

Three decades of floods in Europe : a preliminary analysis of EMDAT data.

{ DRAFT }

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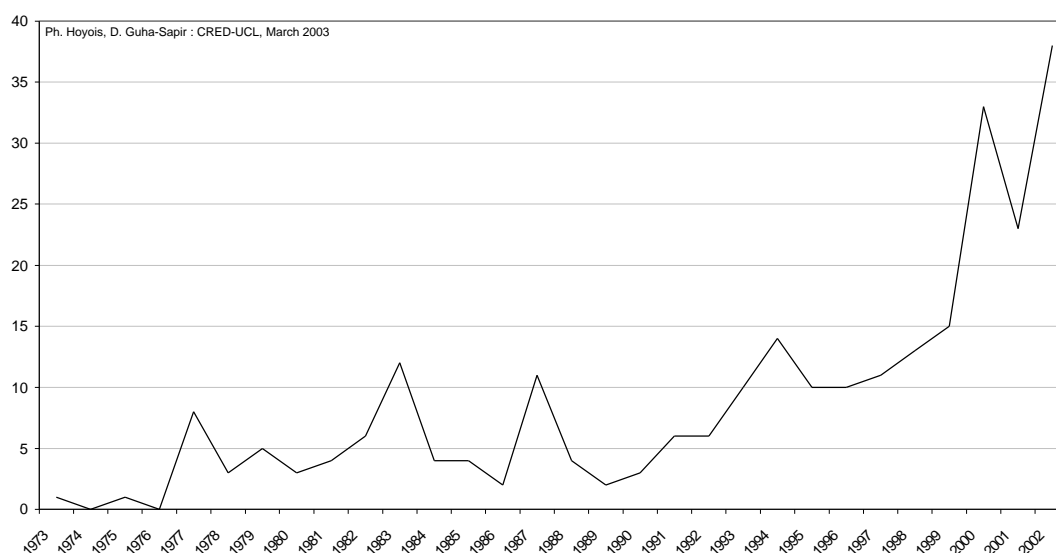
Introduction

In 2002, 20 European countries experienced at least one disastrous flood. In June, in the Caucasian regions of Russia, more than 300,000 people were affected. August was particularly dramatic with 13 countries hit, very large floods in Austria, Czech Republic and Germany and extremely localised and destructive flash floods in the South of France. This unusual situation calls for looking back and examining available data for the three last decades, which are more accurately documented.

1. Total number of flood disasters.

- During the last three decades (1973 – 2002), the reported number of disasters¹ caused by floods has dramatically increased in the UN European Macro-Region², from 31 in the priod 1973 - 1982 to 179 during the last decade (figure 1). **Floods caused a total of 264 disasters during the whole period.**

Figure 1 : Total number of flood disasters reported : UN European Macro-Region : 1973 - 2002



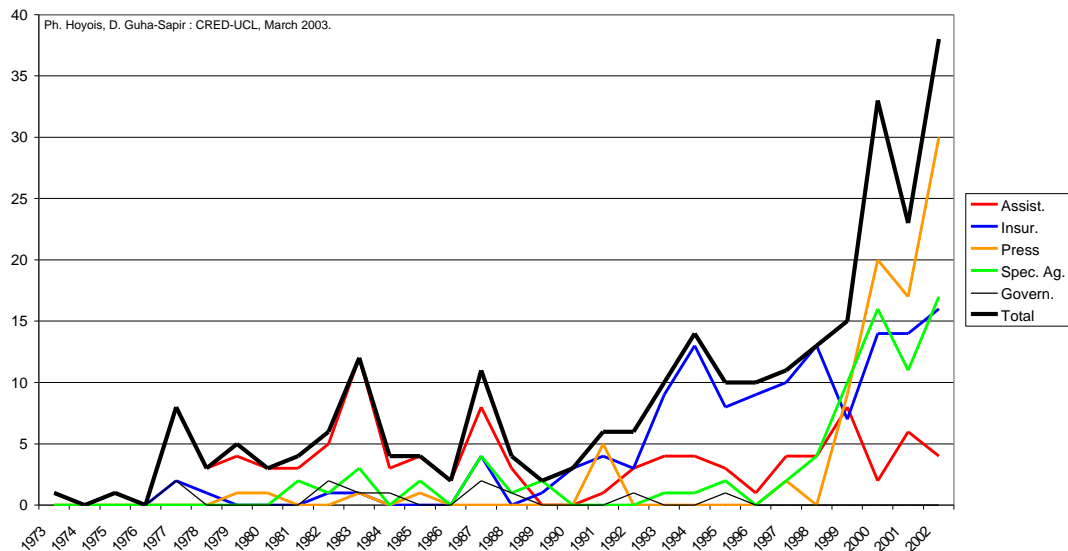
- Changes occurred in the contribution of sources of information used by EMDAT (figure 2).

¹ The EMDAT criteria for a disaster are : at least 10 deaths (persons confirmed as dead and persons missing and presumed dead) or 100 affected (people that have been injured, left homeless or requiring immediate assistance during a period of emergency, i.e. requiring basic survival needs such as food, water, shelter, sanitation and immediate medical assistance after a disaster) or request for national or international assistance.

² The United Nations Macro-Region for Europe is subdivided into four European Region :
Eastern Europe : Belarus, Bulgaria, Czech Republic, Hungary, Poland, Moldova, Romania, Russian Federation, Slovakia and Ukraine;
Northern Europe : Channel Islands, Denmark, Estonia, Faroe Islands, Finland, Iceland, Ireland, Isle of Man, Latvia, Lithuania, Norway, Sweden, United Kingdom;
Southern Europe : Albania, Andorra, Bosnia-Herzegovina, Croatia, Gibraltar, Greece, Holy See, Italy, Malta, Portugal, San Marino, Slovenia, Spain, FYR Macedonia, Yugoslavia;
Western Europe : Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland.

- During the years 1973 – 1992, disasters reported by official humanitarian agencies explain significantly the variability over time of the total number of recorded floods.
- Governments stopped providing information in the nineties.
- During the period 1989 – 1998, data from insurance and reinsurance companies reflect strongly a curve's inflection.

**Figure 2 : Number of flood disaster reported : Significantly contributive sources of information.
UN European Macro-Region : 1973 - 2002.**



- In the last 4 years, data from specialized and press agencies have greatly contributed to the increase of disastrous floods reported.
- According to their respective contribution to the global flood data, a multilinear regression model including number of disasters reported by specialized agencies, insurance companies and governments explains 92.5 %³ of the variability of the curve through the last 30 years. Models including time have been tested but this variable remained non significant.
- This reflects the fact that, next to possible effects of climate changes and undoubted alterations in land uses, new actors appeared or gained influence with higher sensitivity to smaller disasters as possible outcome, which could be confirmed when considering the number of people affected by each flood over time⁴.
- However, this has to be considered cautiously : because of non standardization of reporting, the proportion of disasters for which numbers of affected people are reported is around 50 % for the years 1973 – 1992 and improves to 85 % in the last decade.

2. Number of flood disasters by UN European Region

- Although there are differences between regions in the distribution of disasters reported over time, these differences aren't significant.

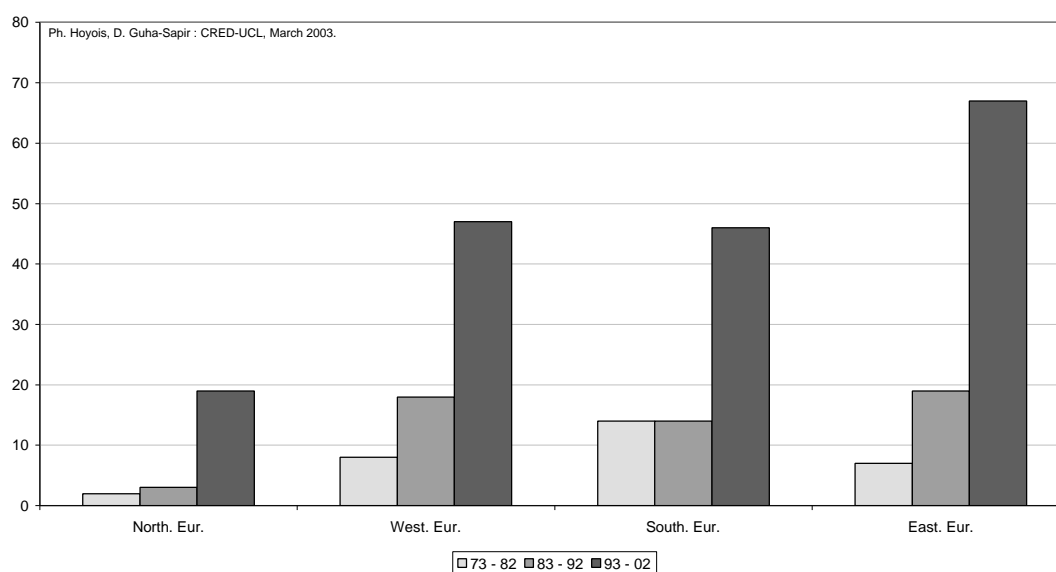
³ Adjusted R².

⁴ The proportion of floods with more than 10,000 people reported affected remains constant at 42 % during the first two decades and decreases to 29 % for the period 1993 – 2002. However the adjusted K_{hi}² (2.19) is non significant (p = 0.1384).

2.1. Northern Europe

- ***Twenty four catastrophic floods had been reported in the region during the last 3 decades.***
- Floods in the United Kingdom account for 62.5 % of the total number of disastrous floods. All except one were reported during the last decade.
- In Iceland, one flood was reported for 1988. In Sweden two floods were reported in 1977 and 1985, none during the last decade. In Ireland, floods were rare. In Norway, two disastrous floods were reported in the last decade.
- No flood was reported for Denmark, Latvia, Lithuania, Estonia and Finland. Eastern Baltic Sea countries were unhurt by floods. However in Finland, regular flooding had limited impact because of the low population density and the implemented measures of monitoring and control. Disastrous floods were reported for the Kaliningrad and the St Petersburg regions.

**Figure 3 : Total number of flood disaster reported : by UN European Region.
1973 - 1982, 1983 - 1992, 1993 - 2002.**



2.2 Western Europe

- ***The region has known 73 disastrous floods during the years 1973 – 2002.***
- The most frequently affected country is France, which accounts for almost 50 % of disastrous floods reported. Half of these floods occurred in the last 4 years
- Belgium and Germany had known 10 flood each. In Belgium, 4 occurred in 2002. In Germany they were more frequent in the beginning of the last decade.
- For Switzerland 8 floods were reported, 3 occurred in the last 3 years.
- In the Netherlands, 3 floods were reported for years 1993, 1995 and 1998.
- For Austria, floods were regularly reported but, since the period 1980- 1985, their frequency of occurrence diminished.

2.3. Southern Europe

- ***Seventy-four floods had been reported for the Southern Region during the last 3 decades.***
- Italy is the country the most frequently hit with more than one quarter of the reported disasters. Nine of the 13 floods of the 1993 – 2002 decade occurred in the last 3 years.
- In Spain, the floods are distributed in a somewhat regular way over the three decades.
- In Portugal, 3 periods can be distinguished : 1979 – 1983 (4 floods), 1996 – 1997 (2 floods) and 2001 – 2002 (2 floods).
- Nine of the 16 floods, which occurred in the former Yugoslavia and the new republics, have been reported during the last 4 years.

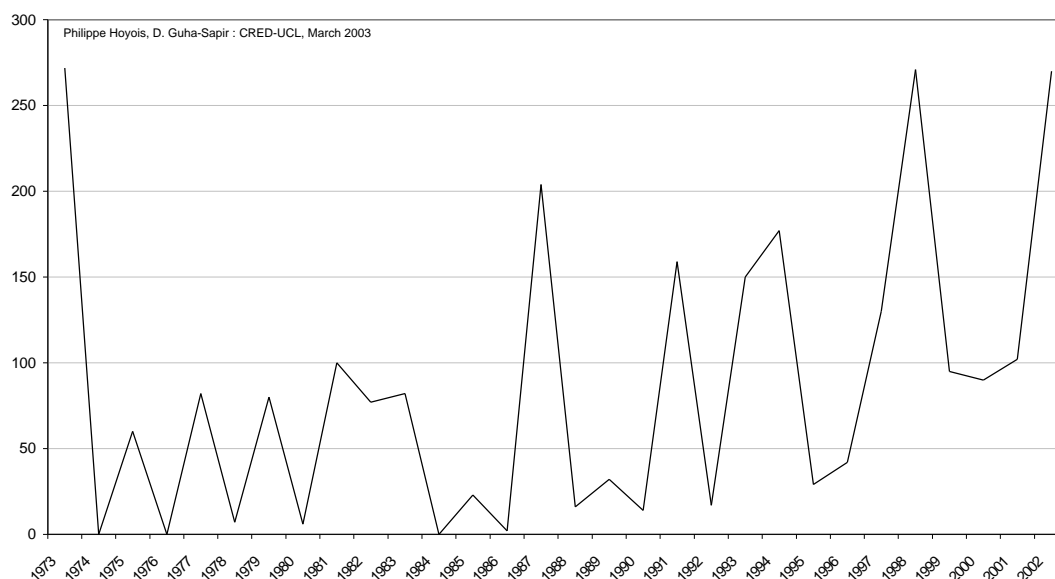
2.4. Eastern Europe

- ***For the 3 decades considered, 93 flood disasters were reported.***
- Considering floods in ex-Soviet Union and its former republics in the last 3 decades, they account for respectively 43, 79 and 57 per cent of the total number of floods reported per decade for Eastern Europe.
- Russia reports the greatest number of disastrous floods from which 52 % occurred in Siberia. Through the years, floods are regularly reported for Russia but a clear peak occurred in year 2000 and years 2001 and 2002 are among bad years for floods.
- After Russia, Romania is the second in rank for the number of disastrous floods, far before the other Eastern Europe countries. Fifteen floods are reported for the 3 decades but 13 occurred since 1996 and their number increased over the years. The highest annual number of flood (3) was reported in 2002.
- In Belarus (3), Moldova (4) and Ukraine (5), 12 disastrous floods regularly occurred in the years 1993 – 2002 but without increase at the end of the decade.
- Considering Czechoslovakia and the countries born from its partition, only one flood was reported before 1993 and 5 after; 3 in 1997, 1998 and 1999 and 2, one for each country, in 2002.
- Hungary reports disastrous floods only for the last decade. The first was noted in 1996 but since 1999, the country knows floods each year.
- In Poland, flood's occurrence is distributed over time but their frequency seems increasing in the last decade.

3. Total number of people killed by floods

- Precautions have to be taken : as reporting is not standardized, it is impossible for some floods to know exactly their figure for deaths : either nobody was killed or data on deaths are missing.
- Deaths have been reported for half of the floods.
- ***2,626 people have been reported killed by disastrous floods for the whole period. This number is respectively of 684, 559 and 1,383 for the 3 successive decades.***
- The total number of deaths increases progressively over time (figure 3).
- The slowly increasing total number of people killed by floods is associated with the increasing number of flood disasters (linear regression : R^2 adjusted = 0.22, $F = 9.028$, $p = 0.006$, including Spain, 1973, as outlier; R^2 adjusted = 0.37, $F = 17.346$, $p = 0.000$ when Spain, 1973, is removed).
- The most deadly floods occurred in Spain in October 1973 : flash floods killed 272 people in the Granada-Almeria-Murcia region.
- In 54 % of the floods with deaths reported, 1 to 10 people were killed; 11 to 20 in 21 %; 21 to 50 in 21 %. More than 100 people died in 3 %.

Figure 4 : Total number of deaths reported : UN European Macro-Region, 1973 - 2002



- During the first two decades, 62 % of the disastrous floods with data on deaths reported more than 10 people killed. This proportion decreases significantly to 38 % in the last decade (K χ^2 with Yates correction = 6.37; p = 0.012). This may reflect a trend to less dead by flood and/or a trend to report, more frequently, less severe floods.

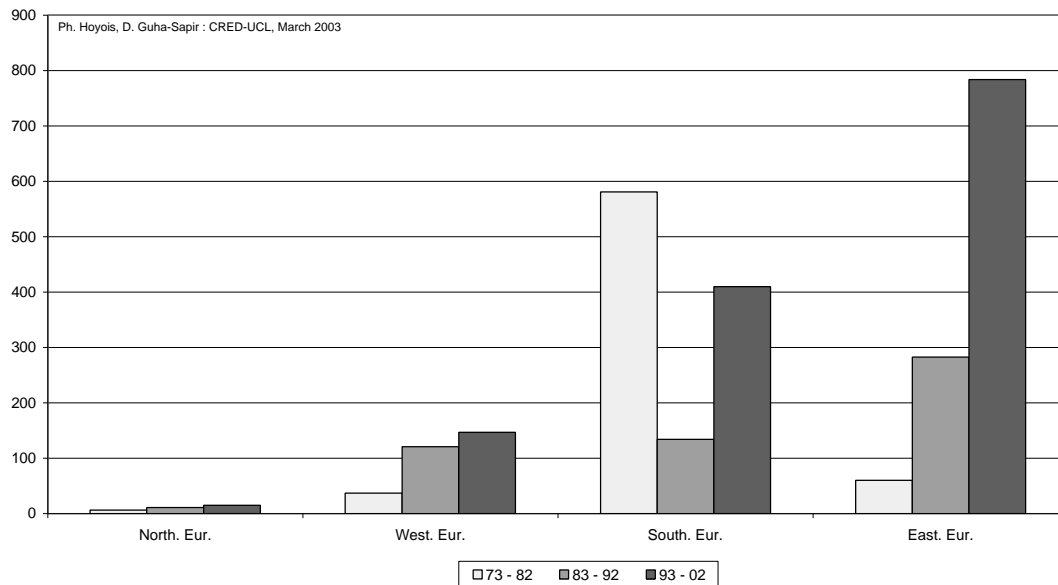
4. Total number of people killed by floods by UN European Region

- As already noted, precautions have to be taken because of weaknesses in deaths reporting. The proportion of floods with reported deaths varies between regions from 33 % for Northern Region to 62 % for the Southern region.
- There is a decrease over the decades in floods with reported deaths for Northern, Western and Southern regions. Inversely, the proportions increase over time for the Eastern Region.

4.1. Northern Europe

- Over the three decades, *deaths are reported for only one third of disastrous floods and amount to 32.*
- In only case the number of dead is over 10 : floods caused by torrential rains killed 11 persons in Sweden in September 1985.
- In all other cases, the number of dead is never over 5.

Figure 5 : Total number of deaths reported : UN European Regions
1973 - 1982, 1983 - 1992, 1993 - 2002



4.2. Western Europe

- *Deaths are reported for 48 per cent of the total of disastrous floods and amount to 315.*
- The total number of deaths is multiplied by more than 3 in the second decade compared to the first. But this increase is sharply reduced during the third decade.
- France accounts for the greatest number of deaths for each decade and for 68 % of the total of reported deaths. Number of deaths over 10 is reported for 41 % of the total number of disastrous flood with reported deaths. The total number of deaths was multiplied by almost three between the first and the second decade to remain stable during the third one.
- Germany is far behind France and accounts for 16.4 % of the total reported deaths. In most of the cases, the number of deaths is low, mostly 5 or lower. However the floods of 2002 is an exception with 27 deaths reported.

- Except Germany and France, the only flood with more than 10 deaths reported occurred in Austria in 1985. Two floods killed 6 and 7 persons, in Belgium and Austria respectively. The other ones killed 5 persons or less.
- For Netherlands and Luxembourg, no deaths were reported.

4.3. Southern Europe

- ***Deaths are reported for 62 per cent of the total of disastrous floods and amount to 1125.***
- The proportion of floods with reported deaths decreases from 100 % in the first decade to 50 % in the third decade.
- Disastrous floods with more than 10 death accounts for 57 % for the 3 decades. This proportion decreases from 79 % during the first decade to 44 % in the third one.
- Twenty-six floods (56 % of the floods with reported deaths) account for 93 % of the total number of reported deaths.
- Two particularly deadly floods were reported : in Spain in 1973 (272 deaths) and in Italy in 1998 (147 deaths).
- When these exceptionally deadly floods are removed from the data, Italy and Spain present similar figures with respectively 211 and 198 deaths. However severe floods, with high number of deaths, appear to have been more frequent in Spain during the first two decades. The contrary happened in Italy where the number of deadly floods increased significantly in the last decade.
- In Spain and Portugal the proportion of floods with reported deaths is respectively of 92 and 100 %. These disastrous floods are regularly reported in Spain. In Portugal they are concentrated on three periods : 1979 – 1983, 1996 – 1997 and 2001- 2002. For both countries, the number of deaths decreases over time.
- In Greece, severe floods with more than 10 deaths are reported for 1977, 1980, 1994 and 2001. However, in the last decades, floods seems to have been less deadly than in the first decade.
- In Albania, a flood causing 11 deaths occurred in 1992. Since this date, only 4 deaths have been reported.
- In former Yugoslavia, two severe floods, with 22 and 71 deaths, occurred in 1979 and 1981. Disastrous floods were again reported in 1986 and 1990 but without reported deaths. In the new states, resulting from the partition of Yugoslavia, 11 dead people were reported for a flood in Serbia-Montenegro in 1999. For the 8 other disastrous floods which occurred in the region in the last decade, no deaths were reported.

4.4. Eastern Europe

- ***Deaths are reported for 48 per cent of the total of disastrous floods and amount to 1144.***
- The proportion of floods with reported death increases significantly from 23 % in the first two decades to 58 % in the third decade (χ^2 with Yates correction = 7.90; $p = 0.005$). This could reflect the reluctance of former authorities to spread information about disasters occurring in their countries. Another hypothesis could be a deterioration of the capacity of the states to maintain appropriate facilities for disaster preparation, prevention and reduction, in connection with their economic changes and problems.
- During the first two decades, all 6 floods with reported deaths were severe : in former Soviet Union, 4 floods made respectively 100 (1987), 41 (1991), 20 (1989) and 14 (1990) deaths; in Romania, 2 floods killed 108 (1991) and 60 (1975) persons.
- During the last decade, 51 % of the floods reporting deaths killed more than 10 persons.
- For this period, the most deadly floods occurred in Russia with 125 deaths in 1993 and 82 and 91 deaths in 2002. Poland (55 deaths in 1997), Slovakia (54 deaths in 1998) and Moldova (47 deaths in 1994) suffered also from lethal floods. The 13 remaining severe floods, with number of deaths between 10 to 30 occurred in Russia (1993, 1994, 1998 and twice in 2001), Romania (1997, 1998, twice in 1999, 2000, 2002), Czech Republic (1997 and 2002), Poland (2001) and Ukraine (1998).
- Romania knows severe floods, with more than ten deaths, virtually each year since 1997.
- In the 6 last years, all reported disastrous floods in Czech Republic and almost all in Poland made around 20 deaths or more.
- In Slovakia, Moldova and Ukraine, at least a third of reported disastrous floods made more than 10 deaths.

5. Total number of people affected by floods

- For the 3 decades, the number of people affected is reported for 74 % of the floods. However, this percentage changed over time from 50.6 % in the two first decades to 84 % in the last one (Khi^2 with Yates correction = 32.33, $p = 0.00000$).
- When considering the each UN European Region, the percentage of affected people reported for the period under review is between 66 % for Northern and Western Regions, to 73 % for the Southern Region and 82 % for the Eastern Region.
- **8,904,942 persons were reported affected by disastrous floods for the whole period. The numbers are respectively of 1,338,593; 876,115 and 6,690,234 for the 3 successive decades.**
- There is a regular, slow increase of the total number of people reported affected by floods (figures 6 and 7).

Figure 6 : Total number of people reported affected : UN European Macro-Region : 1973 - 2002

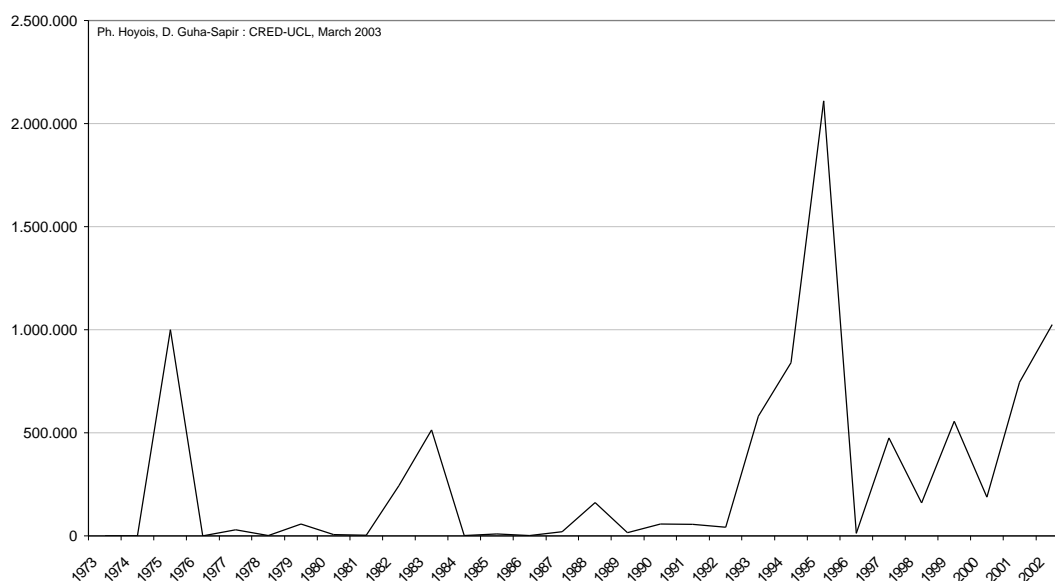
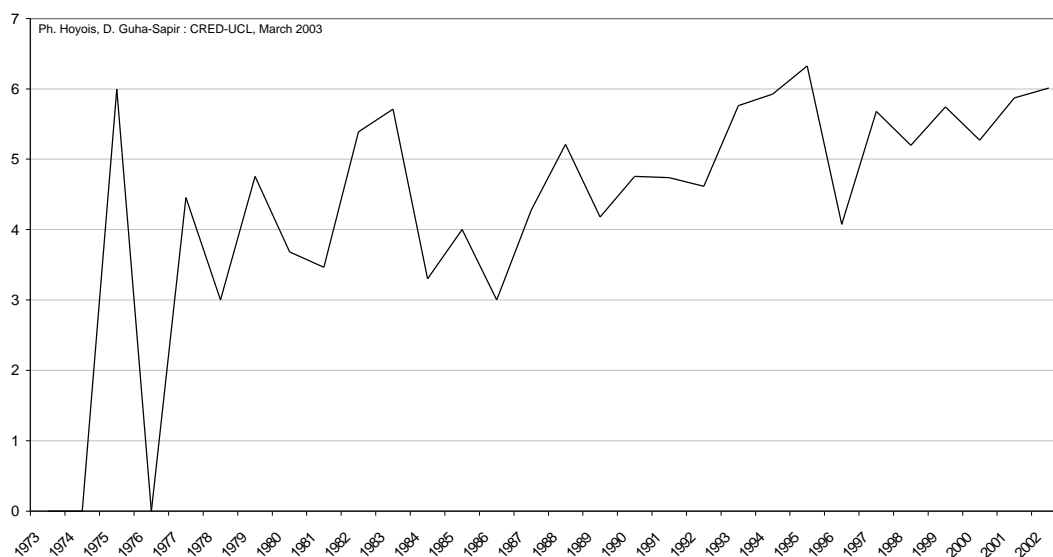


Figure 7 : Total number (log10) of people reported affected : UN European Macro-Region, 1973 - 2002



- When all floods are considered, there is a weak relationship between the increasing number of flood disasters and the increasing number of affected people (linear regression : R^2 adjusted = 0.098, $F = 3.831$, $p = 0.062$) which improves when using logs of affected people (linear regression

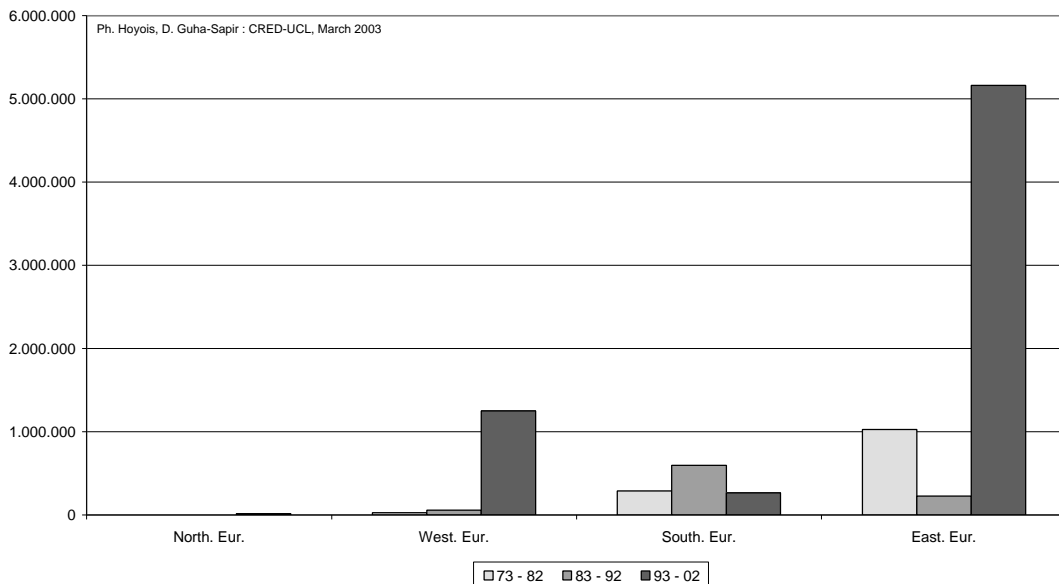
: R^2 adjusted = 0.235, $F = 8.988$, $p = 0.006$). When the two greatest floods, with 1 million or more affected people, are removed the association between the number of floods and the number of affected people improves significantly (linear regressions : R^2 adjusted = 0.462, $F = 22.460$, $p = 0.000$ for raw numbers and R^2 adjusted = 0.344, $F = 14.100$, $p = 0.001$ for logs).

- Two floods affected 1 million people or more : one in the South and North East of Romania in July 1975 (1,000,000 affected) and one in Ukraine in June 1995, where floods incapacitated and partially destroyed the sewage plant of the town of Kharkov, resulting in severe contamination of the water supplies (1,700,000 affected).
- In 32 % of the floods reporting data on affected, 100 to 999 people were affected; 1,000 to 9,999 in 34 %, 10,000 to 99,999 in 23 % and 100,000 or more in 11 %.
- During the first two decades, 56 % of the disastrous floods, with data on affected people, reported less than 10,000 affected. This proportion increased to 70 % in the last decade but the difference is not significant.
- However during the last decade, the proportion of floods with more than 100,000 people affected is of 15.8 % for 11.6 for the two previous decades. In figures, this means 2 floods with more than 100,000 affected for each of the first two decade and 17 in the last one.
- A two-faced trend could appear : increase in floods with relatively low number of affected (less than 10,000) and, concurrently, increase in floods reporting high numbers of affected (100,000 or more).
- To have a better estimation of the human consequences of disastrous floods to hit countries, the number of affected people should be related to their total population.

6. Total number of people affected by floods by UN European Region

- As already noted, precautions have to be taken because of lack of information for some floods. The proportion of floods reporting data on affected people varies between regions from two third for Northern and Western Regions to three quarter for Southern Region and four fifth for Eastern Region.
- In all four Regions, the proportion of floods with reported data on affected increases over time.

Figure 8 : Total number of people reported affected by UN European Regions
1973- 1982, 1983 - 1992, 1993 - 2002



6.1. Northern Europe.

- *People affected are reported for two thirds of the disastrous floods and amount to 13,750.*
- Except for one flood in Iceland in 1988 (with 280 people affected), all floods reporting data on affected people occurred in the last decade.

- In this decade, there were less than 1,000 affected people in 80 % of the floods with information on affected.
- One flood with 3,500 affected is reported for Ireland and two, with 1,500 and 4,000 affected, are reported for Norway.
- In the United Kingdom, data on affected people were reported for two third of the floods. In all cases, there were less than 1,000 people affected. The figures vary between 150 to 700.

6.2. Western Europe

- ***People affected are reported for two thirds of the disastrous floods and amount to 1,334,681.***
- The quality of information increases significantly through the decades, with 35 % of the floods with data on affected people in the first two decades to 83 % in the last decade.
- The proportion of floods with less than 10,000 people affected remains stable over time at around 75 % of the total of floods.
- In Belgium and Switzerland, there were less than 5,000 persons affected for all floods reporting data and figures below 1,000 are the most frequent. However, in Switzerland data are available for only one third of the floods.
- In France, 64 % of the floods with information report less than 1,000 people affected; 21 % between 1,000 and 10,000 affected. Bigger floods have been reported in 1977 (25,000 affected), 1988 (more than 50,000 affected) and especially in 1995 (120,000 affected) and 1999 (200,000 affected).
- In Germany, 71 % of the floods with information report more than 10,000 people affected. Very large floods, with more than 100,000 affected, accounted for two third of these floods. These floods are reported for 1993 and 1999 (around 100,000 affected) and 2002 (more than 300,000 affected).
- In the Netherlands, data are available for all the disastrous floods. The figures are 2,000 (1998), 12,000 (1993) and 250,000 (1995).
- For Austria, data are available only for the flood of August 2002 (60,000 affected).

6.3. Southern Europe

- ***People affected are reported for 73 % of the disastrous floods and amount to 1,144,734.***
- For Southern Europe, information on people affected by floods were better in the first two decades than in the other European Region, with data for 57 % and 71 % of floods respectively. In the last decade, the figure slightly improved to 78 %.
- For the entire region, the proportion of floods reporting less than 10,000 affected increased from 56 % in the first two decades to 86 % in the last one. Two very large floods, with more than 100,000 affected have been reported, in Spain, in 1982 (225,000 affected) and 1983 (500,000 affected) but none in the last decade.
- Over the last thirty years, Spain was the most severely hit when considering the total number of people affected by floods. However, this is attributable to the two floods quoted above. During the last decade, one flood is reported with 4,000 affected and three with 500 affected or less.
- A similar trend seems to appear for Portugal. Although very large floods have not been reported, there is a decrease in the number of people reported to be affected by floods over decades, with figures around 20,000 in the first decade (1979) to less than 1,000 most frequent in the last decade.
- For Italy, data are lacking for half of the floods with a slight improvement in the last decade. In 70 % of the floods with data on affected people, their figure is under 5,000. However, in the last decades more severe floods were reported for years 1994 (17,300 affected), 2000 (43,000 affected) and 2002 (more than 10,000 affected).
- For Greece, data are available for two third of the floods. In 75 % less than 1,000 affected were reported. One flood with 1,600 affected was reported in 1977, another with 6,000 affected in 2000.
- For the former Yugoslavia and its new states, data are available for 87 % of the floods. In 77 % less than 10,000 affected were reported of which 80 % with less than 5,000 affected. However, only one flood affected less than 1,000 persons. Greater floods have been reported for Serbia in 1999 (more than 70,000 affected), Yugoslavia/Serbia in 1979 (12,000 affected) and Yugoslavia/Slovenia/Croatia in 1990 (25,000 affected). Floods occur more often and tend to affect more people in Serbia.
- By comparison to the neighbouring countries, Albania seems more often affected by floods. Although 3 floods report between 1,500 and 8,000 affected, greater floods occurred in 1992 (35,000 affected) and in 2002 (more than 66,000 affected).

6.4. Eastern Europe

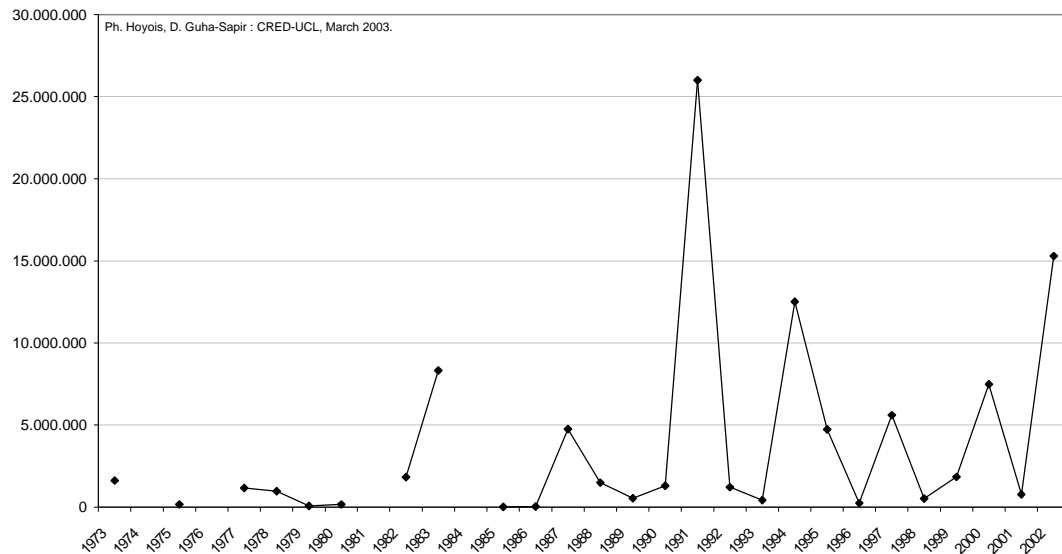
- ***People affected are reported for 82 % of the disastrous floods and amount to 6,411,957.***
- The proportion of floods with less than 10,000 affected people increase from 40 % in the first two decade to 49 % in the last one. For the three decades, the proportion is of 47 %, far below the 100 % of Northern Europe and the 76 % of Western and Southern Europe.
- Concurrently, the proportion of very large floods, with more than 100,000 affected, grows from 13 % in the first two decades to 18 % in the last one. For the three decades, the proportion is of 17 %, far over the 4 % of Southern Europe and the 12 % of Western Europe.
- For former Soviet Union data on people affected are available for half of the disastrous floods reported. In two third of these floods more than 10,000 affected were reported. One very large flood, with around 100,000 affected, occurred in 1988.
- For Ukraine data on affected are reported for all floods. In the last ten years, this country was the most severely hit with one flood with around 25,000 affected (1998) and four floods with more than 100,000 affected : 1993 (August : 300,000 affected; December : 108,000 affected), 1995 (1,700,000 affected) and 2001 (300,000 affected).
- For Russia, data are available for 88 % of the disastrous floods. Affected people are in the range 1,000-10,000 in 54 % of the cases. However very large floods (12.5 %) were reported in 1994 (more than 775,000 affected), 2001 (300,000 affected) and 2002 (more than 320,000 affected).
- During the last decades two other new independent states, Moldova and Belarus, suffered from relatively small floods (2,000 affected and below) but also of greater ones (with 25,000 and 42,000 affected respectively).
- For Romania, data on affected are available for all disastrous floods. Since the very large flood of 1975, with around 1 million affected, most of the floods (64 %) affected 5,000 people or less. However two large floods had been reported in 1997 (more than 120,000 affected) and 2000 (60,000 affected).
- In Czech Republic, only two very large floods are reported : in 1997 (more than 100,000 affected) and in 2002 (200,000 affected).
- In Slovakia, data are reported for two out of three disastrous floods. More than 10,000 and 36,000 people were affected respectively.
- In Hungary, data are available for 85 % of the floods. 50 % affected less than 5,000 people but three floods affected 10,000; 42,800 and 90,700 people respectively.
- For Poland, data are available for 85 % of the floods. 50 % of them affected between 1,000 to 4,500 people; 33 % around 15,000 but one flood, in 1997, affected more than 220,000 people.
- For Bulgaria, two disastrous floods were reported. One of them affected 200 persons.

7. Amount of direct damages caused by flood disasters.

- Amounts of direct damages are reported for 48 % the of disastrous floods. This may be explained by the interval between the first reports - linked with the emergency situation and the humanitarian issues and giving only some general information on destruction - and the detailed valuation of infrastructural and material losses. In many cases, the estimates of direct damages remains ignored or uncited by sources of information according to the specific objectives they pursue (humanitarian relief, reporting of hydro-meteorological events...). Estimates from reinsurance companies are not always publicly spread and retrieval of data from public authorities may be difficult because of their local diffusion and differences in administrative organizations which, more and more, are decentralized.
- Moreover, the proportion of disastrous floods with data on direct damages may significantly differ from one country to another. Globally, data on damages are available for 60 – 100 % of all disastrous floods in one third of the European countries. For a second third, the available data cover 35 – 59 % of the floods, in one sixth 10 to 33 % of floods are covered and in one sixth no information on direct damages are available.
- Globally, damages are also documented for large with great numbers of affected (mean number of affected when damages are reported : 70,520; when damages aren't reported : 24,798. $F = 3,819$; $p = 0.052$).
- Unlike data on people killed or affected, there are no real changes in the proportion of reported damages over time, which tends to remain stable over the three decade (48.4; 55.6 and 46.1 respectively). Figures also tend to remain stable for most of the countries, probably indicating specific ways to report data on damages.
- Possibly, linked with the increasing number of “small” floods, the available data on damages could also decrease over time.

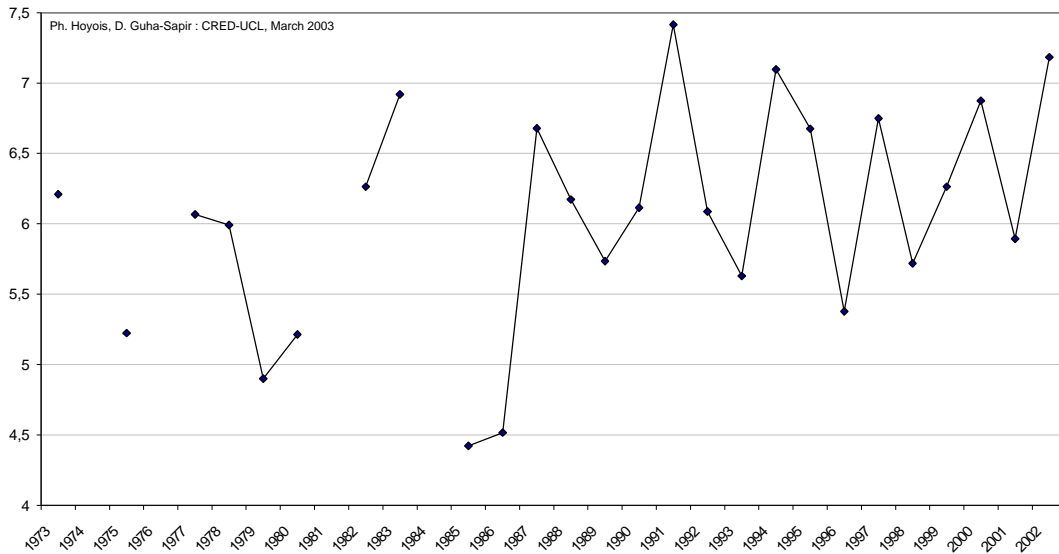
- The estimation of damages may be complex and methods are not known. Thus data have to be considered as rough estimates.
- In one case damages are clearly overestimated, making the flood the first most damaging among those listed in EMDAT. It happened in the region of Krasnodar in Soviet Union in 1991. When looking at details, it is already clear that conversion rate used by the authorities overestimated the value of the rouble. Even after correction, the total amount of damages by this flood remains excessively high although, contrarily to all other great floods, detailed research gives only weak information on the causes and consequences of this flood. We kept the data in the figures 9 to 11, but removed it from the more detailed analysis.

**Figure 9 : Total amount of damage reported : UN European Macro-Region , 1973 - 2002
(2002 Euros x 1000)**



- ***The total amount of reported damages, in Euro at 2002 value, from disastrous floods (Krasnodar, 1991, removed) add up to 5.7; 17.7 and 48.6 billions Euro for each decade respectively, with a total of more than 72 billions for the three decades.***
- There is a clear relationship between the increasing amount of annual damages from disastrous floods and their increasing number over years (linear regression : R^2 adjusted = 0.51; $F = 30.69$; $p = 0.0000$)

**Figure 10 : Total amount of damage reported (log10) : UN European Region, 1973 - 2002
(2002 Euros x 1000)**



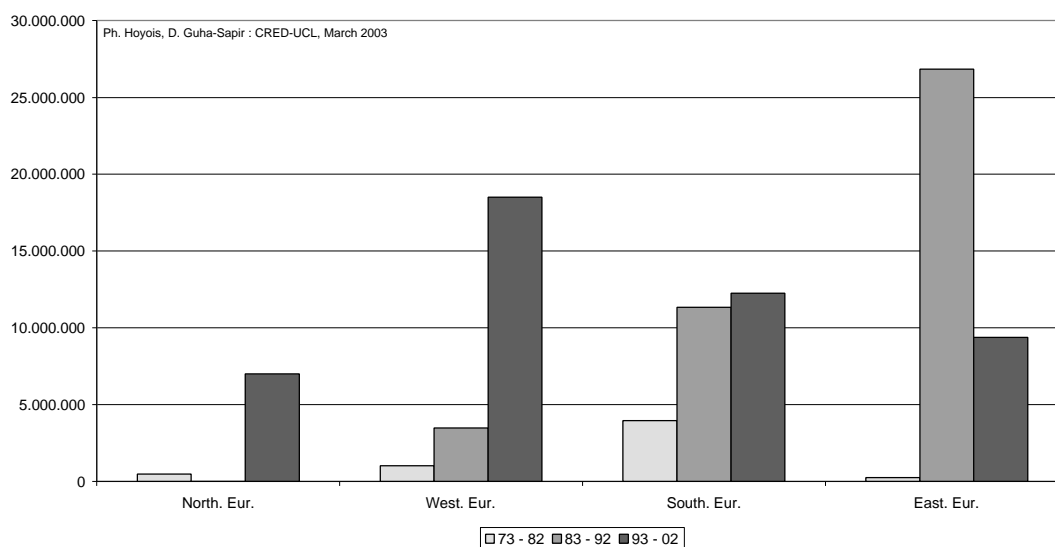
- During the first two decades, damages of 100 millions (2002) Euros or more are reported for 60 % of the floods with data on damages. This proportion decreases to 49 % in the last decade but the difference is not significant.
- Floods with damages estimated at 1 billion and above are in proportion of 13, 17 and 12 per cent of the total number of disastrous floods with data on damages for each decade respectively.
- For a better estimation of the economic consequences of disastrous floods hitting countries, damages should be related to their GNP.

8. Amount of direct damages caused by flood disasters by UN European Region.

8.1. Northern Europe.

- Data on damages are reported, in a valid way, only by Sweden (100 %). Data from the United Kingdom are available for 60 % of the disastrous floods. For other countries, data on damages appear in a somewhat uncertain way.
- The **total amount of damages reported for this region is of 7.5 billions Euros** (2002) for the three decades and of 484.3 millions; 9.2 millions and 6.9 billions for each decade respectively.
- Floods with over 100 millions Euros of damage account for 54 % of the total number of disastrous floods with damage data.
- Data for the first and second decade are almost all attributable to disastrous floods in Sweden. In the third decade, damages from the UK (underestimated) account for almost 95 % of the total, at 6.6 billions Euros.
- Severe damages, at more than 335 million Euros, are reported for Norway in 1995.

**Figure 11 : Total amount of reported damages : UN European Regions
(2002 Euros x 1000)
1973 - 1982, 1983 - 1992, 1993 - 2002**



8.2. Western Europe

- Data on damages are reported in a valid way only by The Netherlands (100 %). Data from Germany are available for 70 % of the disastrous floods and for 67 % in Switzerland. In the last decade, reported data increase to 83 % in Switzerland and 100 % in Austria. For Belgium, France and Luxembourg, data on damages appear in a somewhat uncertain way. However, in France, most severe floods seem to be documented.
- The **total amount of damages reported for this region is around 24.5 billions Euros (2002)** for the three decades and of around 1; 3.5 and around 20 billions for each decade respectively.
- In the first decade, the estimated damages came from only two disasters : one in France (156 millions Euros) and one former DDR (869 millions Euros). In the second decade, data for 7 disastrous floods are available (one in Austria, Germany and Switzerland and 4 in France). In the third decade, data for 23 disasters are available (one in Belgium, 2 in Austria, 3 in The Netherlands, 5 in Germany and Switzerland and 7 in France).
- Disastrous floods in Germany account for 49.5 % (12.1 billions) of the total of damages reported for the Region over the three decades. Damages from France account for 22 % (5.6 billions) of the total and those from Switzerland, The Netherlands and Austria for 11.7 (2.6 billions), 8.4 (2.1 billions) and 8.4 % (2.1 billions) respectively.
- Floods with over 100 million Euros of damage account for 72 % of the total number of disastrous floods with damage data. This proportion is 92 % for France, 67 % for Austria and Switzerland, 57 % for Germany and 33 % for the Netherlands.
- During the last two decades, one quarter of the floods with damage data costed more than 1 billion Euro to the country they hit.

8.3. Southern Europe

- Data from Italy are available for 70 % of the disastrous floods, for 60 % in Albania and for 50 % in Macedonia, Spain and Portugal. For all other countries, data on damages are unreported or appear in a somewhat uncertain way.
- The **total amount of damages reported for this region is around 27.6 billion Euros (2002)** for the three decades and of around 4; 11.3 and around 12.3 billions for each decade respectively.
- In the first decade, 82 % and 14 % of the total reported damages are attributable to Spain (4 floods) and Italy (3 floods) respectively. In the second decade, the proportion for these two countries remain similar : 81 % (3 floods) and 9 % (4 floods) respectively. In the last decade, damages from Italy (8 floods) account for 96 % of the reported estimation.

- These two countries contribute to 93 % of the total amount of damages reported (Italy : 13.3 billions, 48 %; Spain : 12.4 billions, 45 %).
- Half of disasters with data on damages had direct costs from floods over 100 millions Euros. This proportion was of 55 % in the first decade and 70 % in the second. It decreased to 31 % in the last decade.

8.4. Eastern Europe

- Data from former Czechoslovakia, Czech Republic and Slovakia are available for 100 % of disastrous floods, for 67 % in Belarus, for 57 % in Poland, 53 % in Romania and 50 % in Bulgaria. Data on damages are reported for 40 - 48 % of the disastrous floods in Ukraine, Hungary and Russia.
- The *total amount of damages reported for this region is around 12.5 billion Euros* (2002) for the three decades (Krasnodar, 1991, removed) and around 254 millions; 2.9 and around 9.4 billions for each decade respectively.
- In the first decade, Romania (1 flood) accounted for 63 % of the damages reported and Poland for the rest. In the second decade, the former Soviet Union and Russia accounted for 52 % (8 floods) of the reported damages, Poland for 26 % (1 flood) and Romania for 21 % (1 flood). In the last decade, two floods in Poland accounted for 52 % of the reported damages, two other floods in the Czech Republic for 22 % and 12 floods in Russia for 13 %.
- For the three decades, the amount of damages is the highest for Poland (5.7 billion Euros) followed by Russia (2.7 billion), Czech Republic (2.1 billion) and Romania (1.2 billion).
- Damages over 100 millions Euros are reported for 43 % of disastrous floods with damage data. This lower proportion than in the other European region is certainly explained by the differential associated with exchange rates.

Conclusions

- During the last three decades (1973 – 2002), the reported number of disasters caused by floods and registered in the EMDAT database which remained more or less stable during the first two decades increased progressively during the last decade and knew an exponential growth in the last three years.
- This reflects the fact that, next to possible effects of climate changes and undoubted alterations in land uses, new actors appeared or gained influence over the years, with higher sensitivity to smaller disasters, and consequently an increase in the reporting of such disasters.
- Eastern Europe is the region for which the greatest number of flood disasters is reported (93 disastrous floods), followed equally by Western (73) and Southern (74) Europe, far ahead of Northern Europe (32).
- In Northern Europe, floods are most often of small magnitude, affecting a small number of persons when compared with the biggest ones hitting ten to hundred thousand inhabitants.
- In Western Europe, small disastrous floods are more frequently reported for Belgium, France, Switzerland. In France, however, big disastrous floods occurred several times during the period. The Netherlands and Germany offer more contrasted figures with an apparently lower frequency of floods but with more severe ones reported proportionally.
- In Southern Europe, Italy knew an increasing number of disastrous and large floods during the last years. Inversely, the Iberian peninsula, hit by severe floods during the years 70 – 85, saw their severity decrease over time although few changes in frequencies. Greece and countries from former Yugoslavia have been regularly hit by rather low magnitude floods. However Serbia appeared to be a country at high risks of floods these last years.
- In Eastern Europe, Russia was the most frequently hit with more than half of the disastrous floods occurring in Siberia. Comparatively, Romania is a country with a very high risk of floods, higher than Hungary, flooded almost each year and Moldova, Belarus and Ukraine which were regularly flooded during the last decade. In Czech Republic, floods are unfrequent but of far greater magnitude than in Slovakia.
- Few people were reported to be killed by disastrous floods. Their increase over time is linked with the increasing number of disastrous floods reported. However, differences appears between region, with Southern and Eastern Europe reporting greater number of deaths. In Southern Europe, the risk of death could be higher for each flood; in Eastern Europe, some floods appear to be associated with higher number of deaths.
- During the last 30 years almost 9 million persons were affected by floods. Their growing number is linked with the increasing number of disastrous floods. Again differences appeared between

regions with Northern Europe clearly spared, Western and Southern Europe equally hit and Eastern Europe very highly affected. In Western Europe, the number of affected seems related to large floods. In Southern Europe, it appears that the number of affected is higher for each disastrous flood than in the Western Region. In Eastern Europe, very large floods affecting a high number of persons and an increasing amount of smaller floods affecting also several thousands of persons produce the high figure of affected for the region.

- Data on direct damage are difficult to collect because of their low diffusion which, moreover, may sometimes happen months after a flood occurrence. The total available amount of damage for the 3 decades is of more than 72 billions of Euros (at 2002 value). Because of lack of data, analysis is weakened and results are clearly underestimated. However, the increase in damages is related to the increasing number of disastrous floods.
- Three countries report more than 10 billions of damages for the whole period (Italy, Spain and Germany); three countries report damages between 6 and 7 billions (UK, Poland and France); for 3 countries damages are between 2 and 3 billions (Russia, Switzerland, Austria, Netherlands and Czech Republic) and for one country (Romania) over 1 billion.
- This preliminary analysis gives a first overview of the evolution and the consequences of disastrous floods in the different region and countries of Europe.
- Contrasts appear through regions and countries, which are related to differences in exposure to extreme meteorological events, physical geography, land uses, adequacy and maintenance of preventive and protective measures against floods, country's wealth.
- Changes over time are also linked to these factors. In the future, detailed systematic studies should enhance our knowledge of their contribution to occurrence or prevention of flood disasters.
- This underlines the necessity to improve the quality of available data. Data also have to be linked with other sources (meteorological, population, economic, institutional ... data) to refine analysis.
- Different scales and/or indices should also be developed for analysis and disaster management purposes.