

DAMS AND FLOODS

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Summary

Floods are the most important natural hazard among the natural disasters. They are responsible for about 30% of the total number of natural disasters and related economic damage, as well as almost 20% of the fatalities attributed to natural disasters. This article provides data on the most important floods of recent years, and describes the results of a survey carried out by the Committee on Dams and Floods of the International Commission on Large Dams (ICOLD). The data reveals the important impacts that floods produce on human life, and the considerable economic damage they cause. Particular attention is paid to effects of floods in developing countries, where the amount of damage and social disruption they cause can be significant factors holding back development. An analysis of extreme flood events shows that extreme floods around the world have envelope curves, which limit the relationship between peak flow and catchments area. Measures to prevent and mitigate the damage produced by floods are described, pointing out the importance of considering actions holistically, and developing the application of combined structural and non-structural measures.

Finally, the role of dams and reservoirs in flood mitigation impacts is analysed, classifying the dams in diverse categories according to their purpose, particularly regarding flood mitigation. It describes significant cases, which show, with quantitative values, the important role played by dams in flood mitigation in Japan, USA and Spain.

1. Floods as a Natural Hazard

Natural hazards pose an important threat to human life and produce serious social effects and grave economic losses. The natural disasters constitute a curb on sustainable development, affecting its three basic mainstays: economic, social and environmental factors. In spite of the efforts made by the UN International Decade for Natural Hazard Reduction, there was an upward trend in worldwide natural disasters in the last decades of the twentieth century. The average annual casualty rate is about 40 000 victims, and

the mean economic loss is more than US\$50 billion per year. The impact of major natural disasters during the period 1963 to 1992 increased by a factor 3.5 as regards affected people, and 2.3 as regards the number of victims. Likewise, economic losses are increasing with an exponential tendency, having doubled during the 1990s, as shown in Figure 1.

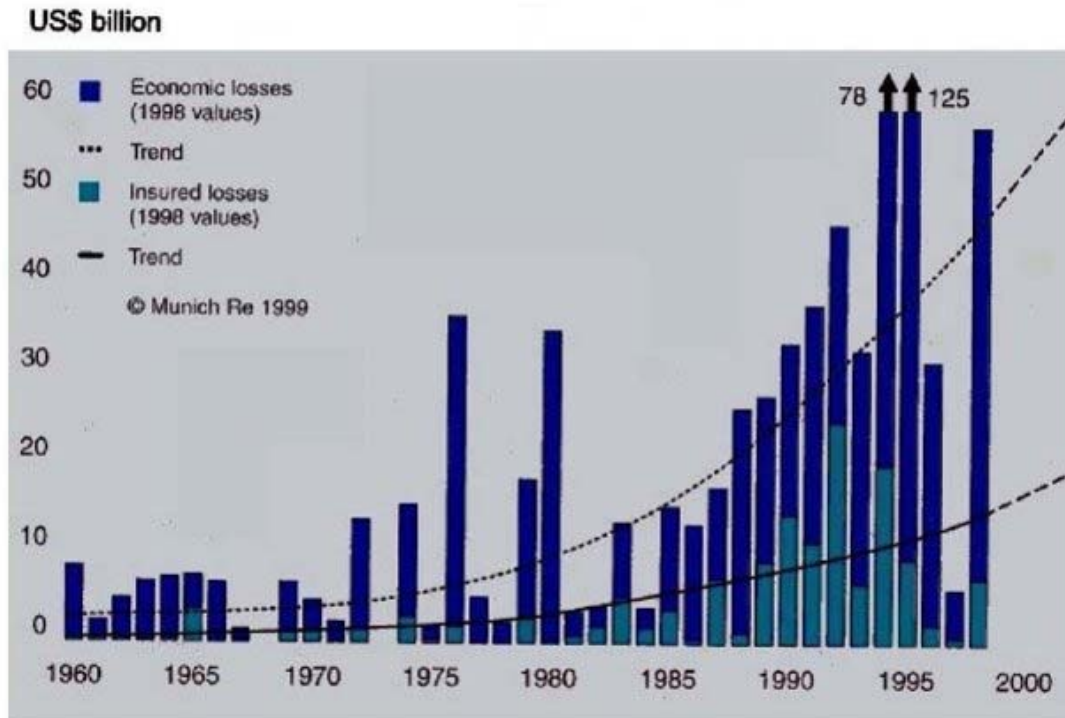


Figure 1. Natural disasters. Economic and insured losses, with trends.

The greatest natural disasters of recent decades, which have produced economic damage greater than \$10 billion, are shown in Table 1. It can be seen that of the 18 disasters, seven are floods—those of 1993 in USA, 1991, 1993, 1996 and 1998 in China, 1995 in North Korea, and 1999 in Venezuela; the latter had more than 20 000 victims.

Location	Date	Type of disaster	Number of fatalities	Economic damage (US\$ 1000)
Japan	Jan 1995	Earthquake	6348	100,000
USA	Jan 1994	Earthquake	61	44,000
China	May-Sept 1998	Floods	3656	30,700
USA	Aug 1992	Hurricane Andrew	62	26,500
China	June –Aug 1996	Floods	3048	24,000
USA	June –Aug 1993	Floods	50	16,000
Venezuela	Dec 1999	Flash floods, landslides	20,000	15,000
North	July-Aug	Floods	68	15,000

Korea	1995			
China	May-Sept 1991	Floods	3074	15,000
Europe	Dec-Mar 1990	Winter storms	230	14,800
Taiwan	Sept 1999	Earthquake	2474	14,000
Armenia	Dec 1988	Earthquake	25,000	14,000
USA	April-June 1988	Drought		13,000
Turkey	Aug 1999	Earthquake	17,200	12,000
Italy	Nov 1980	Earthquake	2914	11,800
China	June-Sept 1993	Floods	3300	11,000
America	Sept 1998	Hurricane George	4000	10,000
Japan	Sept 1991	Typhoon Mireille (no.19)	62	10,000

Table 1. Major natural disasters, since 1991

Of the natural disasters, the greater number correspond to floods (see Figure 2) which are responsible for about 30% of the socio-economic impacts (32% in relation to significant damage and to affected people, and 26% in relation to the number of deaths).

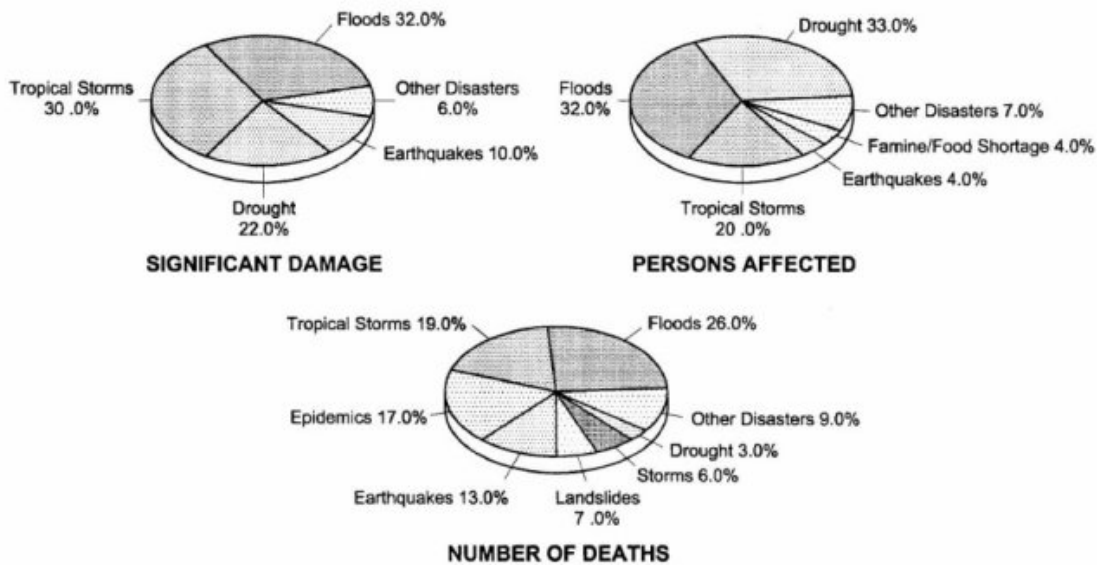


Figure 2. Major disasters around the world, 1963 to 1992. Percentage of significant disasters by type, based on damage, persons affected and deaths

In recent decades the impacts caused by floods have been very significant and Table 2 lists the most catastrophic floods that have occurred since 1991.

COUNTRY	YEAR	VICTIMS	ECONOMIC LOSSES (US M\$)
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China	Jul.-Aug. 1991	3,074	15,000
China	Jun.-Sep. 1993	3,300	11,000
Usa	Jul.-Aug. 1993	38	15,600
Netherlands	Jan.-Feb. 1995	5	1,650
Norway	May -Jun. 1995	1	240
China	Jun.-Aug. 1996	3,048	24,000
Korea (South)	July 1996	99	600
Korea (North)	Aug.-Sep 1996	68	15,000
China	Jul.-Aug. 1998	4,150	30,000
Bangladesh	Aug.-Sep. 1998	1,655	13,000
America (Hurricane George)	Sep. 1998	4,000	10,000
Central America (Hurricane Mitch)	Oct. 1998	20,000	4,000
Venezuela	Dec. 1999	20,000	15,000

Table 2. The most important catastrophic floods since 1991

In order to analyse in more detail the significance and importance of the floods, ICOLD carried out a survey on the social and economic impacts of floods in twenty countries with large dams. These countries include about 90% of the existing large dams. It was found that the floods were the most important natural hazard in 65% of the countries and that floods represented 90% of the first or second most important natural hazard events. Furthermore, the recurrence of floods is high, with an average incidence of 7.2 years. In the majority of cases the number of years between major floods ranges from 5 to 10 years.

The “mean” number of victims per year produced by floods worldwide is shown in Table 3.

VICTIMS	COUNTRIES
0 – 10	Argentina, Australia, Brazil, Canada, France, Ireland, Italy, Netherlands, Norway, South Africa, Sweden, Russia
10 – 20	Spain
50 – 100	Indonesia, USA.
100 – 150	Japan
> 150	Korea (250), Bangladesh * (200), India (1500), China (2000 to 3000)

Table 3. “Mean” number of victims per year caused by floods.

The majority of victims are produced in the Asian countries: 200 victims per year in Bangladesh (without including cyclones or storm surges), 250 in South Korea, 1500 in India and more than 2500 victims per year in China. Numbers of victims are also very high in USA and Japan, however, with 94 and victims per year respectively. This is largely a consequence of intense occupation of flood plains, and the occurrence of flash floods. In most countries the mean number of victims per year is less than 20.

In relation to the economic impact of floods, Table 4 gives an evaluation of “mean” annual damage.

Country	Damage (M\$ per year)
Brazil, France, Ireland, South Africa, Sweden	< 10
Norway	27
Argentina	30
Canada	100
Bangladesh	135
Netherlands	150
India	240
Australia	320
Russia	380
Korea	500
Spain	600
Italy	800
China	3000
U.S.A.	3400
Japan	7200

Table 4. Mean annual damage produced by floods.

It can be seen that in South Korea damage is some \$500 million, Spain \$600 million, and China \$3000 million, but the most important damage occurs in highly developed countries: USA at \$3400 million and Japan at \$7200 million per year. Also, we must mention the impact and economic damage produced by floods in several developing countries, where the amount of damage and social disruption could become a significant brake on their development.

So experience shows that damage caused by floods continues to increase progressively, and in many countries it constitute a veritable restraint to economic and sustainable development. In view of this the UN decided in year 1987 to establish the International Decade for Natural Disaster Reduction (IDNDR) for the ten years 1990 to 2000, with the objective of reducing through concerted international action, especially in developing countries, the loss of lives, material damage and social and economic disorder caused by natural hazards. Among the essential elements of the activities of IDNDR, the following stand out:

- Greater emphasis on planning and preventive measures.
- Adoption of integrated action (structural and non-structural) for reduction of the disasters.
- Establishment of forecasting and alarm systems compatible with the technology and culture of the countries.
- Development of social awareness of the necessity for reduction of the impacts.

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Biographical Sketch

Luis Berga was born in Manresa (Barcelona), Spain. 1946. He has graduated in Civil Engineer at Civil Engineering School, Polytechnic University of Madrid. 1971 then got Ph.D. Civil Engineering. At Polytechnic University of Madrid. 1977.

Professional Experience

Full Professor of Hydraulic Engineering. Chair of Hydraulics and Hydrology, since 1977.
Director of the Water Administration of Catalonia, Spain. 1987-1993.
Advisor to the Water Administration of Catalonia. Spain. 1993-1998.
Member of the Spanish National Committee on Large Dams. SPANCOLD, since 1985.
Chairman of the Spanish National Committee on Large Dams. 1998-present.
Vice-President ICOLD. 2000-2003
Chairman of the Committee on Dams and Floods. ICOLD. 1994-present.
Chairman of the Advisory Committee to the President. ICOLD. 2002-present.

Publications

Author or Editor of 26 books or books chapters, 75 papers in Journals, and more than 140 papers or reports at Congresses and Symposia.

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