



**Convention on the Protection and Use of Transboundary
Watercourses and International Lakes**

**Seminar on flood prevention, protection and mitigation
(Berlin, 21-22 June 2004)**

**Conference room paper
MP.WAT/SEM.3/CRP. 8**

FLOODS IN EUROPE

Discussion paper transmitted by the Government of Poland¹

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Natural disasters are unpreventable phenomena, as man can not shape their magnitude or time of occurrence. It is only possible to decrease the losses inflicted by the occurrence of phenomena causing such catastrophe events, or reduce the likelihood of arising a new natural disaster being an effect of another natural disaster, happening before.

Among natural disasters occurring in Europe, special place is occupied by floods which on our continent have appeared with exceptional intensity, particularly in the last decade.

Strong winds, droughts and earthquakes with centre of occurrence in the south-eastern part of the continent, are equally threatening and frequently occurring natural catastrophes.

The flood occurrence intensity on continents and losses caused by floods are presented in the table below.

Table 1. Flood occurrence according to continents from 1900 – 2004

	# of Events	Killed	Injured	Homeless	Affected	Total affected	Losses (000 USD)
Africa	434	18,580 43*	22,635 52*	4,385,041 10,104*	32,119,915 74,009*	36,527,591 84,165*	3,385,483 7,801*
America	665	96,352 145*	40,572 61*	3,554,172 5,345*	47,832,827 71,929*	51,427,451 77,335*	57,165,484 85,963*
Asia	1,025	6,756,615 6,592*	1,176,966 1,148*	125,207,976 122,154*	2,601,314,049 2,537,867*	2,727,689,991 2,661,170*	166,417,157 162,358*
Europe	337	9,546 28*	21,743 65*	427,122 1,267*	10,376,179 30,790*	10,825,044 32,122*	85,310,551 253,147*
Oceania	85	355 4*	91 1*	95,000 1.118*	452,998 5,329*	548,089 6,448*	2,086,128 24,543*

Source: EM DAT

* – average of events

In relation to the amount of events, Europe represents an average among the continents. The structure of losses appears to be interesting (Fig. 1).

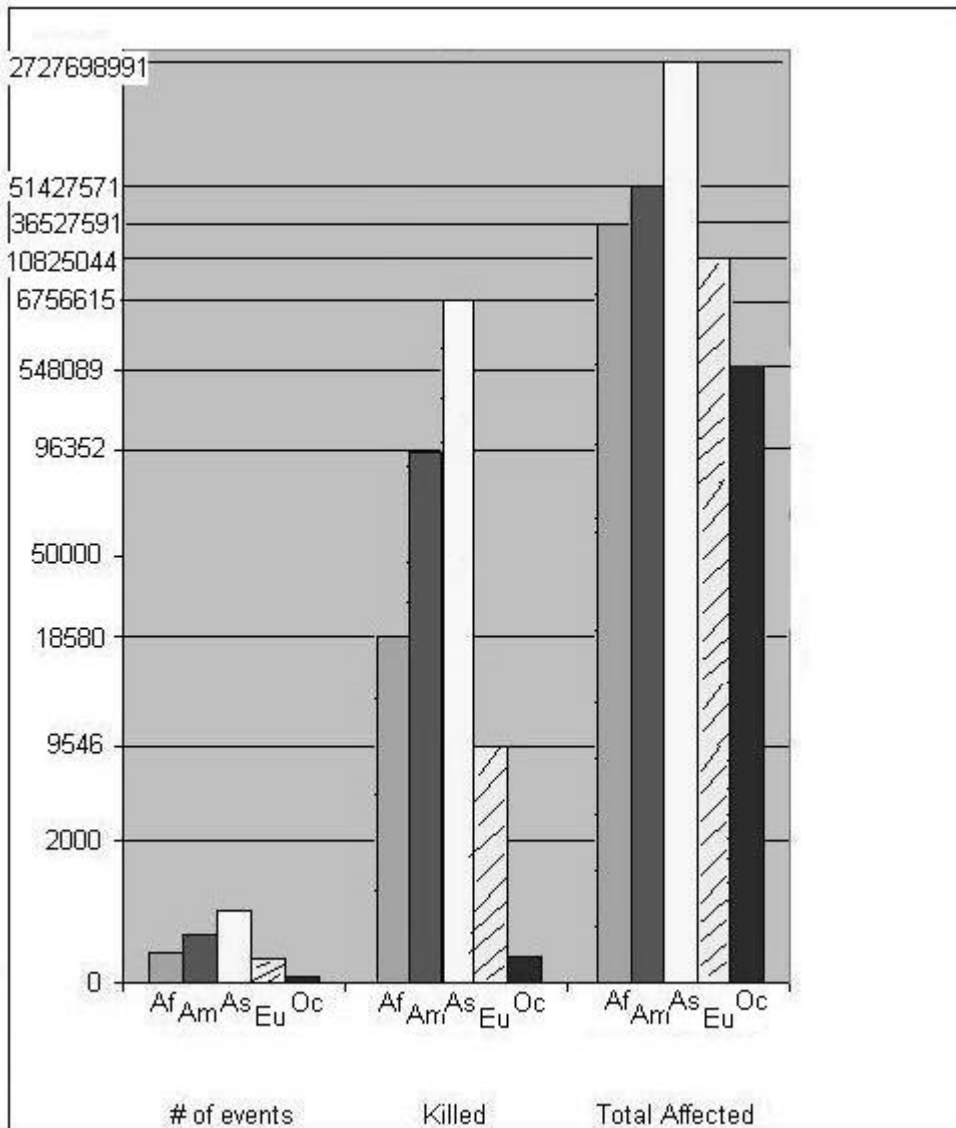


Fig. 1. Comparison of loss quantity according to continents

Among the continents, Asia has the most considerable number of floods and suffers the heaviest losses in all categories. In relation to other continents, Europe is characterized by a very interesting structure of losses, which results from the fact that in Europe floods frequently affect areas with dense population, mostly cities with valuable buildings and facilities, and also industrial plants and expensive telecommunications infrastructure, 1997 Poland – the Czech Republic – Germany, 2002 the Czech Republic – Germany.

Relatively small number of killed during floods can be a sign of the enhanced efficiency of warning systems and the operation of rescue systems.

Early flood warnings, continuous monitoring of the phenomenon, forecasts, especially the hydrological and meteorological ones, and up-to-date technical control of hydraulic engineering structures help reduce the threat, and above all save maximum number of people from the flood effects.

Efficiently functioning telecommunications systems facilitate the operation of monitoring devices at real time, which is very important for the effectiveness of carrying out the operations.

Unquestionably, the magnitude of losses is also influenced by the character of the phenomenon.

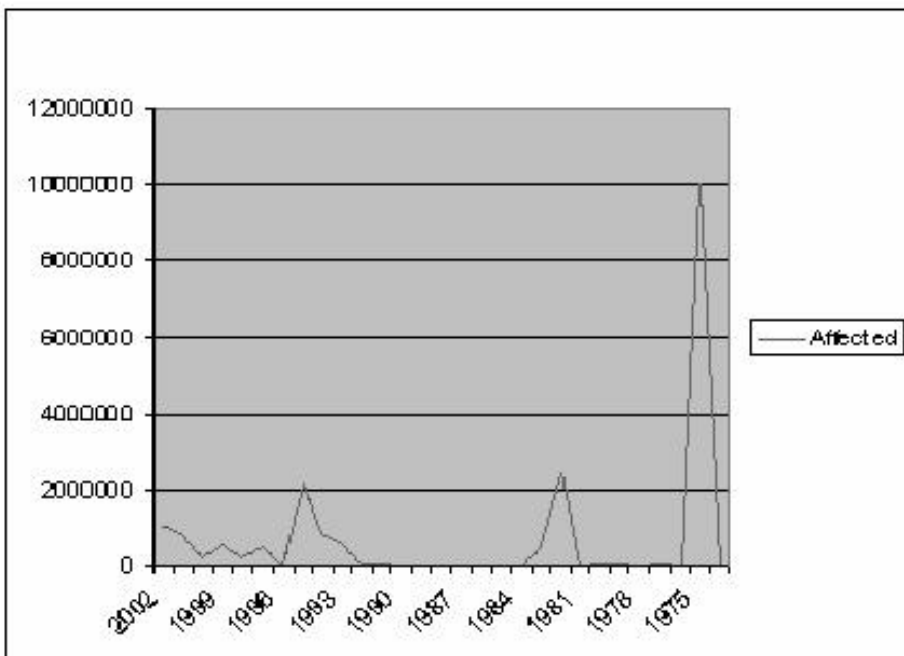
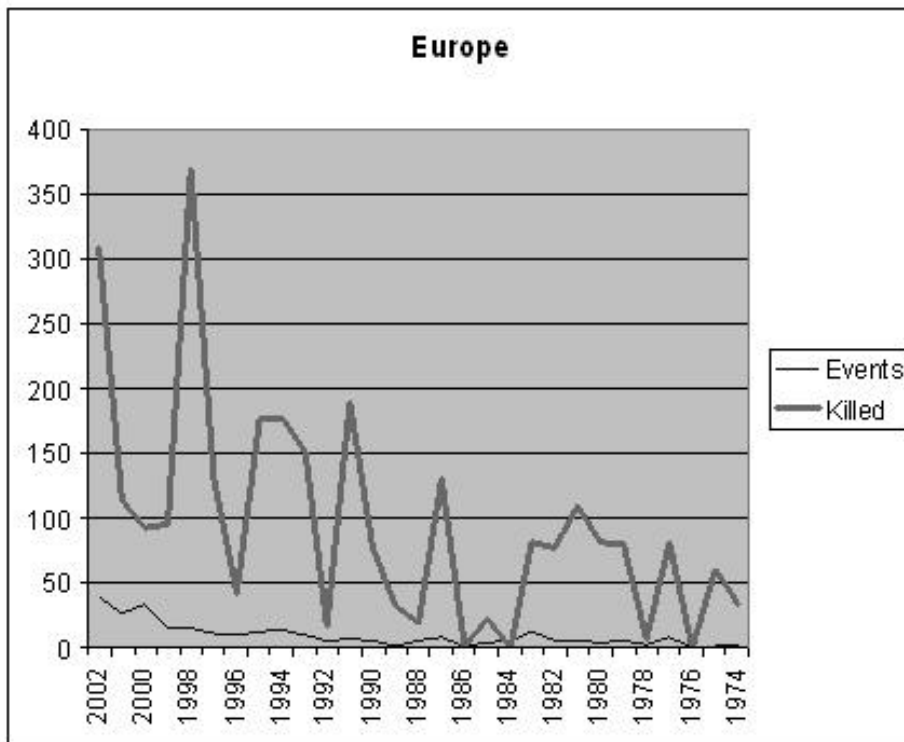


Fig.2. Total number of flood disaster (events, killed, affected).

In the above-mentioned period of 1973-1982 – 31 flood events were recorded, and in 1992-2002 – 179 events.

Source: Philippe Hoyois, Debaaratii Guka – Sapr [2002].

In 1997-2002 a flood with great magnitude was recorded; during this flood, absolute water levels (flows) were exceeded.

To illustrate that, during summer flood in 1997 in the Oder river basin, absolute water levels were exceeded on 27 among 32 water-level gauges.

Table 1. Exceeding of absolute water levels during the flood in 1997

WATER-LEVEL GAUGE	WATER LEVEL IN 1997 [cm]	CURRENT ABSOLUTE WATER LEVEL [cm]
Oder	317	373
Svinov	433	820
Bohumín	556	660
Chalupki	675	705
Krzyżanowice	844	912
Miedonia	838	1045
Kozle	818	947
Krapkowice	811	1032
Opole	604	777
Nysa estuary	709	768
Brzeg Most	658	730
Olawa	722	766
Trestno	666	724
Redzin	746	1030
Brzeg Dolny	946	970
Malczyce	772	792
Scinawa	657	732
Głogów	673	712
Nowa Sól	659	681
Cigacice	649	682
Nietków	700	667
Polecko	556	595
Eisenhüttestadt	655	717
Frankfurt	635	657
Ślubice	634	637
Gozdowice	649	659
Hohensaaten – Finow	778	729
Bellinchen (Bielinek)	765	712
Schwedt (Oderbrücke)	883	886
Widuchowa	783	760
Greifenhagen/Ostoder (Gryfino)	737	649

Source: IMGW Poland

At the same time, losses in the Vistula river basin during the flood came close to absolute water levels exceeding them at a few points.

In 2002, during the flood occurring in a vast area of Central Europe, absolute water levels were exceeded on the Elbe, Havela and Danube rivers.

The table below presents the situation on the Elbe.

Table 2. Exceeding of absolute water levels on the Elbe river during the summer flood in 2002.

WATER-LEVEL GAUGE	WATER LEVEL IN 2002 FLOOD	ABSOLUTE WATER LEVEL
Dresden	940 cm (17.08.02, 07:00 Uhr)	877 cm (31.03.1845)
Riesa	945 cm (17.08.02, 19:00 Uhr)	755 cm (31.03.1988)
Mühlberg	1.011 cm (17.08.02, 21:00 Uhr)	1.008 cm (1890)
Torgau	845 cm (18.08.02, 02:00 Uhr)	943 cm (06.02.1850)
Wittenberg	708 cm (18.08.02, 15:00 Uhr)	628 cm (03.02.1862)
Aken	765 cm (19.08.02, 04:00 Uhr)	740 cm (03.04.1845)
Barby	700 cm (19.08.02, 11:00 Uhr)	733 cm (03.04.1845)
Magdeburg	670 cm (19.08.02, 22:00 Uhr)	701 cm (18.02.1941)
Tangermünde	767 cm (20.08.02, 22:00 Uhr)	736 cm (20.01.1920)
Wittenberge	734 cm (20.08.02, 21:15 Uhr)	744 cm (14.03.1838)

Source: Das Elbehochwasser in Sommer 2002 – Bericht des LUA Brandenburg – 2002.

In the period of 1900-2002 the largest number of victims in one event occurred in Holland during the flood in which 2000 people died, the next one appeared in Spain in 1973 where 500 people were killed, and in 1962 – 455 people, then in Portugal – 462 people in 1967, and in Italy – 322 people in 1954. In respect to the number of people affected by the flood during one event, the numbers are as follows: 1.700.000 people in Ukraine in 1995, 1.301.650 people in 1954 in Italy, in Spain – 506.000 people (1983), in Germany 330.108 people (2002), in Holland 300.000 (1953), and in Poland 224.500 (1997).

The spatial distribution of the flood occurrence in Europe is fully differentiated. The flood occurrence in 1975-2002 is presented on the map.

The spatial distribution of the flood occurrence is presented on the map below.

The above-mentioned data, handled on the basis of accessible EM DAT data, should be perceived with some approximation because of the differentiation, particularly in the early stage of data gathering, of phenomena evaluation criteria and data adaptation process.

The EM DAT data show that among countries in Europe, which are the least frequently hit by floods, there are countries of the Baltic Sea basin, mainly Scandinavian countries and former soviet republics.

On the other hand, France, Spain and Turkey are the countries in Europe, where flood events occur most often.

EUROPE			
Years	Events	Killed	AFFECTED
2002	39	309	1,024,242
2001	26	113	747,540
2000	34	92	187,565
1999	15	95	556,032
1998	16	369	159,877
1997	11	130	474,771
1996	10	42	11,830
1995	13	177	2,131,091
1994	14	177	840,178
1993	10	150	579,453
1992	6	17	41,000
1991	7	189	55,016
1990	5	77	4,500
1989	2	32	-
1988	5	19	5,291
1987	9	130	18,000
1986	2	2	1,000
1985	4	23	10,000
1984	5	-	2,200
1983	12	82	514,324
1982	6	77	244,010
1981	5	110	2,900
1980	4	81	64,813
1979	5	80	57,270
1978	3	7	1,000
1977	8	82	28,600
1976	-	-	-
1975	1	60	1,000,000

Fig. 4. Losses caused by floods in Europe in 1975-2002. Source: EM DAT

The following years are considered as the worst with relation to the flood occurrence in the last thirty years:

- 1997 – a great flood in the Oder river basin, which involved the territories of the Czech Republic, Poland and Germany. The flood on the Oder was the largest among the

previously recorded ones. The losses were estimated at 6.5 milliard USD, and the number of killed was 105.

- 2002 – when the flood appeared in the Elbe, Danube, Vitava, Inn and Sazach river basins, and inundated the territories of Germany, Austria, the Czech Republic, Hungary and Slovakia, at the same time tragic floods occurred on the Black Sea coast, and in the end of August 2002 in Europe, rapid rainfall with high intensity occurred, e.g. 650 mm in 24 hours in Anduza in the southern part of Rhône Valley, also in November there was a flood caused by rainfall in the northern part of Italy. The flood on the Elbe was the largest among the previously recorded ones. It inflicted losses in Austria of 2-3 milliard EURO, in the Czech Republic of 2-3 milliard EURO, and in Germany the losses reached 9.2 milliard EURO.

The analysis of data from the last 30 years shows the increase in the frequency of flood occurrence in Europe. In the last decade floods were exceptionally numerous.

These are main causes of floods in Europe:

- long-lasting rainfall with high intensity
- snowmelt connected with intensive rainfall and rapid temperature rise
- embacle
- marine storms.

As regards occurring in the recent years flood events, rainfall with very high intensity and long duration was their dominant cause, e.g. during the flood on the Oder in 1997, rainfall amounts exceeding 500 mm in 24 hours were recorded.

In 2002 in the Elbe river basin, rainfalls higher than 300 mm in 24 hours and higher than 400 mm in 72 hours were recorded. It is worth mentioning that successive rainfall waves occurred during the flood, which to a great extent hindered the execution of flood defence operation, and above all constituted a threat to flood defence earthen structures.

A significant increase in relation of maximum 24 hours precipitation amount to mean annual precipitation height has been observed. On the Mediterranean coast of Spain, in periods 1940/41 and 1995/96 the above-mentioned relation grew by almost 100%, and for the rest of Spain except the north of the country – by about 30%. The relation in question increased similarly for the Mediterranean coast of France, the territories of Italy and Greece. In Germany, the eastern part of the country also shows nearly 30% increase in the aforesaid relation (Sustainable Water Use in Europe 2001).

A similar situation can be observed in the western part of Poland and the Czech Republic. The causes related to adverse activity of man, include above all river engineering, affecting the increase in river drops due to the shortening of course of the river, the cut-off by means of river embankments from natural flood areas, and the decrease in high water channel. This can be exemplified by a situation in Dresden, where flood peak water levels have been measured since the 13th century ranging 8.2-8.9 cm. In 2002 the flood peak water level reached 9.4 cm with flow 4680 m³/s, on the other hand, in 1845 with water level 8.8 cm the measured flow achieved 5700m³/s [A. Becher, U. Grünwald 2003].

The above-mentioned data clearly show adverse changes in transverse shape of the channel and river valleys, which is a typical phenomenon for the rivers in Europe.

Moreover, adverse changes caused by the river basin development decisively affect river regime, especially accelerate the time of flood wave concentration.

It is very important to determine areas particularly often hit by floods; attempts to observe this problem are presented below.

Major flood occurrence areas in Europe include areas placed along the European coast of the Mediterranean Sea, the coast from the Dutch border to the Danish border, the Portuguese coast, Alpine valleys of France and Italy where small streams inflict considerable losses in the Po, Sarno and Quindici river basins in Italy, the Seine and Lorie in France, and the Rhine where floods have been occurring very frequently recently.

Hungarian river, the Tisza, poses a serious threat during floods, where because of the basin shape, even slight increases in river water levels result in great floods and losses.

Among rivers flowing through Poland, the Vistula and Oder rivers are particularly threatening, despite relatively different development of the rivers and their tributaries. In the 50s, 60s and 70s, winter floods were dominant, produced by increase in flows resulting from snowmelt, often together with great precipitation, or by embacle.

In the last 20 years floods on European rivers have been dominated by summer events caused by precipitation.

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