triggered Tsunami of December 2004, which claimed the life of nearly 243 thousand people. Therefore, in the course of building a so-called holistic risk management strategy for disaster mitigation it is vital to consider such overwhelming events despite their very low probability of occurrence.

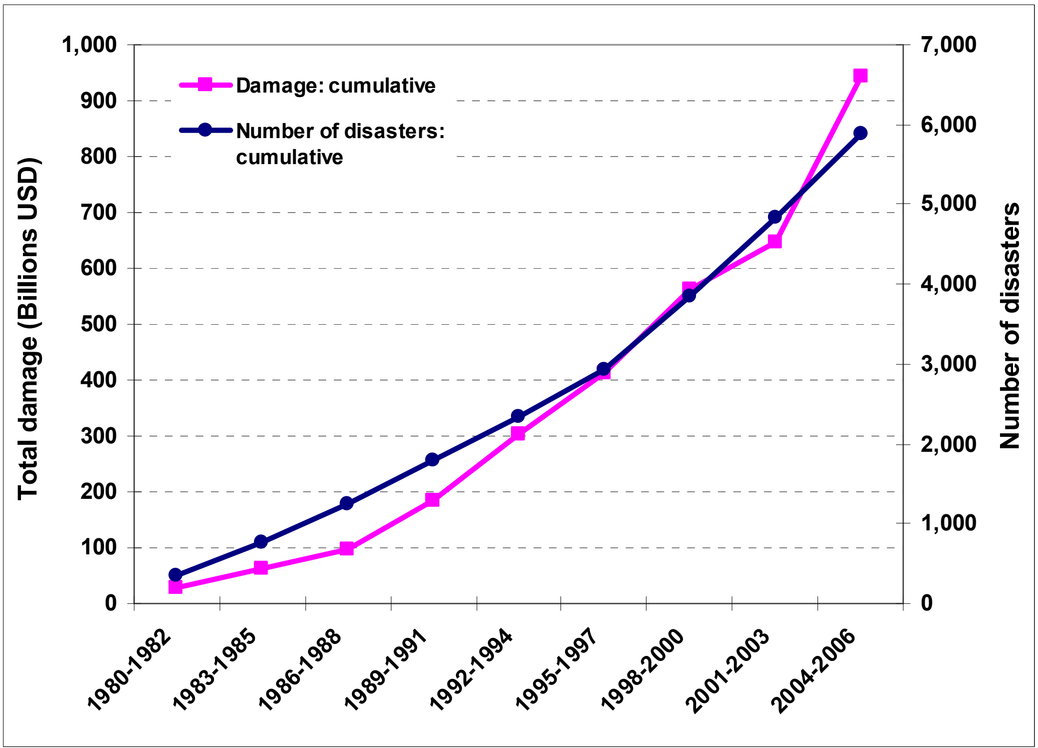

Figure 5 Global cumulative water-related disasters and estimated damage

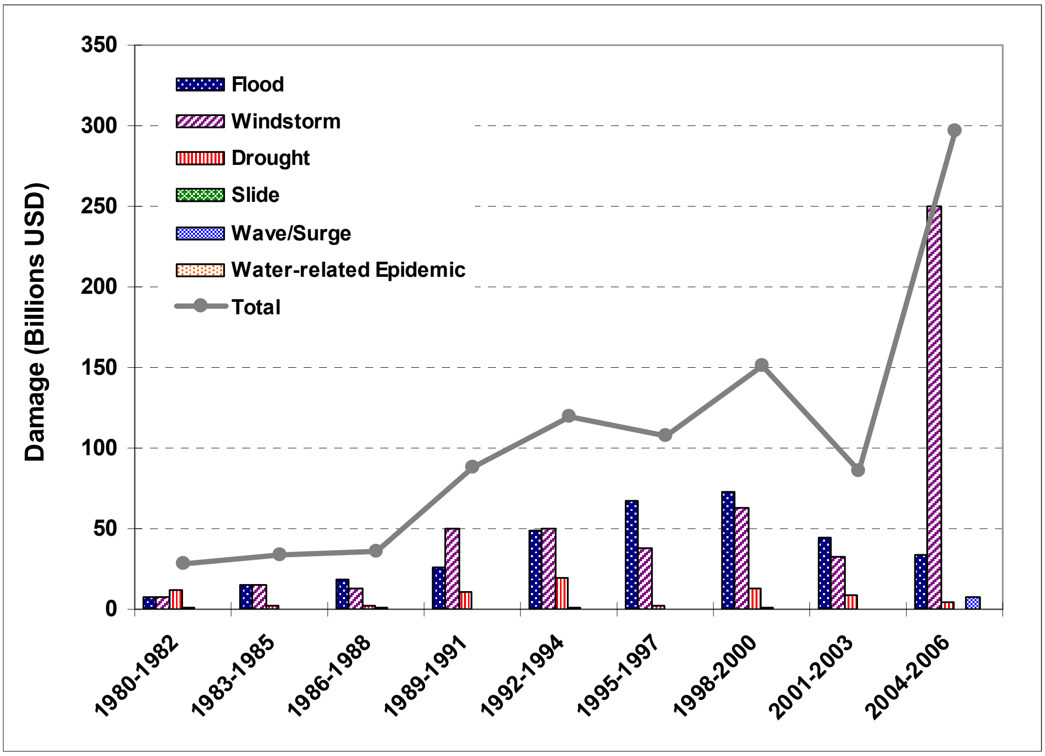

Figure 6 Damage caused by water-related disasters in three year period each since 1980 to 2006 calculated in billions of USD

2.2 Social impact of natural disasters

National stability could be at verge because of devastating natural or technological disaster events when prolonged detrimental impact of these hazards lingers in the communities leading to astounding physical and mental damage to society. The trend of impact on people specifically the number of fatalities, victims and the economic loss has been increasing proportionately with the natural disasters. It is very important to scrutinize and understand the diverse effect of the past natural disasters and their trends to examine the progress, efforts and the know-how of different nations to tackle these disasters so far; and learn, design, plan and prepare to live with these disasters in the future.

2.3 Trend of the number of fatalities

Protecting human life from natural disasters has been the goal of major national and international initiatives in hazard mitigation and disaster reduction. 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 243 thousand people from nations in the Asian region and from others around the world (**Figure 7**). In other words, despite the decrease in the number of fatalities, 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 not yet occurred.

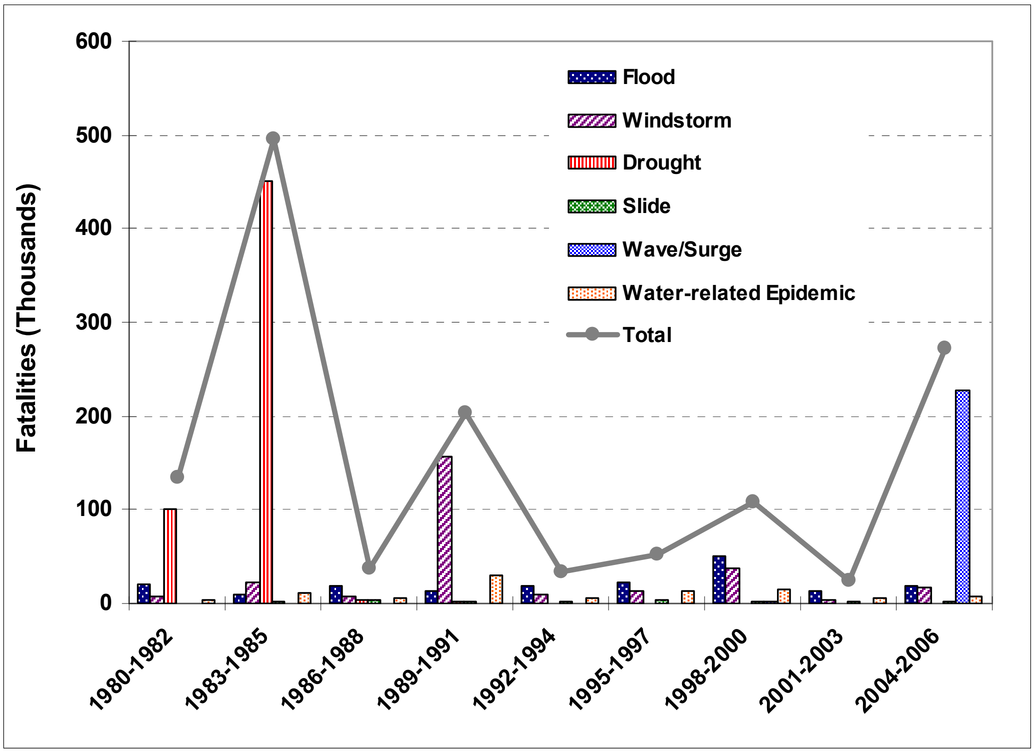

Figure 7 Fatalities from each water-related disaster type and their total for each three year period since 1980 to 2006

Extreme disasters have become more common, the fatalities of more than 100 thousand per disaster are not rare events anymore. For instance, the Tangshan earthquake of 1976 in China claimed over 240 thousand lives, 1991 windstorm in Bangladesh, killed nearly 140 thousand people, and the Sumatra tsunami of December 2004 took 243 thousand invaluable lives.

2.4. 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 thousand depending on the type and place of the natural disaster; the common ones are droughts and floods in Asia within the last quarter of the century (**Figure 8**). Though progress has been made in disaster mitigation humankind is still not well equipped with the knowledge and technology to fully harness the power of nature. More people are protected from small disaster but the unprecedented colossal events catalyzed by some other natural events may have tremendous effect on humankind. Merabtene and Yoshitani (2005) state that 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 on an average. They further add that 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 2006.

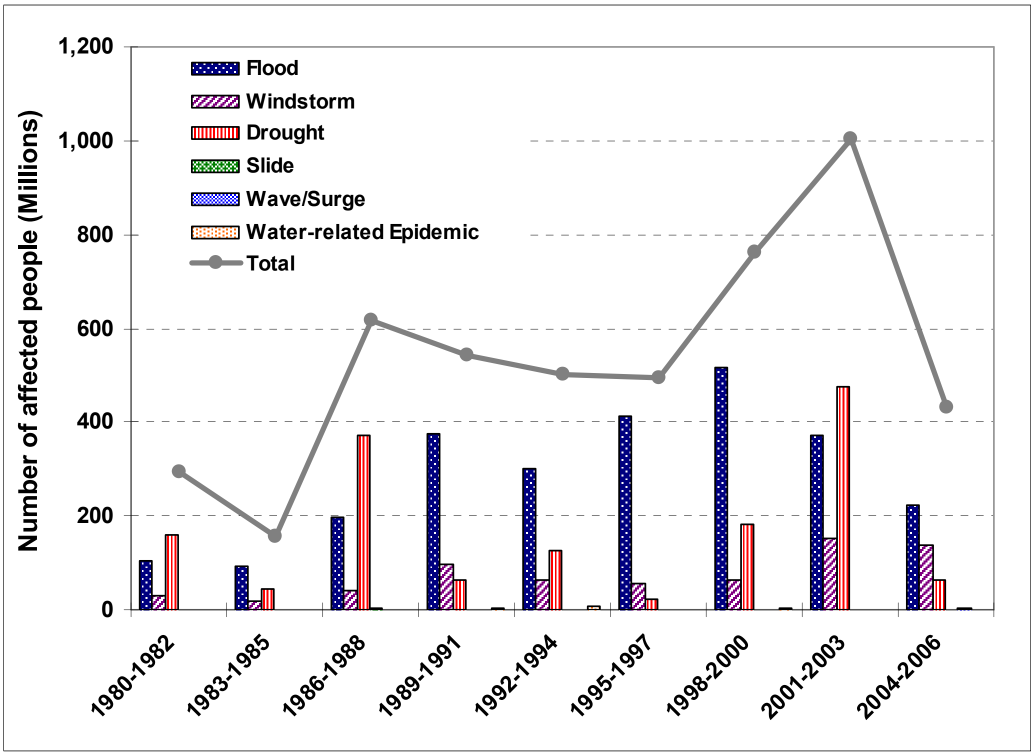

Figure 8 Number of affected people from each water-related disaster type and their total for three year period each since 1980 to 2006

Chapter 3: Water-related Disaster Trends

3.1 Water-related disaster trends

Water-related disasters are increasing but the decreasing trend of the number of fatalities to population ratio is an important indicator of the degree of achievements made globally (WWDR2, 2006). Nevertheless, the extent of the extreme disastrous events and number of disasters; economic loss, victims and the fatalities during these events are ever increasing. This phenomenon strongly demands the need and importance of carrying out an in-depth analysis of disaster type at all scales (see Merabtene and Yoshitani, 2005).

The results presented hereafter will be based on the disaster database for the period from 1980 to 2006. A comprehensive database set of information about the global trends and consequences of water-related disaster type in Africa, Americas, Asia, Europe and Oceania are presented here.

Figure 9 depicts the global trends of different water-related disaster type since 1980 to 2006 plotted for 3-year period. Windstorm events that turned into disasters also show an increasing trend except there was a drop in 1995-1997.

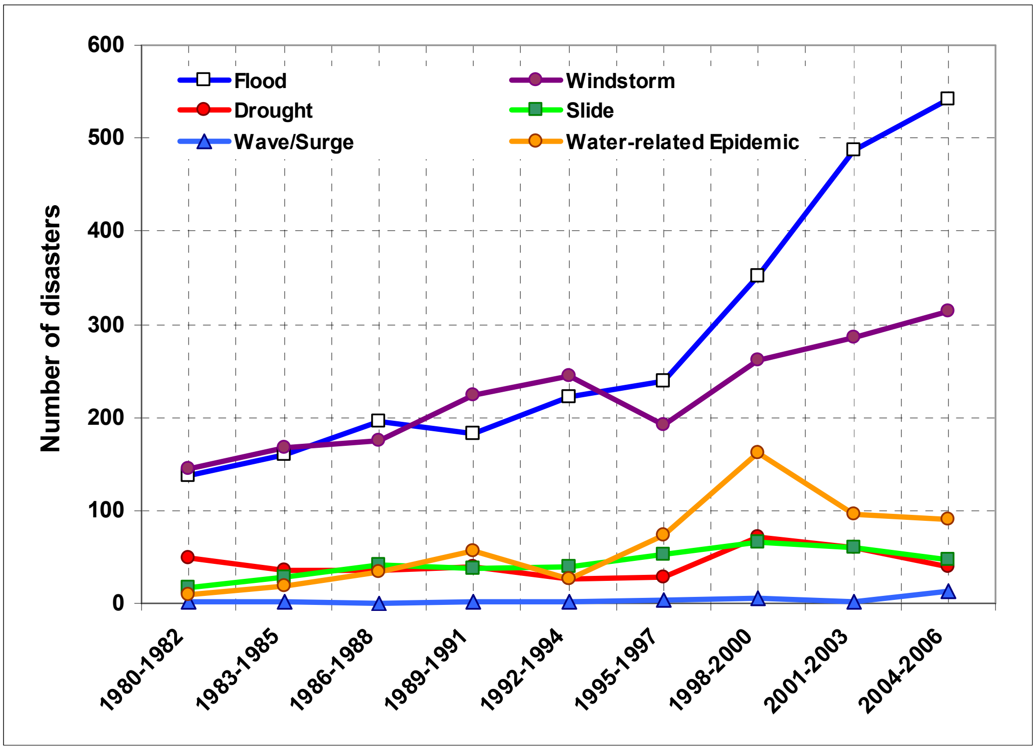

Figure 9 Number of water-related disasters plotted every three year since 1980 to 2006

Drought had been severe in the beginning of 80s and gained its momentum again since the turn of the century. This is rather interesting to note that the number of floods and droughts increased during the same period of time which may point out that the "wet places are getting wetter and dry places are getting drier". Does this phenomenon have a direct relation to the global climate and/or demographic change is a serious concern of the present and future scientists and policy makers throughout the world. The landslide disasters peaked at the turn of the century and now are in a receding trend and so is true with water-related epidemics but the wave/surge disasters is in an increasing pattern. The increasing pattern of surge/wave may be complementary to the increase of average sea level rise due to so called "global warming" These complementary terms such as floods and windstorms, wave/surge and average sea level rise may have direct or indirect relation to global warming.

Figure 10 illustrates the state of the general 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 at the turn of the 21st century.

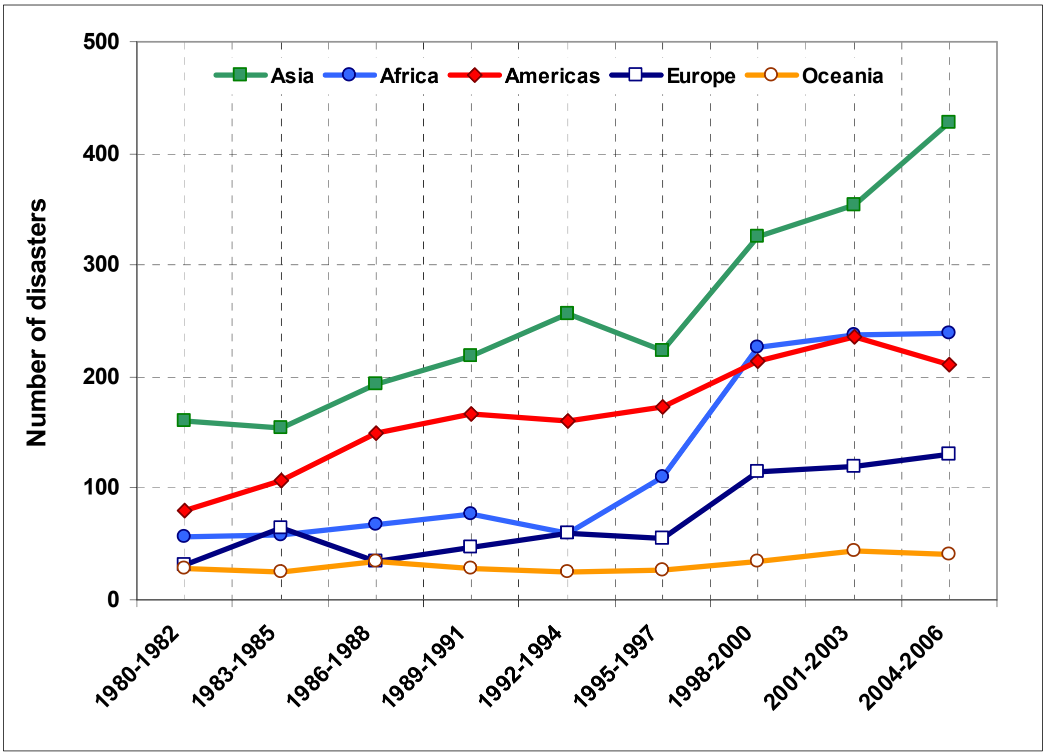

Figure 10 Total number of water-related disasters every three year since 1980 to 2006 in different continent

The regional and proportion of water-related disaster events, plotted for the period 1980-2006, showed an increasing trend for all the events for each 3-years successive period. Within the last quarter of a century the number of water-related disasters in Asia increased to more than double from 160 during beginning of 80s to 427 events in during 2004 to 2006 period. More than one third of the total number of water-related disasters occurred only in Asia within the period of 2004 to2006 and is a grave situation to note that the number of water-related disasters in the beginning of this century increased in all the continents and especially escalated in Asia. If this marathon trend continues the development goals in the developing countries especially in Asia would come to a screech halt which my lead to tremendous unexpected negative side effects throughout the globe. Water-related disasters increased more than four folds in Africa and almost four times in Europe. These water-related disaster trends may be very important guidelines for policy makers, engineers and all other concerned to mitigate the impending hazards brought about by these calamities.

The development of scientific technology for improved forecast and reporting greatly enhanced the accuracy, speed, time lag of disaster reporting and improved creation of better disaster database to help study, understand and further scrutinize the disaster trends, and plan mitigation measures. Nevertheless, the temporal variation of the trends plotted for each individual water-related disaster as in **Figure 9** and the temporal variation of the trends by continent as in **Figure 10** clearly reflect the decreasing resiliency of the world communities to water-related disasters. **Figure 11** illustrates the exposure ratio of each continent to the different types of water-related disasters.

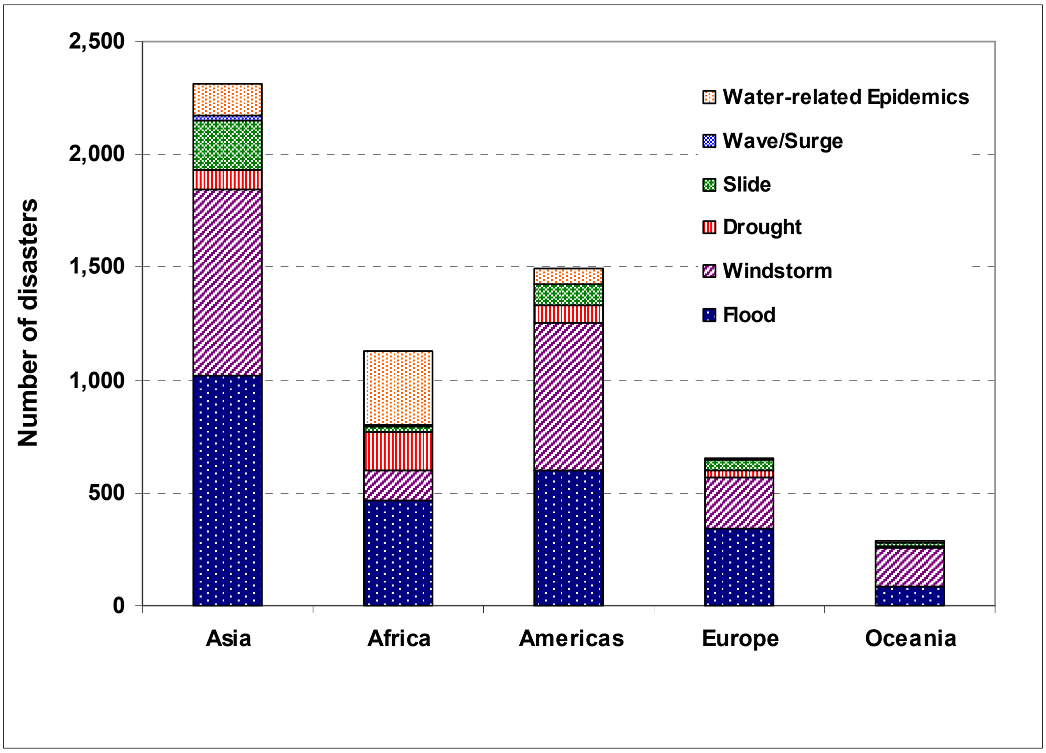

Figure 11 Water-related disasters distribution in different continent from 1980 to 2006

Asia is the most flood and windstorm prone region in the world and more than one third of all the water-related disasters in the world occur in this region. In this figure flood and windstorm are at the top of the list of water-related disasters striking all continents but Africa where water-related epidemics are more prominent than windstorms. This situation further reminds how important it is to work on water-related disaster mitigation to help the people living in these disaster prone areas and regions.

Hereafter a three year trend of each water-related disaster is highlighted in a broad spectrum since we are interested in disaster trends to understand the occurrence of disasters and try to predict the future similar disaster by studying them. Number of floods throughout the world kept on increasing since they were recorded and the increasing trend took momentum since the turn of the 21st century (**Figure 12**).

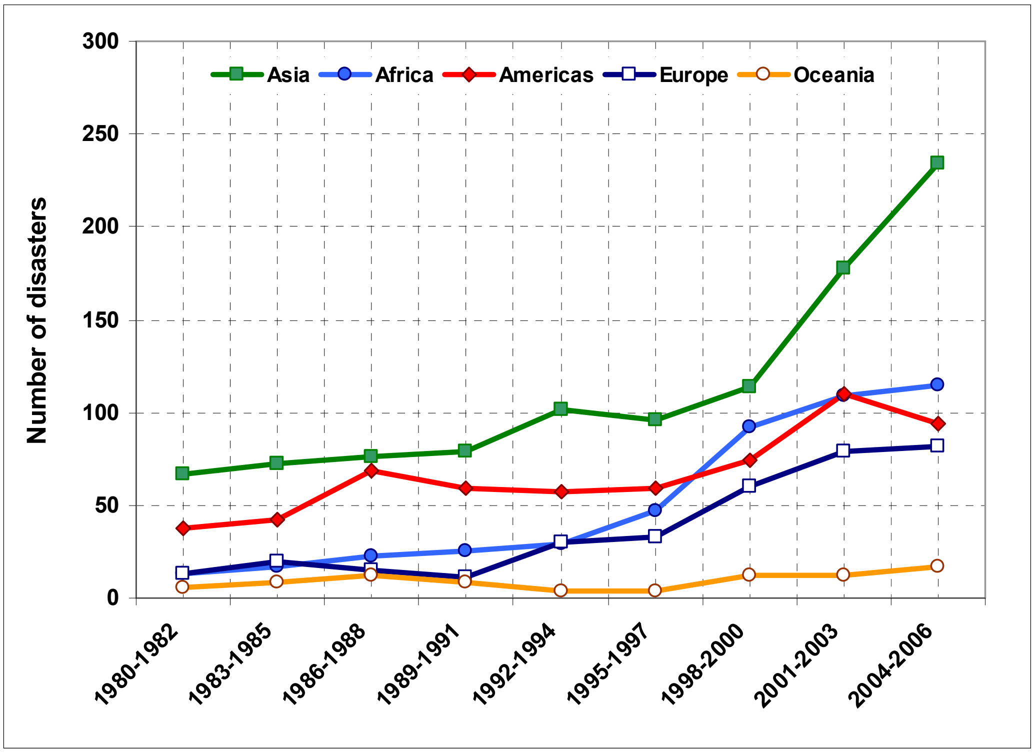

Figure 12 Continent wise three year flood trends since 1980 to 2006

Almost half of these floods occurred in Asia followed by Africa, Americas, Europe and Oceana in a decreasing series. The wind storms have been frequenting Asia and Americas the most (**Figure 13**). The significant point to note here is the peak in 1992-1994 then receding once to let Americas overtake and then increased again. This Asian windstorm peak during prime 90s coincides with the El Nino phenomenon or the southern oscillation. Neither the process of the existence and development of northern and southern oscillations has not been fully understood nor their relations with other events such as tropical storms and/or hurricane. Further investigations on these phenomena may lead to better understand their formation processes and relationship with other natural phenomenon which gives a way to holistic risk management.

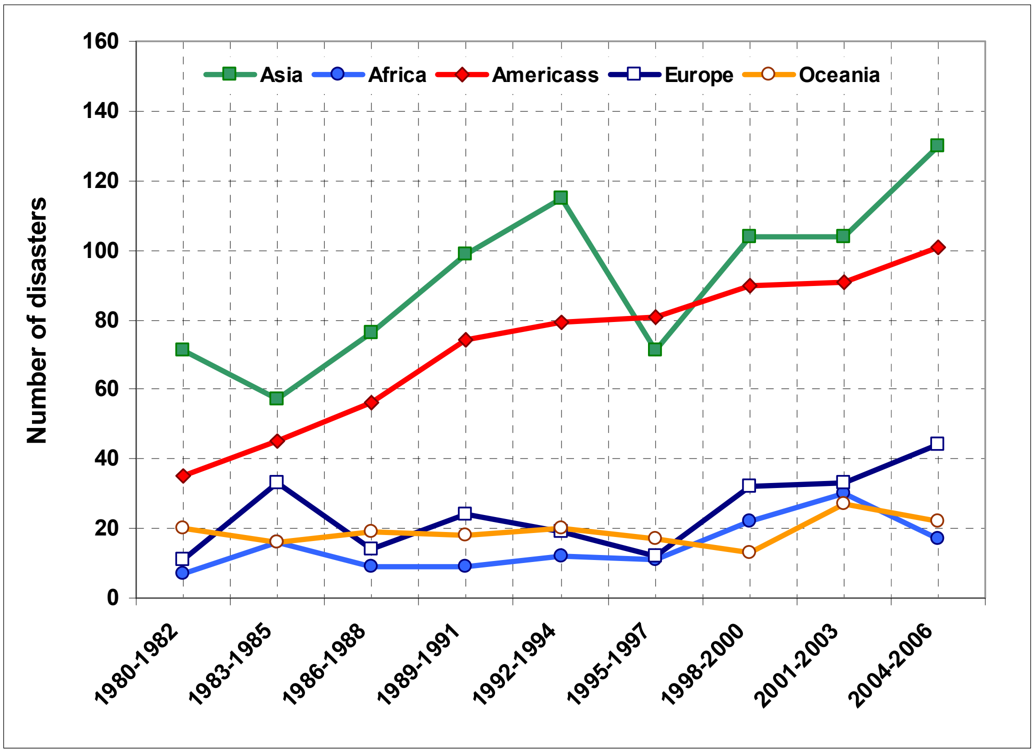

Figure 13 Continent wise three years each increment of windstorm since 1980 to 2006

Another interesting point to note is that the fluctuating windstorms trends in Europe during 80s and 90s and a steady rise thereafter. Slides; especially the landslides had been havoc to Asia and Asia is still leading in the landslides occurrence (**Figure 14**). Americas is second in line but there is a big gap in numbers and also the slides in Asia are increasing whereas in other continents they are more or less constant or descending. The floods, windstorms and slides may be categorized as complementary events so that these three events may be included in the national policy together for a more comprehensive mitigation plan during a disaster because most often the root cause of these disasters is rainfall. The most affected countries in terms of the number of disasters in Asia are India and China, followed by Bangladesh, the Philippines and Iran. Japan ranked number 10 after Pakistan in terms of the numbers of flood disasters.

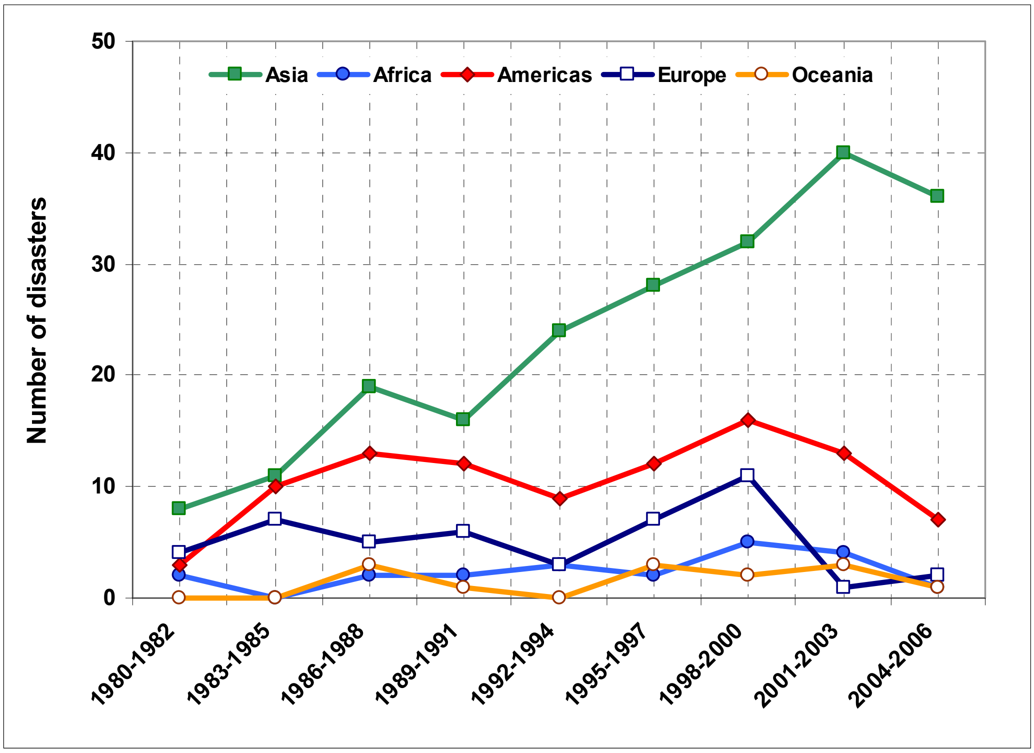

Figure 14 Continent wise three years each increment of slides since 1980 to 2006

Tsunami in our data set is included under wave and surge disaster category and it has come to light how devastating and fearsome a tsunami could be after the Indian Ocean Tsunami triggered by the Sumatra Earthquake on 26 December 2004 (**Figure 15**). Wave and surge disasters are on and off but they are in increasing trend. Since 1980 until the mid 90s no wave and surge occurred anywhere else in the world except Asia but, since the mid 90s the disasters started to appear in Americas and after the turn of the century they even proliferated to Oceania.

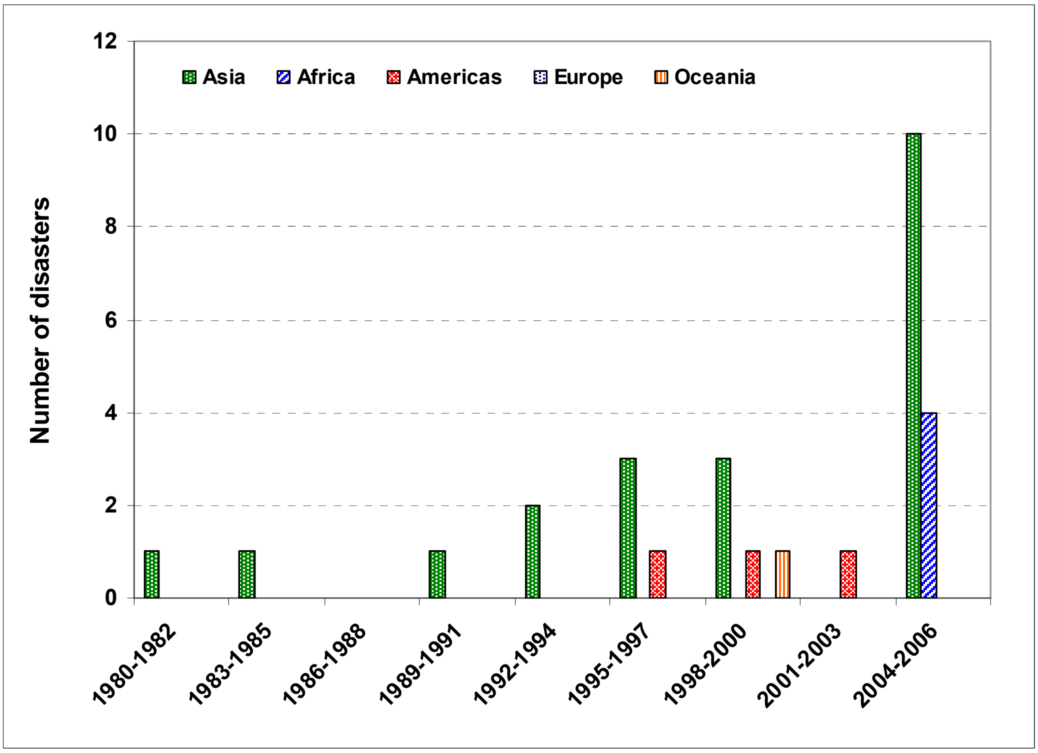

Figure 15 Occurrence of wave and surge (tsunami included) plotted for three year each since 1980 to 2006

Drought disasters are most severe and prominent in Africa such as Mozambique and now are becoming common in Asia especially in India and China (**Figure 16**). The droughts fluctuate very much year by year and they are very relative terms since the original soil, plant and animal capacity to endure lack of water itself is dependent. Besides, different crops/plants have different water thresholds therefore for one crop it may be drought and crop failure which may not apply to another crop. Droughts are also gaining momentum in different part of the globe since the turn of the 21st century as has been noted for floods and windstorms.

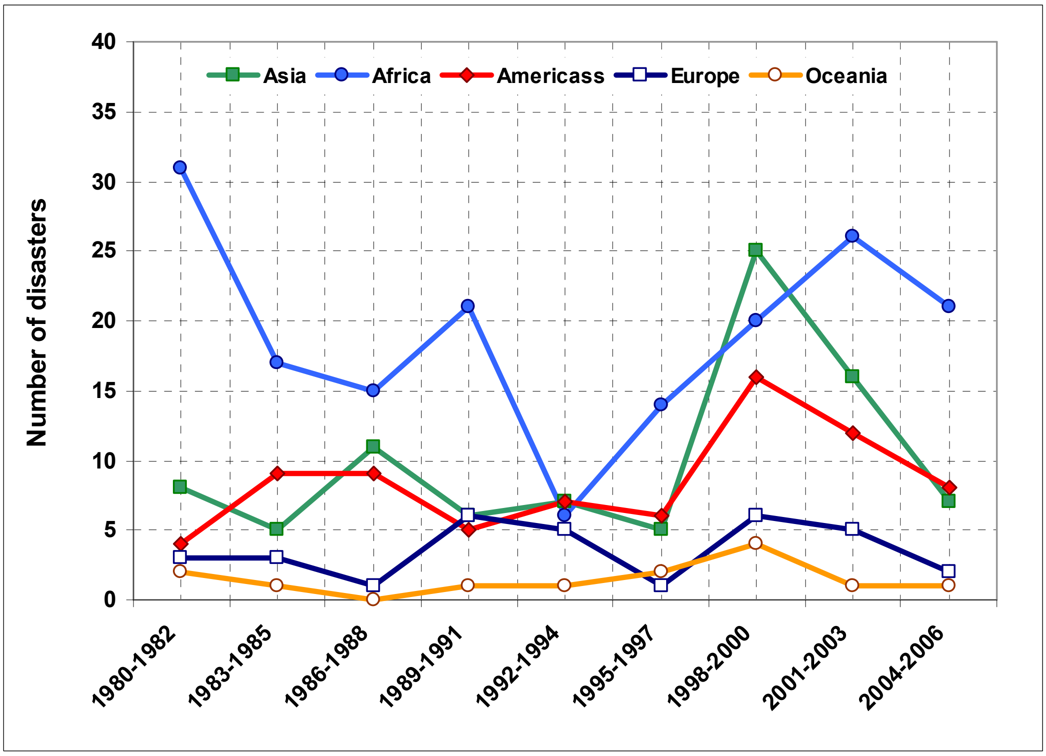

Figure 16 Occurrence of drought plotted for three year each since 1980 to 2006

Epidemic diseases increased since mid 90s (**Figure 17**) and there is an obvious increase in water-related epidemic diseases since late 90s. This coincides with the number of floods and windstorm disasters leading to the understanding that the epidemics are the aftermath of floods.

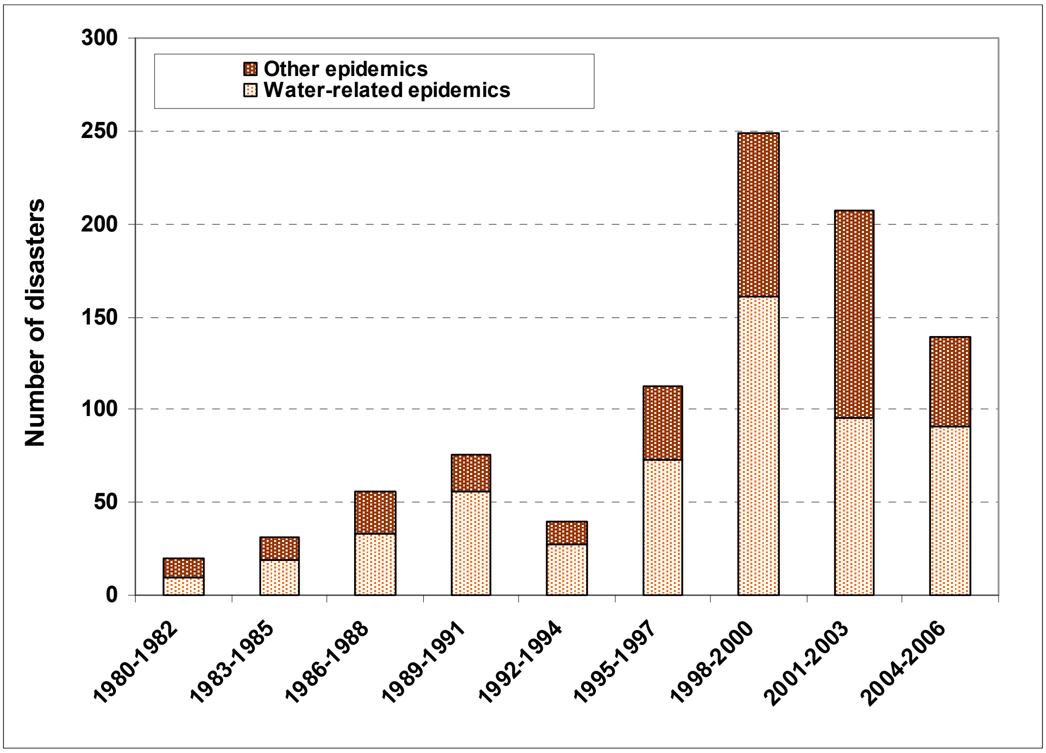

Figure 17 Temporal distributions of water-related and non-water-related epidemics for each three year period since 1980 to 2006

Epidemic disasters were expected to decrease through proper sanitation, safe drinking water, toilet facilities, better living conditions but the figure point out otherwise. The geographical distribution indicates that Africa is severely affected by epidemics (**Figure 18**) suffering a total of 334 water related epidemics within the last quarter of a century whereas Asia encountered less than half of it (145 events). The number of disasters peaked in 1998-2000 (**Figure 19**) and then declined. The interesting point is that Asia and Africa both had similar pattern since 1980 to up until 1994, then suddenly the African trend increased drastically and did not decrease as it did in Asia. Why do we have this difference is yet to be answered.

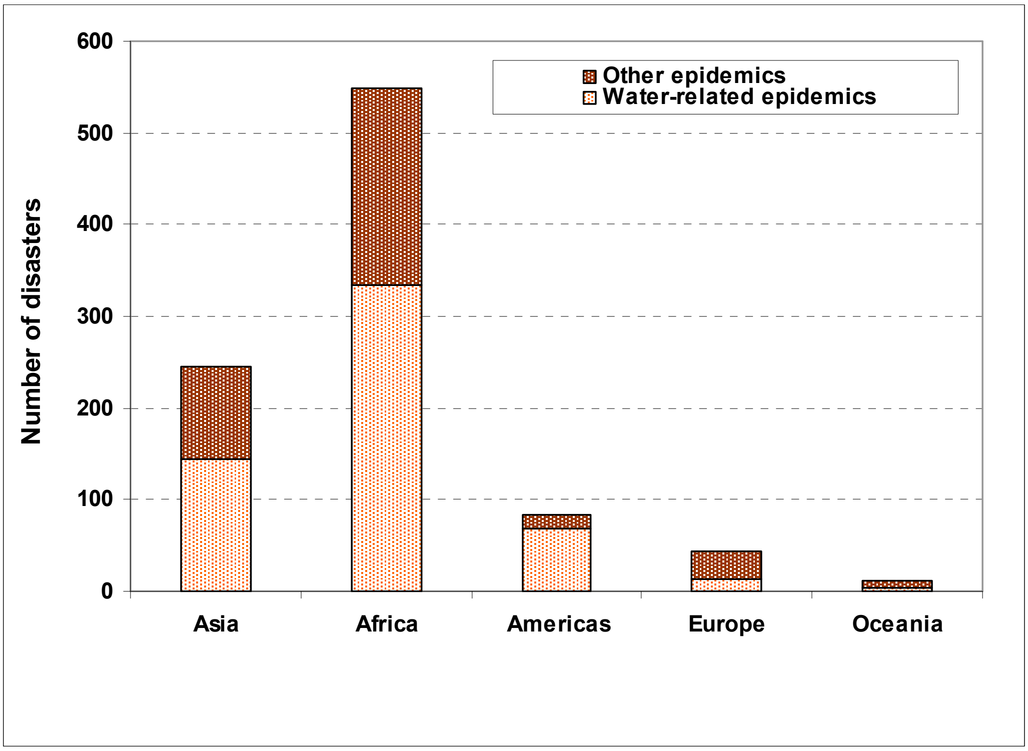

Figure 18 Distribution of water-related epidemics in different continent since 1980 to 2006

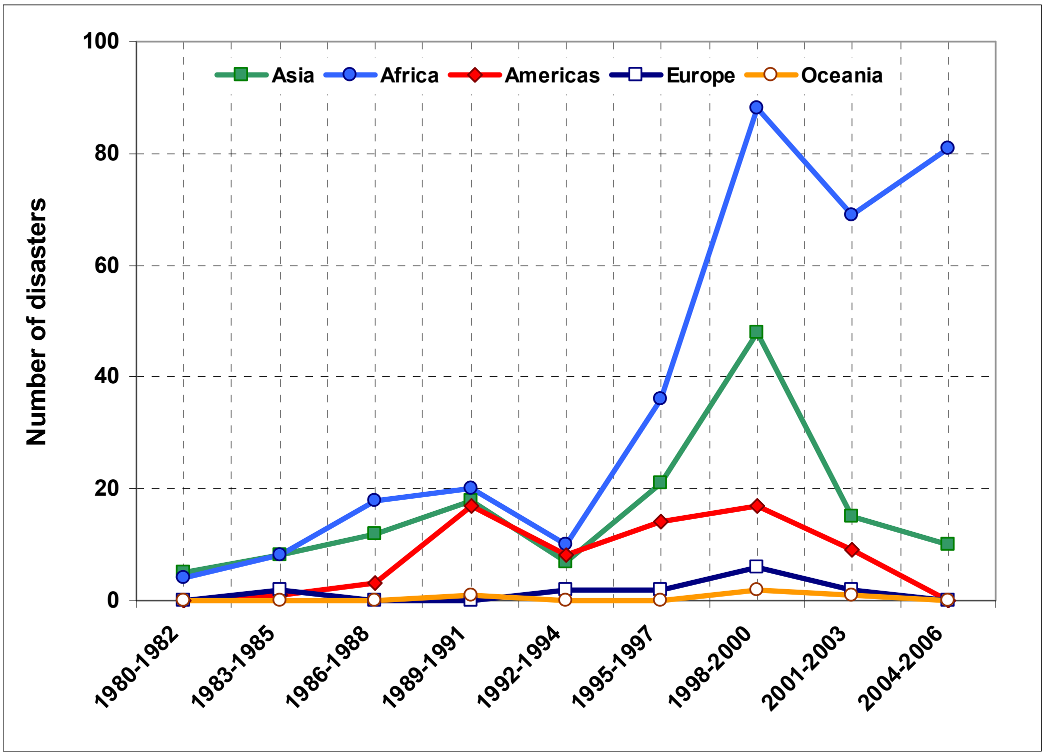

Figure 19 Water-related epidemics for each three year period according to continents since 1980 to 2006

3.2 Human versus water-related disasters

Understanding hazard and developing a mechanism for risk quantification leading to accurate assessment of socio-economic damages and impact of disaster in itself is a basic mitigation plan and would be even better if national policies are developed based on the understanding of the water-related risk management. In this light the United Nation General Assembly in 1998, has declared 1990-1999 the "*International Decade for Natural Disaster Reduction*". One of the specific goals declared then was "*to disseminate existing and new information related to measure for the assessment, prediction, prevention, and mitigation of natural disasters*." As always the 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…*" But it is an irony that in 1998, the penultimate year of the Disaster Reduction Decade, was also the year in which natural disasters took a marathon start uphill.

Confronting water-related disaster, its potential impact and damage is difficult since there are many ill-defined factors involved. The most ambiguous definition is probably of affected people. The accountability of fatalities and the number of affected people is also affected by the social and political conditions imposed in the country where the disaster occurred (Guha-Sapir, 2002 Hoyois et al., 2007; Wisner et al., 2004). Furthermore, biased disaster assessment methods, politically influenced reporting mechanism, unreliable identification and quantification of social and economical damages strongly demands a standard ethic of conduct internationally accepted so that we may be able to standardize the data we have to get an unbiased view of the extent of the natural disaster.

The decade wise result of the fatalities and affected people gained wide acceptance among professionals and practitioners to understand the trend of impacts of hazards and/or mitigation progress over long-term periods (Merabtene and Yoshitani). Long-term disaster impact trends may cultivate feeling of success when a project is finished and that experience may be very important to put clear emphasis on the long-term future goals on disaster mitigation, planning and long-term studies from a global standpoint; but 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 are important too, therefore, short term data analysis should be emphasized worldwide and the meaning of the result should be interpreted in the way they are understandable to policy makers at local, national and regional level of all the countries in the world to achieve faster and objective oriented targets.

The number of fatalities and affected people very much depend on individual disaster event extremities, its location and the social and demographic situation therefore it may be difficult to find a rather reliable trend that show a particular way forward. The trends may depend on the population densities, so called economic migration to exposed areas, time and the magnitude of the disaster; for instance a tsunami might create hundreds of fatalities in a place where it was never expected or a glacier lake outburst flood somewhere in the Himalayas may flood Bangladesh leaving many people dead. **Figure 20** shows the number of disaster for every three years since 1980 to 2006 and the number of fatalities and affected people during the same period of time.

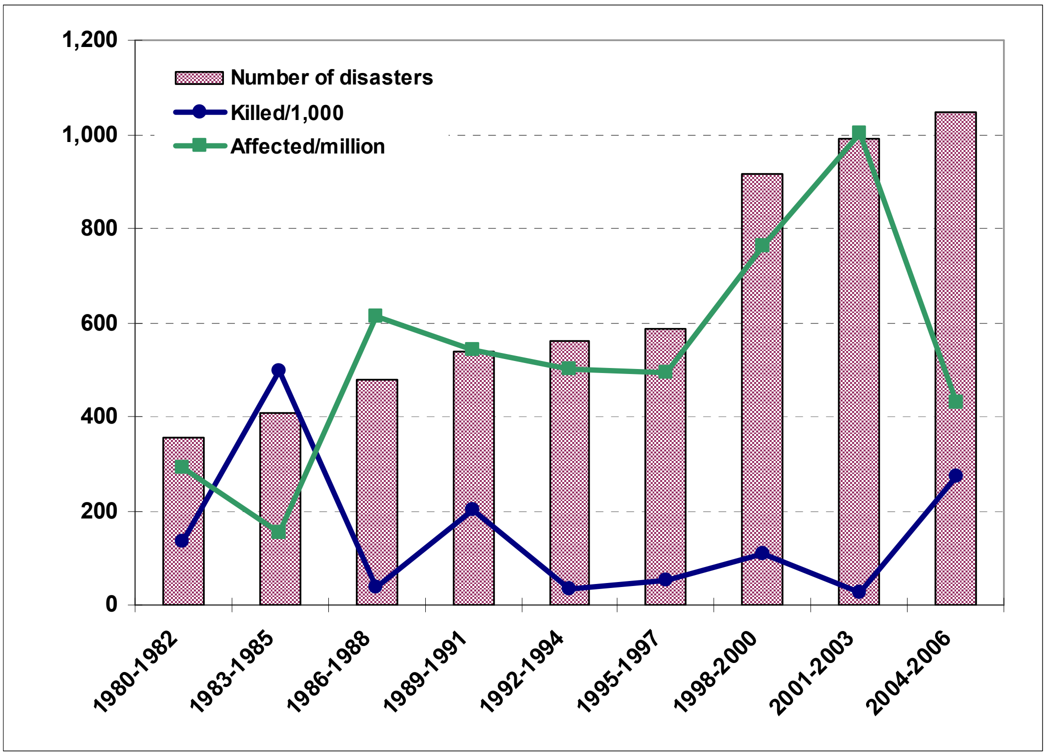

Figure 20 Three years total number of fatalities, affected people and disasters since 1980 to 2006

Merabtene and Yoshitani (2005) and WWDR 2 (2006) pointed out that the number of fatalities after each successive decade showed a continuous decrease from nearly 2 million people in the 1960s to 0.5 million in the 1990s. This trend clearly shows the effectiveness of the effort made by local, national, regional and international communities have not been in vain and gives a ray of hope for the future proposal but there is no defined trend for a short term interval of three years period further indicating how vast and difficult the water-related risk management is. The extreme impending water-related events are disastrous since they are unexpected and are of usually greater in scale, for instance, in India 500,000 drought fatalities were reported in 1965 and more than 100 million were affected; another 100,000 people were drowned during a rainstorm in 1991 in Bangladesh (ReliefWeb, 2000).

3.3 Trend of fatalities and affected people

The trend of fatality and affected people highlights that Asia is the most vulnerable region to water-related disasters in the world (**Figure 21** and **Figure 22**). The trend in Americas and Oceania are fluctuating in a similar trend since the mid 90s which may suggest that the cause of this fluctuating trend may be the southern oscillation (Philander, 1990). The exceptionally high fatality during 1998 to 2000 period is very interesting to note for it is the first time fatalities in Americas exceeded Asia. But the 1983 drought in Ethiopia and Sudan had the highest fatalities since 1980 which even surpassed Indian Ocean Tsunami of December 2004. The total fatalities percentage since 1980 until 2006 shows that Africa is still on the top of the list (**Table 4**) and this is the aftermath of the water shortage in 1983. This shows that how important the water is to sustain life and how dangerous if it is not managed properly. Asians are the most water-related disaster affected people and the total general trend was exploded by the 2002 drought in India, 2002 and 2003 floods in China. Ninety percent of the total affected people in the last quarter of the century live in Asia (**Table 5**) and even if one considers the high density of population in Asia this figure is still very significant.

Table 4 Total water-related fatalities and their ratios since 1980 to 2006 in different continent

Continent	Total Fatality	%
Asia	621,740	45.62
Africa	628,637	46.13
Americas	103,205	7.57
Europe	5,607	0.41
Oceania	3,572	0.26
Total	1,362,761	100.00

Table 5 Total water-related disaster affected people and their ratios since 1980 to 2006 in different continent

Continent	Affected people	%
Asia	4,334,826,819	90.49
Africa	288,331,721	6.02
Americas	126,178,050	2.63
Europe	26,618,644	0.56
Oceania	14,224,826	0.30
Total	4,790,180,060	100.00

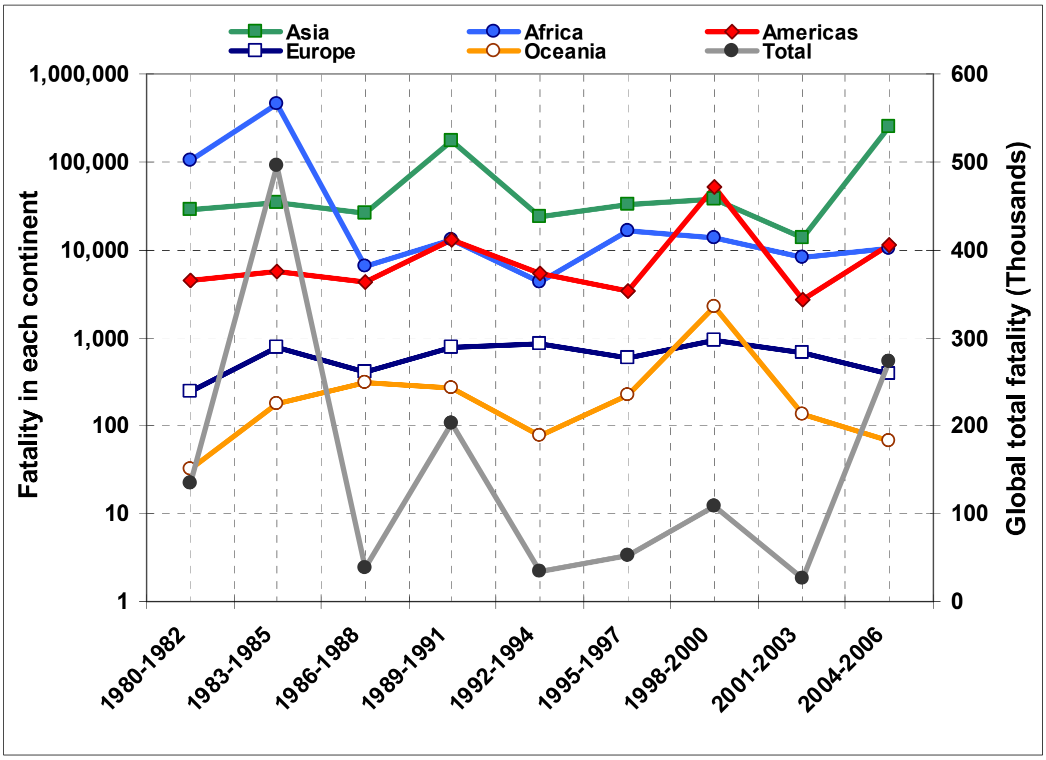

Figure 21 Three years total number of 6 water-related disasters fatalities in different continent since 1980 to 2006

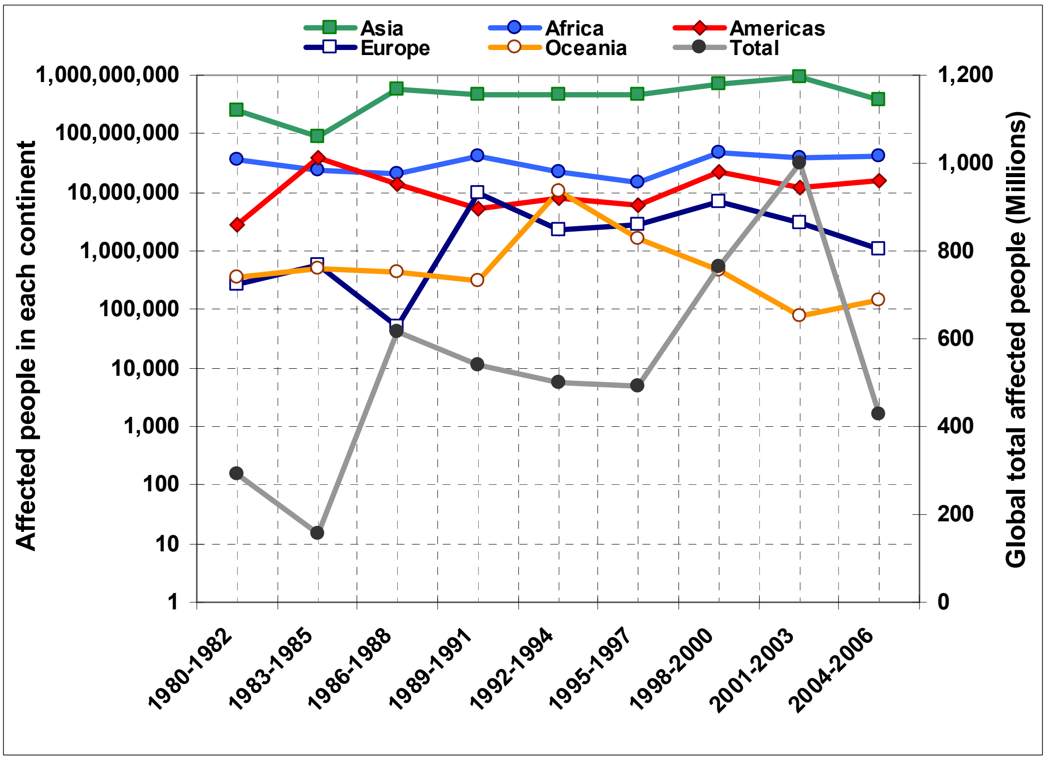

Figure 22 Three years total number of people affected by 6 water-related disasters in different continent since 1980 to 2006

Fatalities Trends:

A comprehensive understanding is sought for the regional characteristics of the social impacts of water-related disasters therefore in this section we present some important regional trends so that the governments and policymakers in each region could realize the need, importance, significance, difficulties, complications underlying the quantification of risks in water-related disasters. Careful interpretation of the trends of the fatalities; importance and coexistence water-related disaster from global and regional perspectives is indispensable.

Flood:

Commencing from 1980 to 2006 flood disasters throughout the world claimed nearly 200 thousand fatalities (**Table 6**). The number of fatalities observed fluctuates drastically with a global average of 7 thousand people killed each year since 1980 till present.

Table 6 Total flood fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	117,325	64.42
Africa	14,673	8.06
Americas	47,782	26.24
Europe	2,120	1.16
Oceania	218	0.12
Total	182,118	100.00

It is interesting that the trends from 1960 to 2004 and 1980 to 2006 show that the flood disaster decreased in Asia and Africa during the last quarter of the century implying that the flood disaster risk management knowledge, understanding, and policies have made significant progress towards flood control and risk management during this period (see also Technical Memorandum of PWRI No. 3985, October 2005), but the trend of the fatalities in Africa increased from three digit to four digit figures since late 80s (**Figure 23**). The high number of flood fatalities in the late 1990s in Central America and during devastating hurricane Katrina in the US in 2004, indicate that the flood disasters are becoming more common within the last decade and taking more lives in Americas which need immediate attention for its mitigation.

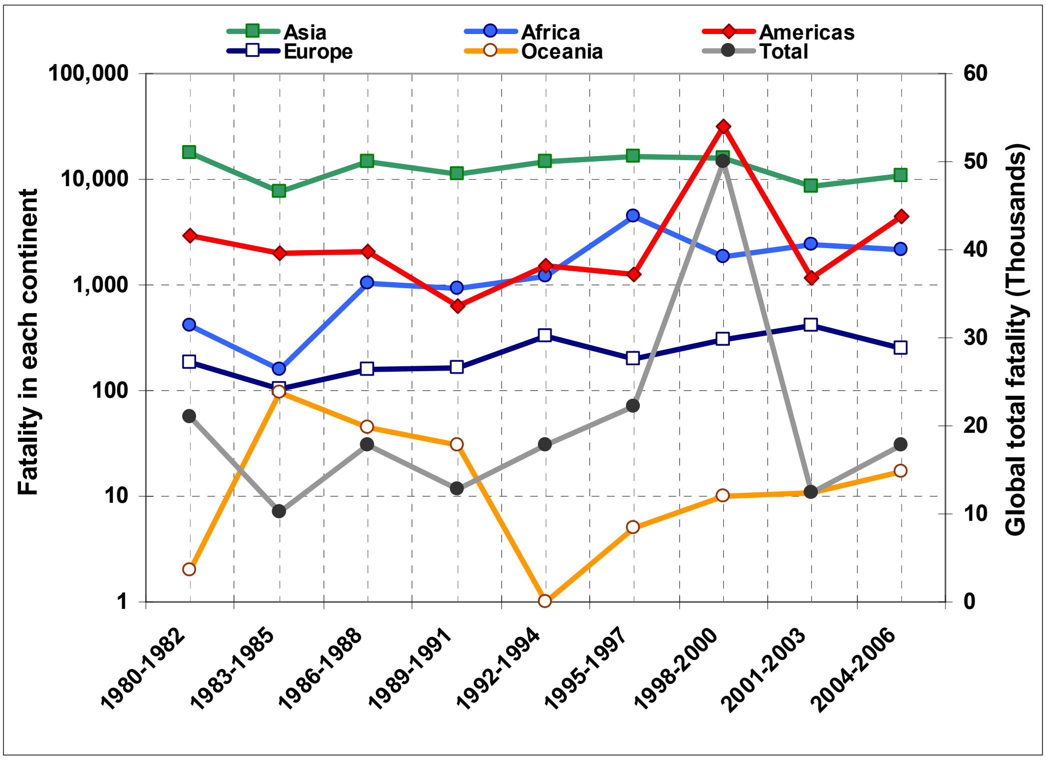

Figure 23 **Three years total number of flood fatalities in different continent since 1980 to 2006**

Windstorm:

During the last quarter of the century the fatalities of windstorm decreased in Asia but were in increasing trend in the rest of the world especially in Americas (**Figure 24**).

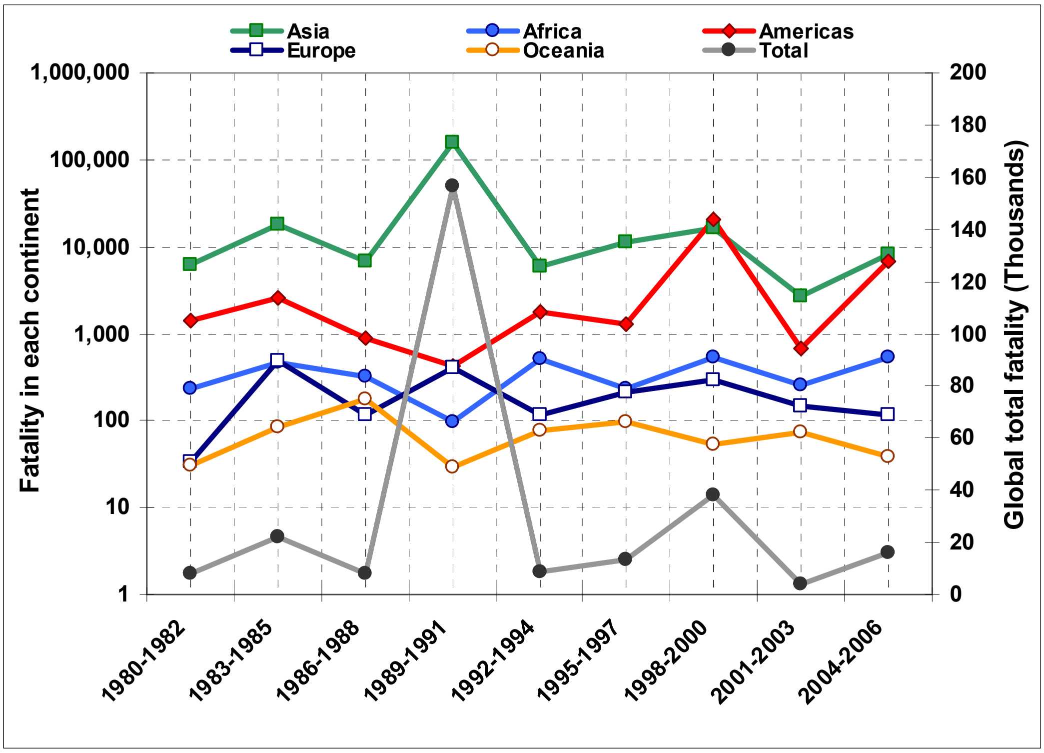

Figure 24 Three years total number of windstorm fatalities in different continent since 1980 to 2006

It is interesting to note that there were two major peaks in Asia alone, one in prime 1970s and another in prime 1990s (1991 Bangladesh Cyclone) showing that Asia is most windstorm prone region in the world (**Table 7**). The three year trend for the last quarter of the century shows that Asia was and still is the most windstorm prone region followed by the Americas where the trend is oscillating.

Table 7 Total windstorm fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	231,382	84.63
Africa	3,175	1.16
Americas	36,276	13.27
Europe	1,917	0.70
Oceania	656	0.24
Total	273,406	100.00

Flood and windstorm:

Asia and the Americas are vulnerable to Flood and windstorm (**Table 8**). This is clear from the experiences during the 1991 Bangladesh cyclone, 1998 and 1999 Central America hurricane (**Figure 25**). It is more comprehensive and easier to form a guideline policy if flood and windstorm events are together as a set. For instance, in the monsoon Asia major large floods are triggered by typhoons.

Table 8 Total flood and windstorm fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	348,707	76.55
Africa	17,848	3.92
Americas	84,058	18.45
Europe	4,037	0.89
Oceania	874	0.19
Total	455,524	100.00

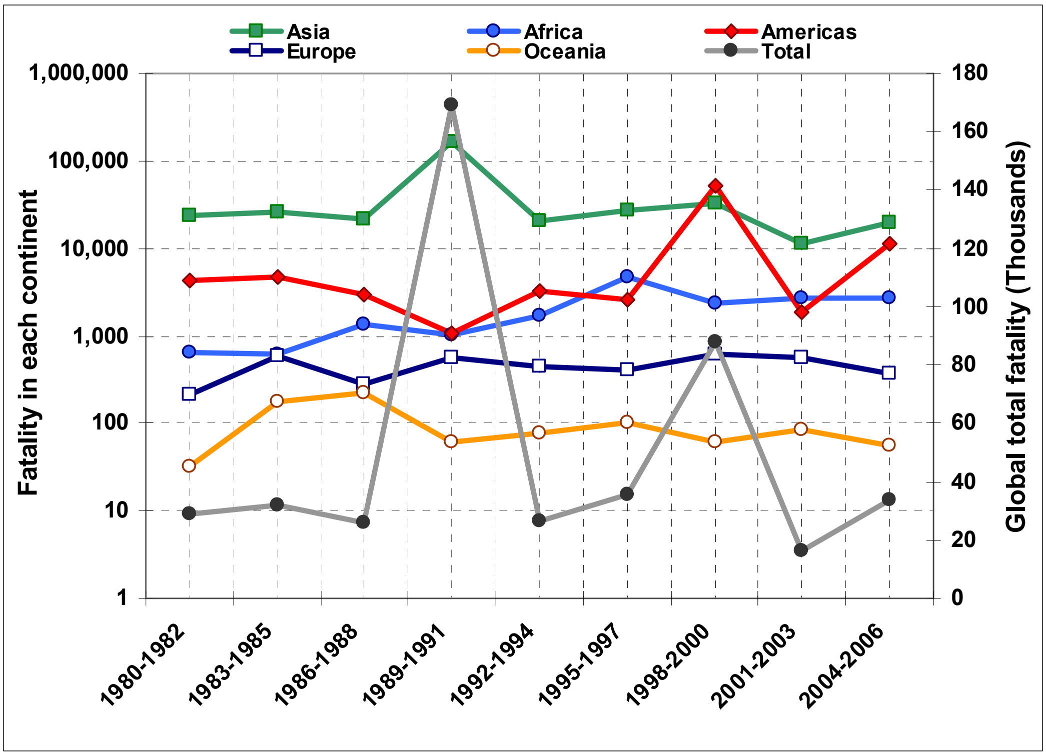

Figure 25 Three years total number of flood and windstorm fatalities in different continent since 1980 to 2006

Slide:

More than 60% of slide fatalities in the last quarter of the century are from Asia, 25% from Americas and less than 10% from Europe (**Table 9**).

More than 1,200 lives were lost during the February 2006 St. Bernard Landslide in Leyte, Philippines (**Picture 1**), in 1986 and 1987 more than 800 people were killed by slides in Colombia and more than 600 fatalities in India and Nepal in 1988 alone (**Figure 26**).

Table 9 Total slide fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	13,371	64.02
Africa	437	2.09
Americas	5,288	25.32
Europe	1,362	6.52
Oceania	428	2.05
Total	20,886	100.00

Picture 1 St. Bernard Landslide in Southern Leyte, Philippines (picture taken in March 2006)

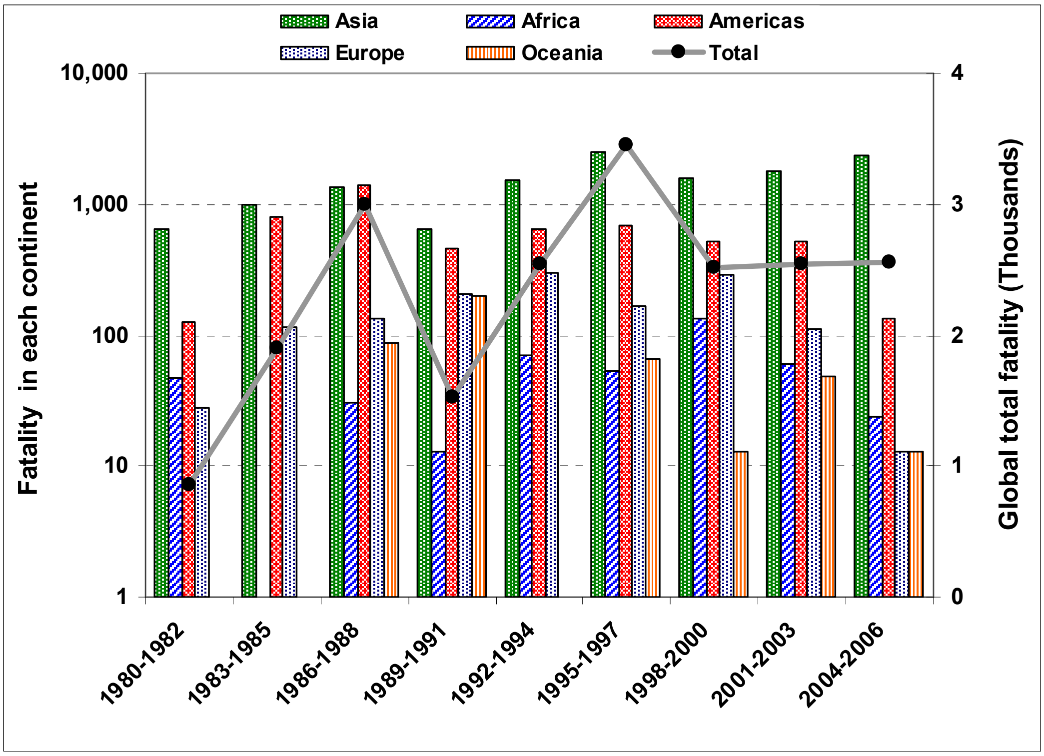

Figure 26 Three years total slide fatalities in different continent since 1980 to 2006

Wave and surge:

The information about wave and surge (tsunami included) is scarce since they occur once in a blue moon but we never could neglect them for we have the vivid memory of the tragedy brought about by the colossal Indian Ocean Tsunami in 2004 which claimed the lives of nearly 243 thousand people (**Figure 27**). UN Commission agreed to launch the first tsunami warning system in the Indian Ocean as a response to this disaster and a permanent system development is in progress. Besides, almost 99% of the fatalities since 1980 to 2006 were from Asia which further suggests that this region is the most vulnerable to wave and surge (**Table 10**).

Table 10 Total wave and surge fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	227,457	98.91
Africa	312	0.14
Americas	10	0.00
Europe	0	0.00
Oceania	2,182	0.95
Total	229,961	100.00

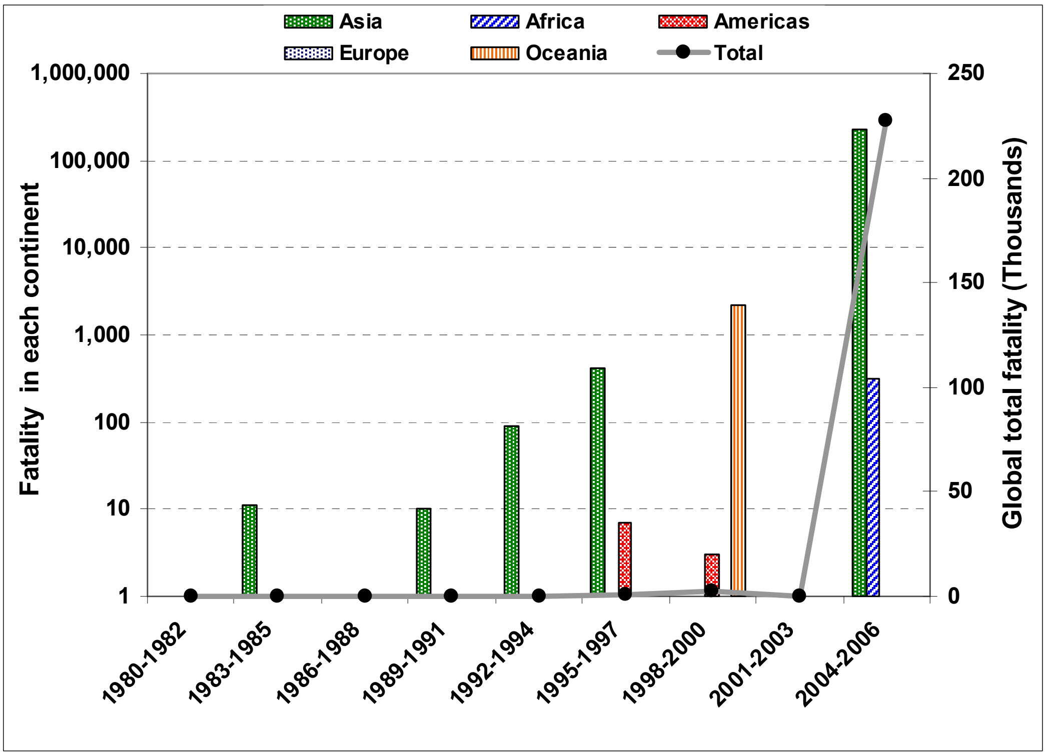

Figure 27 Three years total wave and surge fatalities in different continent since 1980 to 2006

Drought:

Droughts during the last quarter of the 20th century have become very prominent in Africa adding to more than 99% of the total fatalities (**Table 11**), for example the drought fatalities in Sudan and Ethiopia in 1983 adds up to 450,000 (**Figure 28**). In the 60s more than 1.5 million drought deaths are reported in Asia (Merabtene and Yoshitani, 2005). The abnormalities in the water cycle must have been the cause of these disasters around the world demanding immediate mitigation measures; such abnormal phenomenon must be the aftermath of climate change thus proper usage of available water and reduction of green house gas emission may be practiced as a rule of the thumb by all the nations in the world.

Table 11 Total drought fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	4,962	0.89
Africa	553,118	99.09
Americas	73	0.01
Europe	2	0.00
Oceania	60	0.01
Total	558,215	100.00

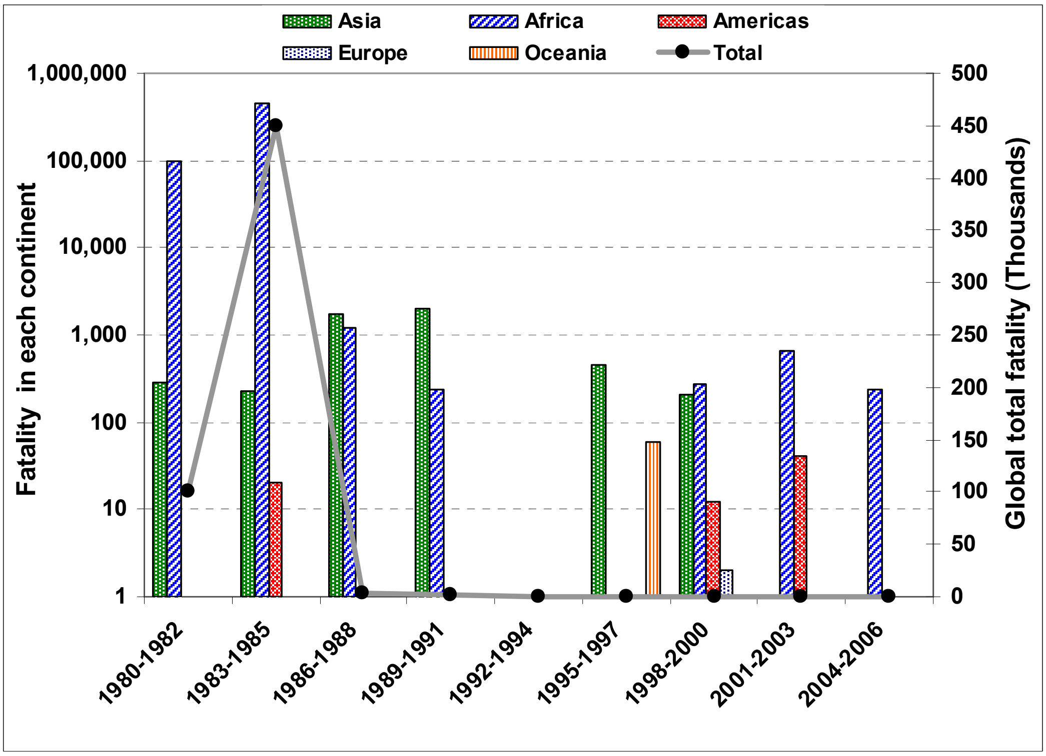

Figure 28 Three years total drought fatalities in different continent since 1980 to 2006

Epidemics (water-related):

Safe drinking water and better sanitation is been advocated by UN agencies to motivate countries to understand the negative impact of water-related epidemics in the communities especially in African region. In 1991 diarrhea in Peru and cholera in Nigeria rendered about 17,000 fatalities (**Figure 29**). If we scrutinize the total fatalities since 1980 until 2006 about 58% are from Africa and 28% from Asia though the numbers of water-related disasters in Asia are more common than in Africa (**Table 12**). This mean that either Africa has a very conducive environment or poor sanitation for these epidemics diseases to proliferate; whichever it may be the policymakers and health workers should have better understanding of these facts and trends to help the people. In our opinion these epidemics mostly affect children that mean the countries at stake.

Table 12 Total epidemics (water-related) fatalities and their ratios in different continent since 1980 to 2006

Continent	Fatality	%
Asia	27,243	27.75
Africa	56,922	57.98
Americas	13,776	14.03
Europe	206	0.21
Oceania	28	0.03
Total	98,175	100.00

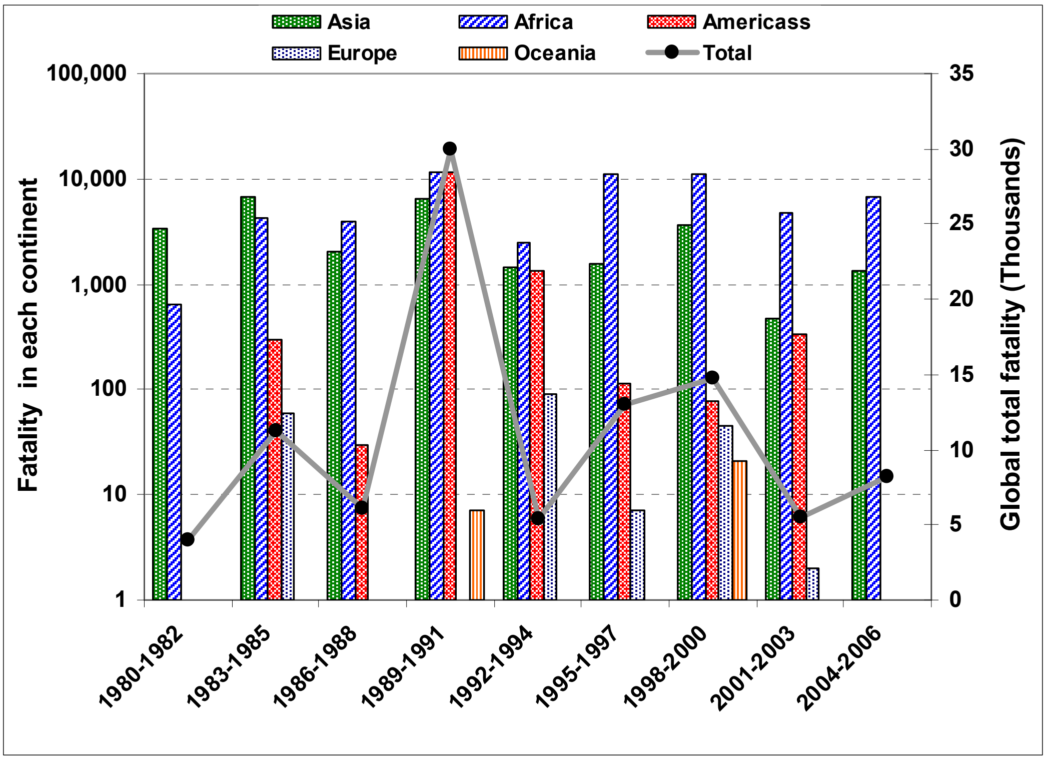

Figure 29 Three years total epidemics (water-related) fatalities in different continent since 1980 to 2006

Trends of Affected People:

Flood:

The total flood affected people had drastically changed in the last quarter of a century and Asia alone contributing to almost 97% (**Table 13**). The trend of the affected people has a high peak at the turn of the 21st century and is brought about by the floods in 1998 and 99 in China (**Figure 30**). Asia always is leading the general regional trend and is parallel to the frequency of disasters and population density. Americas used to occupy the second place next to Asia until mid 90s but Africa has overtaken Americas since then.

Table 13 Total flood affected people and their ratios in different continent since 1980 to 2006

Continent	Affected people	%
Asia	2,506,206,497	96.68
Africa	35,996,167	1.39
Americas	41,238,333	1.59
Europe	8,177,955	0.32
Oceania	530,301	0.02
Total	2,592,149,253	100.00

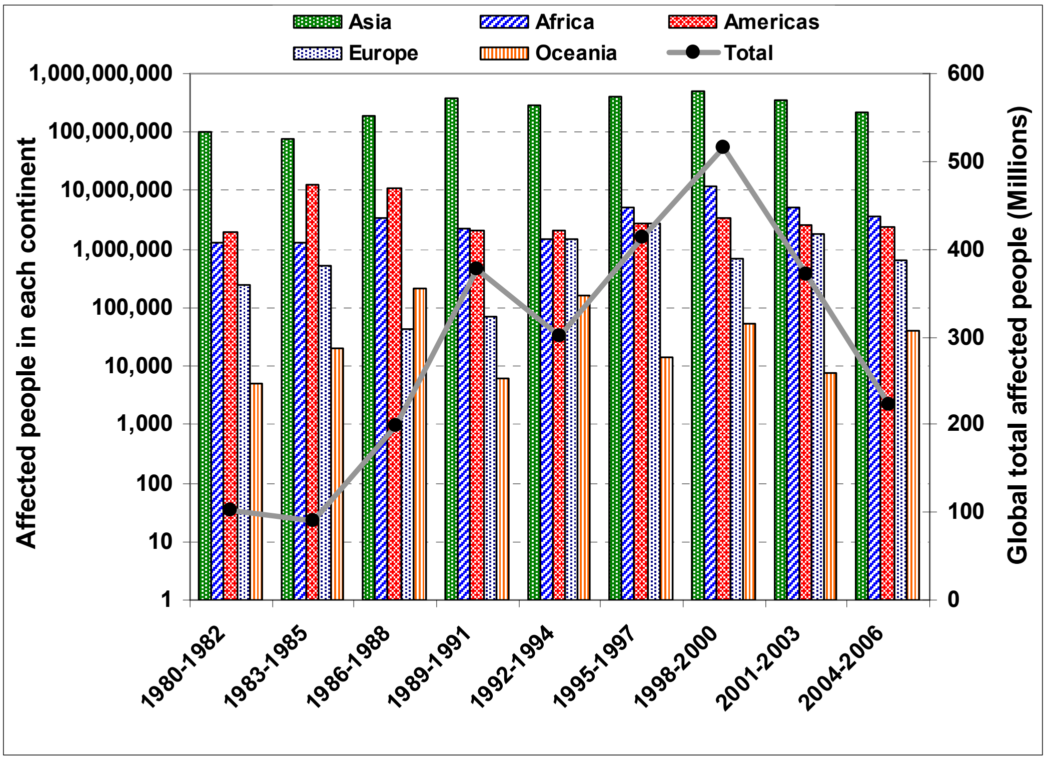

Figure 30 Three years total of flood affected people since 1980 to 2006

Windstorm:

The trend of total number of affected people by windstorm is increasing and has escalated since the turn of the century (**Figure 31**). Within the last quarter of a century the number of affected people increased significantly from a little more than 30 million to more than 137 million, which is more than four times and 90.5% of this figure represent Asia (**Table 14**). The continent wise ranking is as usual Asia comes first and then followed by Americas, Africa, Europe and Oceania; European floods are becoming more frequent and characteristics.

The typhoons in 2001 and 2002; and in 2005 and 2006 in China contributed to the high peak after the turn of the century. This further highlight that the typhoons and hurricanes have become more frequent and also gained in magnitude and they must have been changing their path due to climate change which could be the reason for leaving so many people affected.

Table 14 Total windstorm affected people and their ratios in different continent since 1980 to 2006

Continent	Affected people	%
Asia	595,190,464	90.45
Africa	9,690,871	1.47
Americas	39,388,675	5.99
Europe	8,121,212	1.23
Oceania	5,642,064	0.86
Total	658,033,286	100.00

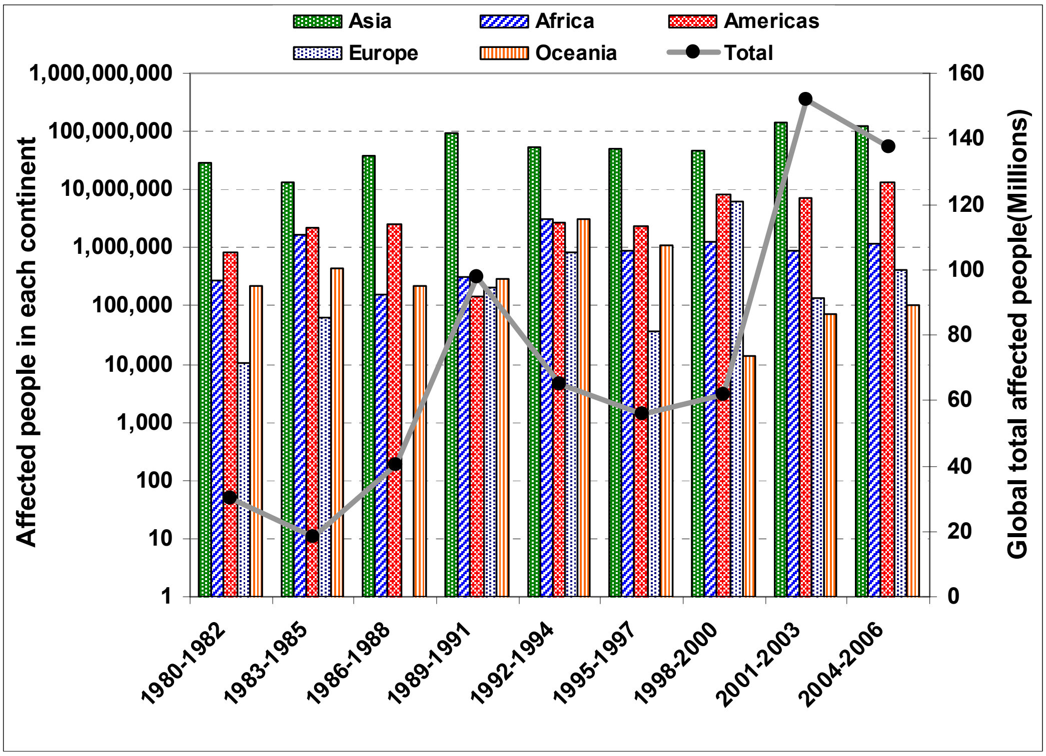

Figure 31 Three years total of windstorm affected people since 1980 to 2006

Slide:

89 percent of the total affected people from slide during the last quarter of a century live in Asia (**Table 15**). The fluctuating total number affected people peaks in the 1986-1988 period and there is a sudden decrease during the next three years period (**Figure 32**). The peak of the affected people during the late 80s was greatly influenced by the landslides in India in 1986. Americas is second in line when it comes to the number of people affected by slides within the last quarter century, followed by Europe. Beside these extreme events the trends in most continents showed periodic peaks and drops over time.

Table 15 Total slide affected people and their ratios in different continent since 1980 to 2006

Continent	Affected people	%
Asia	6,098,090	89.35
Africa	20,304	0.30
Americas	653,385	9.57
Europe	42,521	0.62
Oceania	10,415	0.15
Total	6,824,715	100.00

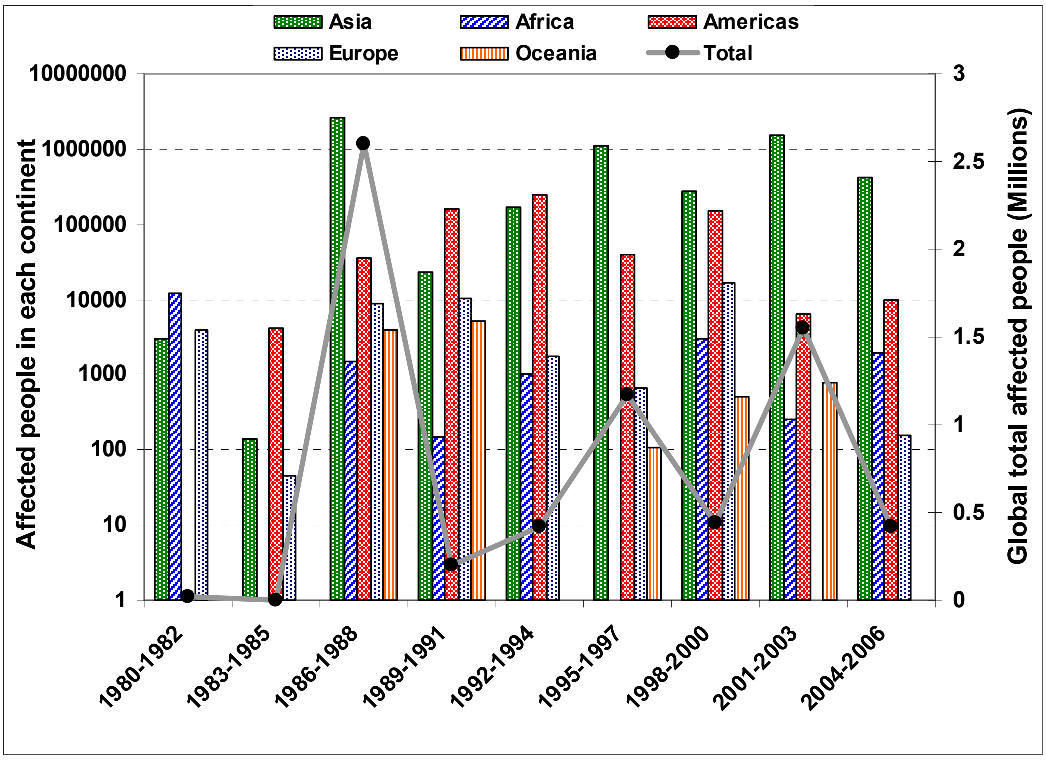

Figure 32 Three years total of slide affected people since 1980 to 2006

Wave and surge:

Major wave and surge disaster were attributed to tsunamis and more than 95% of the 2.5 million affected people since 1980 live in Asia (**Figure 33** and **Table 16**). Especially the Indian Ocean Tsunami of December 2004 increased the vulnerability of the exposed people leaving authorities off guard periling everything on its course at the aftermath. The Indian Ocean Tsunami not only affected Asia alone but also Africa. More than 100,000 people were affected in Somalia making it the most hazardous disaster in the 21st century.

Table 16 Total wave and surge affected people and their ratios in different continent since 1980 to 2006

Continent	Affected people	%
Asia	2,406,715	95.12
Africa	109,913	4.34
Americas	3,572	0.14
Europe	0	0.00
Oceania	9,867	0.39
Total	2,530,067	100.00

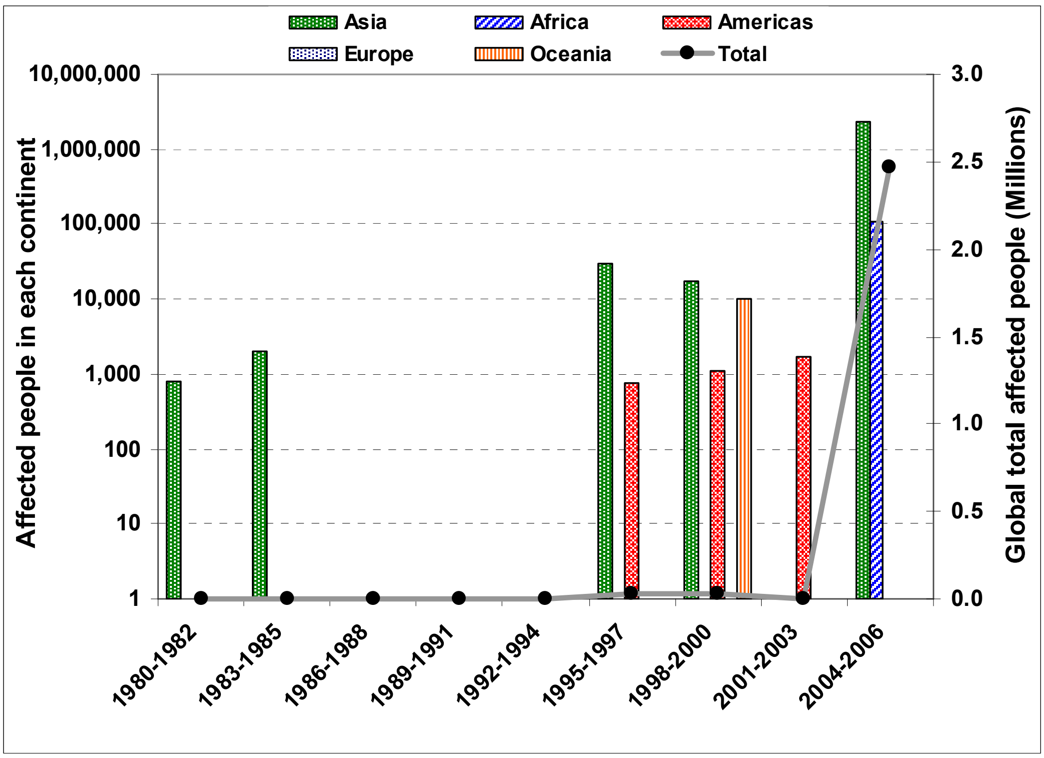

Figure 33 Three years total of wave and surge (tsunami included) affected people since 1980 to 2006

Drought:

The figure of drought affected people is the highest as compared to other water-related disasters (**Table 17**). During the last quarter of a century Asia was hardest hit by drought (**Figure 34**). In India alone, as many as 300 million people were affected by 1987 and 2002 droughts which are the historical extremes worldwide. Inference could be made from the results that the population density governs the peaks and this population density in this case is the people who rely solely on agriculture. This further suggests that had this drought been in an industrialize country with similar population distribution there would not have been so many people suffering.

Drought triggered almost 50% of the top ten famines (Merabtene and Yoshitani, 2005). The geographic general distribution of drought shows that Africa is second in the list next to Asia and followed by Americas. Concurrently, the trend of drought in Oceania was delineated by the series of drought in Australia reported affecting 1.75 million people in 90s.

Table 17 Total drought affected people and their ratios in different continent since 1980 to 2006

Continent	Affected people	%
Asia	1,220,524,542	80.60
Africa	232,286,096	15.34
Americas	43,161,120	2.85
Europe	10,272,575	0.68
Oceania	8,027,635	0.53
Total	1,514,271,968	100.00

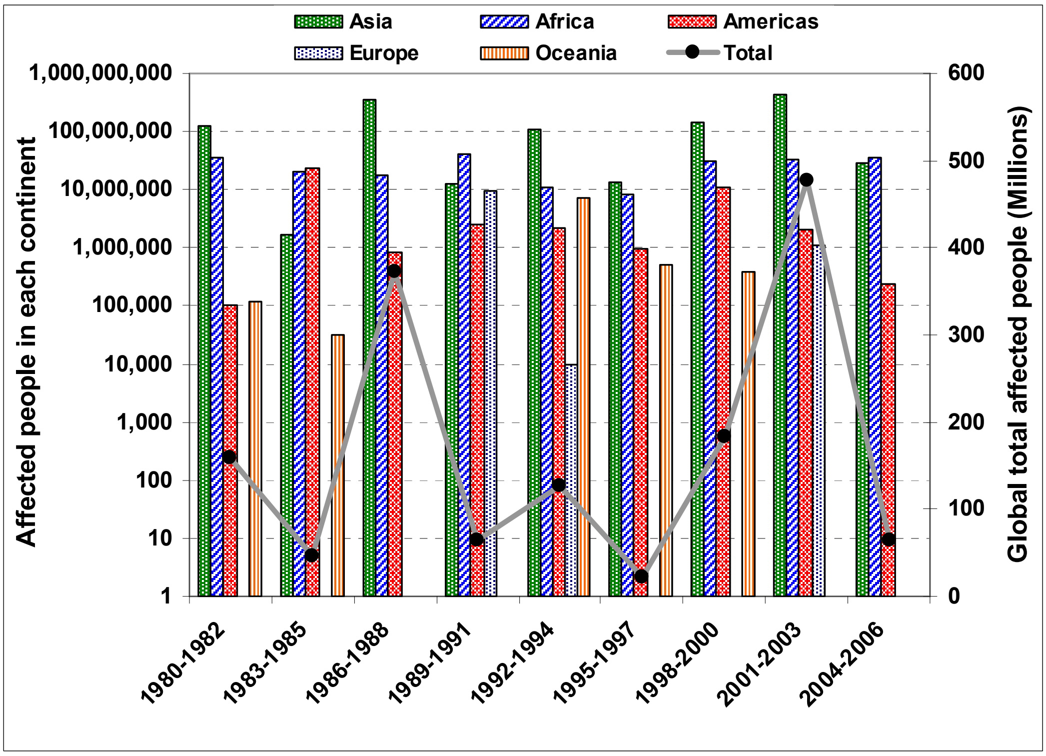

Figure 34 Three years total of drought affected people since 1980 to 2006

Epidemic (water-related):

Nearly 60% of the water-related epidemic occurred in Africa with a drastic increase in number during the past two decades and the decreasing trend in Asia (**Figure 35**). But the general trend shows that the number affected people peaked in prime 90s and after that there is a steady decline at all regions thanks to recent health science developments. The 1994 malaria in Kenya affected over 6 million people and 1991 Diarrheal/Enteric type in Bangladesh another 1.5 million people.

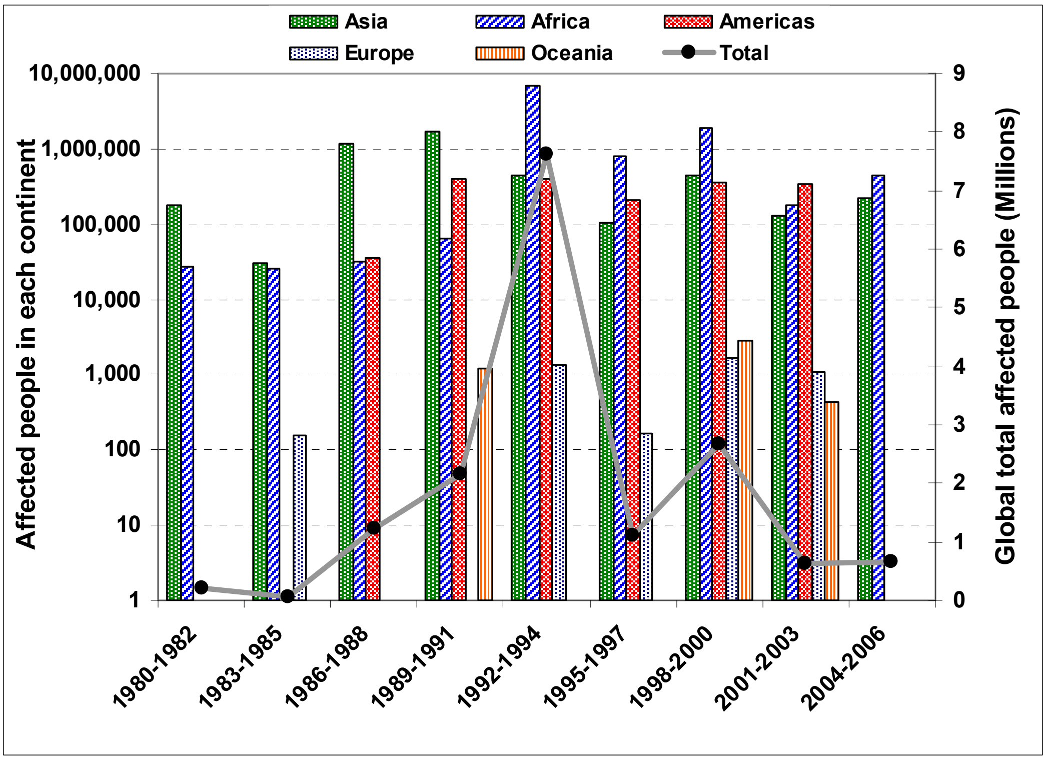

Figure 35 Three years total of epidemics (water-related) affected people since 1980 to 2006

Chapter 4: Final Remarks

Water-related disasters are shared burden among all continents and are proportional to the population density. Negative impacts on society and economy are exponentially ballooning despite local, national, regional and international effort 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".

The pragmatic issues on proper implementation of integrated multidisciplinary approach in water resources management are being stressed and discussed at many scientific and political gatherings; and are mainly reflected as an integral part of action plan of the 4th phase of the International Hydrological Program (IHP-VI Plan: 2002-2007). The major problems in water related disaster risk management process and cycle 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 monitoring methodology and assess to the disasters zone at first stage. This further affects the decision and policy making processes because of the uncertainties surrounding the accuracy of the numbers quantifying the impacts, and the meaning behind the numbers resulting from the risk assessment upon which most mitigation strategies are built on. Strong international platform for cooperation with primary focus on water-related disasters and related risk management issues and to develop and introduce a standard method of disaster quantification equipped with basic risk indices is indispensable (Guha-Sapir & Below, 2002; and Wisner et al., 2004).

An increasing consensus on the importance of the role of the risk management and its implementation in decision making to define safer and holistic and sustainable strategies in natural disasters mitigation is in demand globally. The great importance of undertaking further vigilant quantification of disaster loss data set at a finer temporal and geographical scale than as reported herein is a basic importance and a must. 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. Definitely there is an urgency to undertake a more in-depth survey and analysis to draw *conclusive concepts* for vulnerability analysis and water-related risk management.

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.

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. 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 at the regional and global levels.

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Appendix

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: 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 »).

Annex 3. 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 4. Largest Disastrous Events: EMDAT data from 1900 to 2006

Annex Tables 1 Top 100 disastrous events in terms of killed people (this table is revised and updated)

year	dis_type	dis_subset	country_name	no_killed	total_affected
1932	Complex Disasters	Famine	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
1920	Epidemic	Plague	India	2,000,000	0
1959	Flood	Flood	China P Rep	2,000,000	0
1943	Drought	Drought	Bangladesh	1,900,000	0
1942	Drought	Drought	India	1,500,000	0
1965	Drought	Drought	India	1,500,000	100,000,000
1909	Epidemic	Plague	China P Rep	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
1995	Complex Disasters	Famine	Korea Dem P Rep	610,000	8,000,000
1920	Drought	Drought	China P Rep	500,000	20,000,000
1920	Epidemic	Diarrhoeal/Enteric	India	500,000	0
1939	Flood	Flood	China P Rep	500,000	0
1926	Epidemic	Small pox	India	423,000	0
1918	Epidemic	Respiratory	Bangladesh	393,000	0
1983	Drought	Drought	Ethiopia	300,000	7,750,000
1924	Epidemic	Diarrhoeal/Enteric	India	300,000	0
1970	Wind Storm	Cyclone	Bangladesh	300,000	3,648,000
1976	Earthquake	Earthquake	China P Rep	242,000	164,000
1927	Earthquake	Earthquake	China P Rep	200,000	0
1901	Epidemic	Unknown	Uganda	200,000	0
1920	Earthquake	Earthquake	China P Rep	180,000	0
2004	Wave / Surge	Tsunami	Indonesia	165,708	532,898
1983	Drought	Drought	Sudan	150,000	8,400,000
1923	Earthquake	Earthquake	Japan	143,000	203,733
1935	Flood	Flood	China P Rep	142,000	10,030,000
1991	Wind Storm	Cyclone	Bangladesh	138,866	15,438,849
1948	Earthquake	Earthquake	Soviet Union	110,000	0
1973	Drought	Drought	Ethiopia	100,000	3,000,000
1981	Drought	Drought	Mozambique	100,000	4,750,000
1923	Epidemic	Meningitis	Niger	100,000	0
1911	Flood	Flood	China P Rep	100,000	0
1922	Wind Storm	Typhoon	China P Rep	100,000	0
1910	Drought	Drought	Niger	85,000	32,000
1908	Earthquake	Earthquake	Italy	75,000	150,000
2005	Earthquake	Earthquake	Pakistan	73,338	2,869,142
1932	Earthquake	Earthquake	China P Rep	70,000	0
1970	Earthquake	Earthquake	Peru	66,794	3,216,240
1942	Wind Storm	Cyclone	Bangladesh	61,000	0
1935	Earthquake	Earthquake	Pakistan	60,000	0
1910	Epidemic	Plague	China P Rep	60,000	0
1935	Wind Storm	Cyclone	India	60,000	0
1949	Flood	Flood	China P Rep	57,000	0
1918	Epidemic	Respiratory	Canada	50,000	2,000,000

year	dis_type	dis_subset	country_name	no_killed	total_affected
1912	Wind Storm	Typhoon	China P Rep	50,000	0
1990	Earthquake	Earthquake	Iran Islam Rep	40,000	710,000
1949	Flood	Flood	Guatemala	40,000	0
1942	Wind Storm	Cyclone	India	40,000	0
1965	Wind Storm	Cyclone	Bangladesh	36,000	15,600,000
2004	Wave / Surge	Tsunami	Sri Lanka	35,399	1,019,306
1939	Earthquake	Earthquake	Turkey	32,962	0
1946	Drought	Drought	Cape Verde Is	30,000	0
1939	Earthquake	Earthquake	Chile	30,000	58,500
1954	Flood	Flood	China P Rep	30,000	0
1999	Flood	Flood	Venezuela	30,000	483,635
1902	Volcano	Explosive Eruption	Martinique	30,000	0
1915	Earthquake	Earthquake	Italy	29,980	0
1974	Flood	Flood	Bangladesh	28,700	38,000,000
2003	Earthquake	Earthquake	Iran Islam Rep	26,796	267,628
1978	Earthquake	Earthquake	Iran Islam Rep	25,000	40,000
1988	Earthquake	Earthquake	Soviet Union	25,000	1,642,000
1920	Drought	Drought	Cape Verde Is	24,000	0
1976	Earthquake	Earthquake	Guatemala	23,000	4,993,000
1985	Volcano	Volcano	Colombia	21,800	12,700
2001	Earthquake	Earthquake	India	20,005	6,321,812
1940	Drought	Drought	Cape Verde Is	20,000	0
1906	Earthquake	Earthquake	Chile	20,000	0
1974	Earthquake	Earthquake	China P Rep	20,000	0
1905	Earthquake	Earthquake	India	20,000	0
2003	Extreme Temperature	Heat wave	Italy	20,000	0
1973	Drought	Drought	Somalia	19,000	230,000
1933	Flood	Flood	China P Rep	18,000	3,600,000
1999	Earthquake	Earthquake	Turkey	17,127	1,358,953
2004	Wave / Surge	Tsunami	India	16,389	654,512
1917	Earthquake	Earthquake	Indonesia	15,000	0
2003	Extreme Temperature	Heat wave	France	14,947	0
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
1907	Earthquake	Earthquake	China P Rep	12,000	0
1962	Earthquake	Earthquake	Iran Islam Rep	12,000	103,000
1960	Earthquake	Earthquake	Morocco	12,000	25,000
1907	Earthquake	Earthquake	Soviet Union	12,000	0
1949	Slides	Landslide	Soviet Union	12,000	0
1963	Wind Storm	Cyclone	Bangladesh	11,500	1,000,000
1900	Drought	Drought	Cape Verde Is	11,000	0
1961	Wind Storm	Cyclone	Bangladesh	11,000	0
1937	Wind Storm	Typhoon	Hong Kong (China)	11,000	0
1947	Epidemic	Diarrhoeal/Enteric	Egypt	10,276	0
1944	Earthquake	Earthquake	Argentina	10,000	155,000
1918	Earthquake	Earthquake	China P Rep	10,000	0
1933	Earthquake	Earthquake	China P Rep	10,000	0
1970	Earthquake	Earthquake	China P Rep	10,000	0
1975	Earthquake	Earthquake	China P Rep	10,000	0
1968	Earthquake	Earthquake	Iran Islam Rep	10,000	79,050
1972	Earthquake	Earthquake	Nicaragua	10,000	720,000

Annex Tables 2 Top 100 disastrous events in terms of affected people

(this table is revised and updated)

year	dis_type	dis_subset	country_name	no_killed	total_affected
1987	Drought	Drought	India	300	300,000,000
2002	Drought	Drought	India	0	300,000,000
1998	Flood	Flood	China P Rep	3,656	238,973,000
1991	Flood	--	China P Rep	1,729	210,232,227
1972	Drought	Drought	India	0	200,000,000
1996	Flood	Flood	China P Rep	2,775	154,634,000
2003	Flood	--	China P Rep	430	150,146,000
1993	Flood	Flood	India	827	128,000,000
1995	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	1,500,000	100,000,000
1982	Drought	Drought	India	0	100,000,000
2002	Wind Storm	Storm	China P Rep	0	100,000,000
1994	Drought	Drought	China P Rep	0	82,000,000
2002	Flood	Flash Flood	China P Rep	793	80,035,257
1994	Flood	Flood	China P Rep	1,001	78,974,400
1988	Flood	Flood	Bangladesh	2,379	73,000,000
2002	Drought	Drought	China P Rep	0	60,000,000
2000	Drought	Drought	India	20	50,000,000
1988	Drought	Drought	China P Rep	1,400	49,000,000
2003	Drought	Drought	China P Rep	0	48,000,000
2002	Flood	Flood	India	549	42,000,000
1974	Flood	Flood	Bangladesh	28,700	38,000,000
1999	Drought	Drought	Iran Islam Rep	0	37,000,000
2004	Flood	Flash Flood	Bangladesh	730	36,000,000
1975	Flood	Flood	India	350	34,000,000
2004	Flood	--	China P Rep	133	33,652,026
1982	Flood	Flood	India	932	33,500,000
2004	Flood	Flash Flood	India	900	33,000,000
1995	Flood	Flood	India	1,479	32,704,000
1978	Flood	Flood	India	3,800	32,000,000
1994	Flood	--	China P Rep	258	30,547,665
1989	Wind Storm	Storm	China P Rep	157	30,007,500
1980	Flood	Flood	India	1,600	30,000,023
1984	Flood	Flood	Bangladesh	1,200	30,000,000
1987	Flood	Flood	Bangladesh	2,055	29,700,000
2006	Wind Storm	Typhoon	China P Rep	820	29,622,000
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	--	China P Rep	363	26,130,805
1979	Flood	Flood	India	0	26,000,000
2000	Flood	Flood	India	884	24,600,000
1999	Drought	Drought	Kenya	85	23,000,000
1999	Flood	Flood	India	229	22,120,000
1988	Flood	Flood	China P Rep	577	22,000,200
2000	Flood	Flood	India	867	22,000,000
1988	Earthquake	Earthquake	India	382	20,003,766
2005	Flood	--	India	1,200	20,000,055

year	dis_type	dis_subset	country_name	no_killed	total_affected
1920	Drought	Drought	China P Rep	500,000	20,000,000
1983	Drought	Drought	Brazil	20	20,000,000
1982	Drought	Drought	Bangladesh	0	20,000,000
2002	Flood	Flood	China P Rep	0	20,000,000
2005	Wind Storm	Typhoon	China P Rep	159	19,624,000
1999	Drought	Drought	China P Rep	0	19,000,000
1987	Flood	Flood	India	1,200	18,000,000
2006	Drought	Drought	China P Rep	0	18,000,000
1923	Epidemic	Malaria	Soviet Union	0	18,000,000
2005	Flood	--	China P Rep	235	16,700,000
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
2001	Drought	Drought	China P Rep	0	15,800,000
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
2000	Drought	Drought	China P Rep	0	15,000,000
2004	Drought	Drought	South Africa	0	15,000,000
2001	Wind Storm	Typhoon	China P Rep	33	14,998,298
1977	Wind Storm	Cyclone	India	14,204	14,469,800
1995	Flood	--	Bangladesh	250	12,656,006
1999	Wind Storm	Cyclone	India	9,843	12,628,312
2003	Drought	Drought	Ethiopia	0	12,600,000
1980	Drought	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
2005	Flood	--	China P Rep	58	11,230,230
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
2006	Wind Storm	Typhoon	China P Rep	89	10,000,000
1970	Drought	Drought	Brazil	0	10,000,000
1998	Drought	Drought	Brazil	0	10,000,000
1979	Drought	Drought	India	0	10,000,000
1970	Flood	Flood	Bangladesh	0	10,000,000
2001	Flood	Flood	India	100	9,670,000
2004	Wind Storm	Typhoon	China P Rep	188	9,062,000
1995	Drought	Drought	China P Rep	0	9,060,000