World Meteorological Organization

Regional Association VI

Working Group on Hydrology

Extreme-floods

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Contents

Anthropogenic impacts on extreme floods in Europe

A review of the past 15 years

1 General

The files of the insurance industry allow to compile a list of extreme flood events in Europe over the past few years (**Table 1**). First, it is striking that all the listed events occurred in inland waters. This means that storm surges had secondary significance in the past few years in Europe, what may be due to the functionality of flood protection dykes, but also to the non-occurrence of extraordinary storm surges in this period. Moreover, it is noteworthy that in a number of cases the highest water levels and/or discharges on record occurred in high frequency. Regarding the damage sums listed, these give only limited information about the severity of the events. Ultimately, the extent of damage is a direct result of the intensity of riparian land uses, the size of the inundated area, the season, or in general the "damage potential". These damage potentials, which are ultimately nearly always of anthropogenic origin, are an expression of the sensitivity to flood impacts.

2 Acquisition and collection of information

On the basis of the rough overview presented in **Table 1**, queries were addressed to several countries requesting information material on extreme flood events. The material received varied considerably in volume as well as information value. Altogether, nine countries were asked for information. In a period of about six months, all replies were received, although some material could not be used for the overview. In some cases, the reply was merely a short verbal statement, in others very voluminous material did not give answers to the questions asked. **Table 2** summarizes the material received.

Table 1 Extreme floods in Europe since 1988

Year	Month	River	Country	Casualties	Damage in million US $
1988	3	Danube, Elbe, Rhine	D	8	>30
1989		several	SP	12	375
1991	4	Volga	USSR	-	2,000
1992	10/11	several	I	3	712
1993	9	several	Alpine countries	-	700
1993	12	Rhine, Maas	D, B, NL	3	2,100
1994	4/5	Danube, Elbe, Rhine	D, CH	2	150
1994	8	Danube	Moldavia, RO	50	300
1994	11	Po, several	I	64	9,300
1995	1	Rhine, Maas*)	D, B, NL	28	3,500
1995	6	several	N	1	125
1996	1	several	UK	-	600
1996	6	several	A, I	38	32
1996	11	Flooding by meltwater	IS	-	17
1997	7/8	Oder	CZ, PL, D	>100	5,000
1998	4	several	UK	5	500
1998	6	several	RO	31	160
1998	9	several	NL, B	-	530
1998	10/11	Danube	D	5	500
1999	5	Rhine	CH, D, A	13	750
1999	3	Danube	H, RO, CZ, ...	-	130
1999	7	several	YU, PL, CZ	31	600
1999	11	several	F	31	500
2000	3	several	UK	-	100
2000	4	Theiss	H, RO, YU	10	100
2000	10/11	several	UK	6	>1,500
2000	10	Po, several	CH, I, F	38	8,500
2000	10	several	SP	-	120

*) including wind damage

Table 2 Material received

				Contents/facts		
				on anthropogenic impacts on flood risk	on damage and losses suffered	suitable for analysing?
Nr	**Country**	**Institution**	**Events**			
1	UK	Inst. of Hydrology	1996/1 1998/4	I General description II Detailed, event-related 98/4	General information	YES
2	CH	Bundesamt für Wasser-wirtschaft	1987/7,8	In-depth analysis of causes of 1987 flood	Details	YES
3	A	Bundesamt für Wasser-wirtschaft, Hydrographi-sches Zentral-büro	1991/5,6, 8 1997/7 and others	No description Anthr.impacts + climate	Details of 1987 flood	YES
4	RUS	State Hydrolog. Inst. St. Petersburg	1991/4	Not mentioned	Not mentioned	NO
5	RO	Nat. Inst. of Meteorology and Hydrology Bucharest	1998/6	Not mentioned	Only general	Partly
6	I	Presidenza del Consiglio Da Ministri Information from insurance companies	1984/7,8 1992/11 1994/11 1997/6 1998/5 floods 1994, 2000	Description of causes of floods until 1993	Details	Partly
7	F	Ecole de Mines de Paris	1988/10	Description of events from 1992/93/94	Cost figures in different categories	Partly
8	IS	Hydrol. Service	1996/11	Description of the event	Description of damage	Partly
9	SP	Direccion Ge-neral de Obras Hidraulicas	1996/8	not mentioned	General information	Partly
10	D *)	*BfG*	-	Event description and analysis incl. anthropogenic impacts	Detailed lists for several transbound ary events	YES

*) also for other riparian countries

One can see in **Table 2** that the countries A, CH, F, I, and UK sent information on the issue of anthropogenic causes of extraordinary flood events. Together with the information from our own country (D), reports were available from six countries. Additionally, material on the great floods on the rivers Maas and Rhine in 1993/94 and on the flood in the River Oder in 1997 was accessible from Germany's neighbouring countries. Moreover, reports were available on single events from third parties.

Italy presented its experiences from the period 1968-1987, with information on single events until 1990. It was pointed out that in the case of flash floods it is often difficult to make a clear distinction between the consequences of the flood events themselves and those of landslides. - This problem is particularly relevant in mountain regions. - The **Austrian** reports repeatedly point at the flood-aggravating effect of reduced river cross sections. Such reductions of the discharge area may be caused by landslides, but they are often the consequence of improper storage of buoyant material (in the inundation area of rivers) that may be carried along by flood waves to be deposited at narrows (e.g. in front of bridges). Neglected clearance of rivers (especially torrents) may also be the reason for such jams, either by accumulation of woody debris or growth of weed. Temporary impoundments caused by these phenomena intensified the destructive impacts of floods by additional waves as consequence of the breaking of these impoundments.

Errors in dimensioning flood discharge cross sections were the reason of several damaging events. Here, not only the careless closeness of building grounds to rivers has to be deplored but also the massive narrowing of valleys by roads and bridges.

In single cases, failures of technical facilities (such as weirs) caused particularly severe flood damage. However, the primary cause was in all cases the weather situation. An exception is the flood event in Iceland that was due to volcanic activity.

The reports from **Switzerland** consider the anthropogenic interferences in the catchment, in the rivers, and those regarding the damage potential in the inundation area separately. They underscore that more than half of the cases of damage are due to misdirected developments of anthropogenic origin.

The information material received from the **UK** describes the situation in Great Britain very differentiatedly. There are areas without any flood protection as well as those protected against floods of long recurrence intervals. In some cases buildings narrowed river profiles (e.g. bridges) and were responsible for widespread inundation. In several regions, floods were caused by very different reasons, often located in the catchment. Improvements may be frequently achieved by better prediction. Occasionally, damages occurred because flood defences were dimensioned on recurrence periods that proved to be much shorter than assumed.

Floods in **France** occurred mainly in the fringe areas of high mountain regions (Pyrenees, Alps). Their origin was extraordinarily abundant rainfall, often associated with snowmelt. The situation is aggravated by excessive agricultural exploitation and damage resulting from tourism.

The River Arás flood in **Spain** took place in the Pyrenees and was caused by very extreme rainfall in 24 hours. The damages have been the result of a highly speed stream of water and mud. It has been a flash flood without any chance to alert the population and to proceed the evacuation of people affected.

The events that hit in the 1990s the **Rhine-Maas basin and the Oder** basin were followed by intensive investigations of their causes and reflections aiming to improve the flood situation. It is noteworthy that national efforts are supplemented by international joint studies by all states sharing the river basins. These activities in the private, scientific-technological, and political sectors are purposively coordinated. Besides the detailed description of the *status quo* of the flood situation and its control, future-oriented action programmes are politically fixed. A monitoring programme scheduled over more than 20 years by working groups of the International Commission for the Protection of the Rhine (ICPR) will check in detail the success of the efforts in the Rhine basin.

3 Evaluation of the material received

Annex 1 lists single events as well as so-called flood-years and describes them with few characteristics. Supplementarily, **Annex 2** presents necessary actions for improved flood protection in the future in form of key words. However, some of the listed reports do not provide such information. Nevertheless, the recommendations given to improve the situation after past events allow to derive implicitly proposals for the future.

It is the task of the present study to give an overview on the pertinent literature that allows to identify the influence of anthropogenic activities on the risk of floods. The results should be twofold:

- A description and - if possible - the monetary evaluation of the anthropogenic influence on the given situation; and
- A prospect for the future regarding the technical and economic anthropogenic possibilities to reduce the risk of floods.

In verbal form the literature presents more or less detailed facts, both on mistakes made in the past and on future options. In-depth analyses are rare; especially those based on exact figures. Causes are preferentially identified in fields that cannot or hardly be influenced by own activities; e.g.

- The flood is consequence of a natural disaster of unknown dimension or of
- Climate change.
- The source regions of floods are outside the own political responsibility.
- The flood was intensified by negligence or mistakes of upstream dwellers, etc.

Regarding necessary action in the future, it was usual in the past to list options, demand activities from others and stick to the traditional pattern of behaviour with growing temporal distance from the triggering event and to avoid costly or inconvenient decisions or actions.

Some exceptions from this rule could be found in the 1990s, which are also reflected in the material received, e.g. the reports from Great Britain, Switzerland, and Germany.

The compilation made after the Easter 1998 flood in England and Wales has an exemplary depth of detail and can serve as a model for an analysis. Moreover, the report formulated in Switzerland on the flood-year 1987 gives a comprehensive presentation of causes and consequences of the events. Regrettably, political consequences for sustainable concepts were less pronounced. The more remarkable are the activities that were initiated after the floods in the Rhine and Maas basins (1993 and 1995) and in the Oder river basin (1997), which are still dynamic and set examples for other river basins.

In **Germany** the

"Guidelines for Forward-Looking Flood Protection"

commissioned by the environmental ministers of the German Federal States were adopted as early as in May 1995.

In a parallel process, the environmental ministers of **France, Germany, Belgium, Luxembourg,** and the **Netherlands** declared in 1995 that they deem it necessary to reduce the risks associated with floods as soon as possible. This declaration had been harmonized with Switzerland in advance and the existing river commissions on the Rhine, Saar/Moselle, and the Maas were charged to establish flood action plans. In pursuit of this task, the International Commission for the Protection of the Rhine (ICPR) appointed the project group "Flood Action Plan" to start work on the Rhine and its catchment.

In March 1998, the "Action Plan on Flood Defence" of the ICPR was published. - It formulates four major action targets.

- No increase of damage risks until the year 2000, reduction up to 10 % by 2005 and up to 25 % by 2020.
- Reduce extreme flood stages downstream of the impounded part of the river up to 30 cm until the year 2005 and up to 70 cm until the year 2020.
- Drafting risk maps for 50 % of the floodplains and the areas at risk of flooding by the year 2000 and for 100 % of these areas by the year 2005.
- Short-term improvement of flood forecasting systems by international co-operation. Prolong the forecasting period by 50 % by the year 2000 and by 100 % by the year 2005.

The figures of the reduction of flood stages are the result of an effectivity study of water retention in the Rhine catchment commissioned by the ICPR (*"Wirkungsabschätzung von Wasserrückhalt im Einzugsgebiet des Rheins", Report 1998*).

Cost estimates for the necessary measures amount for the scheduled project life (until 2020) for the whole Rhine catchment to

EUR 12,300 million.

Of these, nearly 2,000 million had been incurred by the year 2000.

A very important element of the Rhine Action Plan is the monitoring of its implementation. Of its four action targets, three have the year 2000 as their first time mark. Accordingly, the first report about the achievements made so far was presented in January 2001.

- The implementation of the action plan was at the end of the year 2000 generally up to schedule, and the estimated costs were within the limits set.

Before the training of the southern Upper Rhine (1950), the riparian dwellers on the Upper Rhine were safe against flood peaks of 200 years recurrence. Today the protection is again ensured for 100-year floods.

Until the time when in 15 to 20 years all plumed retention facilities will be completed, there is a considerable additional risk, because extreme floods may cause vast damage in the Upper Rhine valley, which contains flood threatened property values of a total damage potential of EUR 62,000 million.

The largest possible flood event would cause a maximum property damage of EUR 13,000 million.

On the whole, the inventory of the national economic efficiency of the planned and accepted retention facilities over the 20 coming years shows that the measures have a benefit/cost ratio of 4.0, what is extraordinarily high for infrastructural investments in water-resources management.

Similar to the Rhine Action Plan, action plans exist for the rivers Moselle and Maas. There too, binding political decisions were taken to ensure the implementation of the measures. Following the extreme flood event in the River Oder in 1997, the International Commission for the Protection of the Oder (ICPO) reviewed the flood situation on this river. This transboundary examination identified existing deficits and highlighted, above all, the necessity to strengthen very long reaches of dykes, to create retention facilities, and to improve forecasting and warning systems. Along the reach, where the Oder forms the border between Poland and Germany damaged embankments were restored, and work began to improve the situation elsewhere. Intensive work is being done on forecasting system using mathematical models.

Following the analysis of the causes of the 1987 flood in **Switzerland**, the conclusion was drawn that the "damages were due to the intensive land use, especially of valley floors". No anthropogenic reason was identified as cause of the flood itself. The report summarizes:"Man is only a guest in the alpine landscape and must live in line with its laws".

The analyses of extreme floods presented by **France** point at changes in land uses, resulting from vegetation loss through agricultural and touristic excessive use of mountain regions and producing intensified surface runoff and land erosion. Through its participation in the International Commissions on the rivers Rhine, Moselle and Saar, and Maas, France is involved in the above-mentioned action plans and their consequences. The same applies to the **Netherlands** regarding the action plans on the Rhine and the Maas and Switzerland with view to the Rhine Action Plan.

Great Britain (UK) published already half a year after the Easter 1998 floods a response to the report on the events. This paper, also titled "Action Plan", issued by the Environment Agency of England and Wales lists under the key words

- Flood warning
- Flood forecasting

the shortcomings identified and makes proposals for improvements or recommends for review and possible changes the present attitudes and activities, administrative structures, institutions, and documentations.

This includes, for instance, revision of

- Flood defence facilities,
- Flood warnings and their dissemination,
- Flood risk maps (which are available in England and Wales in contrast to most river basins in Europe),
- Flood probabilities.

The whole bundle of measures deemed necessary under the Action Plan will require in the coming years expenditures of about EUR 11,500 million. Although the report notes that this sum is quoted in a parliamentary bill as necessary expenditure, the funding is obviously not yet secured because it reads in the foreword to the action plan: "The money to pay for these actions will ... have to be found."

However, the tenor remains optimistic about the implementation of the Action Plan when it continues "This Action Plan is the foundation for building those lessons (learned) into real and continuing improvements to our flood warning service."

Anthropogenic responsibilities were recognized for the floods affecting northern **Italy**. After the event of November 1994 it was stated that

- vegetation loss in erosion-prone areas favours landslides,
- irresponsible land uses in floodplains cause high damages,
- poor communication between authorities together with inappropriate management of floodplains and river basins and neglected clearance of weed and debris from watercourses intensify the floods considerably.

Although after the flood of October 2000 improvements were noted against the situation of 1994, some complaints were repeated, in particular the still existing fragmentation of competences and the resulting communication problems in planning of contingency measures and flood defences, including the limited dissemination of flood forecasts and warnings.

The reports received from **Austria** do not mention any anthropogenic causes of the sometimes disastrous damage, but some remarks suggest human negligence in clearing jammed river profiles from flotsam.

The Hydrological Office (Hydrographisches Zentralbüro) of the Austrian Ministry of Agriculture and Forestry sent in addition the study "Cost and benefit of hydrographic data", which also contains a collection of information on flood damage and its reduction. The study quotes at some examples benefit/cost ratios for engineering flood protection projects in Austria. These refer to rather small-scale areas and the benefit/cost values range from 2.5 to far beyond 10. Additionally, two projects of flood forecasting (rivers Drau and Steyr) were examined. The costs of forecasting stand against 3.5-fold benefits.

4 Summary and results

This study is an attempt at deriving information on the

"Impact of anthropogenic activities on the risk of floods"

from literature about extreme floods in Europe that have occurred since 1986 in Europe.

It was not possible to obtain literature on all selected flood events, and the descriptions were focused more on meteorological and hydrological facts than on anthropogenic causes or negligence. - As late as in the last five years of the period 1986-2000 some changes can be noted. They refer mainly to the transboundary damaging floods in the Rhine/Maas basin and the River Oder. Moreover, a particularly intensive analysis of causes was available of the Easter floods in Great Britain.

Human negligence or even contributions through improper management that intensified flood risks were repeatedly mentioned:

- Disturbed communication between regional authorities and resulting organizational failures (lacking preparedness for threatening situations and emergencies, information deficits among the population, such as delayed flood predictions and warnings);
- Mistakes in regional planning and land management (building permits in floodplains or even flood spillways, increasing value potential in flood-prone areas, overexploitation of vegetation in areas susceptible to erosion mainly in mountain landscapes);

- Negligence of river maintenance (neglected clearance of profiles from weed growth and/or floating debris mainly in mountain areas, lacking consideration of the safety margins of dykes).

The usually named "culprits" - river training, rectification, soil sealing - are rarely mentioned.

Regarding proposals for future action, the predominant ones were:

- Appeals to accept living with floods:
    - Strengthen the awareness of flood risks, especially among those affected;
    - Minimize damage potentials in actual and potential flood-prone areas;
    - Improve flood warning.
- Appeals to authorities not to think along administrative borders but to respond to the natural situation in the whole river basin in a holistic and coordinated approach.

Another objective of these studies was the attempt to quantify

"damage and losses suffered from flood events"

("as a possible basis for benefit-cost analyses of flood-protection actions and of flood forecasts").

As expected, comprehensive and reliable cost estimates were made, if at all, only in rare individual cases; and even rarer are the cases that they were made accessible to the public. The figures quoted from the literature (**Annex 1**) must be seen in this light, the more as they were not reported by the competent authorities but were projected from claims to insurance and reinsurance companies. Especially economic losses caused e.g. after the experience of flooding through

- deep-seated fear for the livelihood, health defects, or confidence crisis among the riparian population are addressed and expressed in monetary terms in the reviewed reports only for the Upper and Middle Rhine region. For this region and the envisaged protection measures there, benefit-cost analyses are available.

In two more cases, events of similar magnitudes in the same region could be compared (northern Rhine basin 1993 and 1995 and Piedmont 1994 and 2000). Although all these events were rather similar (in both cases, the second event was even somewhat more intense), the estimated damages and losses were clearly degressive:

- on the German Rhine:

1993	EUR 700 million	3 casualties
1995	EUR 260 million	no casualties

- in the Italian Piedmont:

1994	EUR 13,000 million	68 casualties
2000	EUR 6,500 million	29 casualties

The reduction of damages to half is explained on both the German and the Italian side by "lessons learnt", what resulted in changed behaviour of riparian dwellers and authorities. However, without supporting political long-term activities such learning effects do not last.

The benefit/cost analysis of flood protection on the Upper Rhine described in Chapter 3 showed that even higher reductions may be achieved when technical flood defences are employed (benefit/cost ratio = 4 to 8). This is supported by figures from Austria for small-scale constructive measures and flood predictions. The benefit of predictions is of particular relevance against the background that they are always on the list of future objectives: either to become established at all, or to improve them (**Annex 2**). However, it is essential to provide for the dissemination of predictions and to make those affected aware of their situation.

Annex 1: Detailed characterizitation of the flood events

State	Region	Event	Estimated damage	Deaths *)	Hydrological data
UK	Anglia, Midlands, Thames, Wales	Easter 1998 Floods	Insured losses: EUR 490 million Non-insured losses: EUR 80 million Intangible losses: loss of confidence, chronic fear, impai-red health	5	Precipitation: daily P_{max} about $2xP_{max}$1961/90 -> nearly 100-year precipitation Discharge: peaks between HQ_{30} and HQ_{175}. Single values were the highest since 1735. Area of heaviest destructions: 5000 km²
I, 1 2	Valtellina Piedmont (Po basin)	17-19/07/1987 5-6/11/1994	- EUR 13,000 million	13 68	- Precipitation: 1-day P_{max} 500-1000-year 3-day P_{max} 500-year Discharge: regionally Q_{max} values 10 % higher than HHQ
3	Piedmont, Aosta valley (Po basin)	12-16/10/2000	EUR 6,500 million	29	Precipitation: highest values on record, sometimes 5-day sums equalled mean annual preci-itation Discharge: new HHQ at the Po mouth (13,000 m^3/s) Po basin: 71,000 km²

*) unkown: -

Annex 1: Detailed characterizitation of the flood events

State	Region	Event	Estimated damage	Deaths *)	Hydrological data
A	Inn	5-6/8/1985	-	-	Precipitation: 10- to much more than 100-year rec. Discharge: HQ_5 to HQ_{100} lower Inn HHQ since 1951
	Lower Austria	July 1997	EUR 16.3 million	-	Precipitation: up to 100-year Discharge: HQ_{20} to HQ_{300}, sometimes new HHQ, Area: 3,400 km²
	Vorarlberg	July 1997	EUR 145.3 million	-	Precipitation: about 100-year rec.
CH	Uri, Valais, Ticino, Grisons	18-19/7 and 24-25/8/1987	EUR 802 million	8	Precipitation: 1 to 3-day values 25 to 200-year rec. Discharge: Comparable years since 1800: 1834, 1839, 1868 Areas: 13 to 830 km²
F, 1	East Pyrenees	26/09/1992	EUR 61 million	3	Precipitation: up to 100-year values Discharge: above 70-year values

*) unkown: -

Annex 1: Detailed characterizitation of the flood events

State	Region	Event	Estimated damage	Deaths *)	Hydrological data
2	Corsica	31/10-1/11/1993	-	-	Precipitation: widespread and lasting 24 hours, very extreme in series around 100 years Discharge: HQ_{100} to HQ_{200}
NL, 1 2	Maas Maas	December 1993 January 1995	EUR 120 million Less than 1993	- -	Precipitation: - Discharge: HQ_{125} at Borgharen (HHQ) Precipitation: The P falling on 11 days over the Maas basin was 25 % of mean annual P Discharge: HQ_{65}
D, 1	Rhine	1993/94	EUR 700 million (international EUR 1,100 million)	3	Precipitation: 2-day sums > 200-year values; often highest cumulative monthly values on record Discharge: Lower Rhine up to 80-year HQ, in tributaries above 100-year HQ; often highest peaks on record; Lower Moselle maximum since 1784 Basins: Rhine 185,000 km² Moselle 28,000 km²

*) unkown: -

Annex 1: Detailed characterizitation of the flood events

State	Region	Event	Estimated damage	Deaths *)	Hydrological data
2	Rhine	January 1995	EUR 260 million (international EUR 1,800 million)	-	Precipitation: Middle Rhine basin up to 4 times the mean January P Discharge: Lower Rhine up to 90-year HQ Tributaries up to 100-year HQ Rhine Catchment: 185,000 km²
3	Oder	July 1997	EUR 330 million (international EUR 5,100 million)	(internatio-nal >100)	Precipitation: local monthly sums up to the fivefold of mean annual cumulative values Discharge: Oder HQ > 100 years tributaries HQ > 100 years, often highest known discharge, Basin: 120,000 km²
RO	North-East, central and West Romania	1998 (Jan. to June)	EUR 235 million	-	Precipitation: Extreme precipitation, in Jan. and Feb. with snowmelt Discharge: HQ in rivers Prut, Mures/Maros and tributaries between HQ_{50} and HQ_{150} Affected area: 80,000 km²

*) unkown: -

Annex 1: Detailed characterizitation of the flood events

State	Region	Event	Estimated damage	Deaths *)	Hydrological data
SP	Arás (Pyrenees)	August 1996	EUR 15 million	86	Precipitation: 35 mm in less than 24 hours Catchment: 20 km²
IS	Vatnajökull	Nov. 1996	EUR 19 million	-	Q_{max} 45,000 to 50,000 m^3/s
	This event was an outbreak of glacier water that had melted under the ice as a consequence of a volcanic eruption. The total volume of meltwater is estimated around 3.5 km^3, flowing out during merely 36 hours. The length of the channel from the glacier to the sea was merely 20 to 25 km. The flow velocity reached 2.2 to 2.8 m/s. The width of the inundated area was around 35 km. The destruction affected a bridge of 376 m and one fifth of another one of 900 m length, 12 km of public roads and 7 km of dykes. Moreover, 23 towers of power line broke. Off the coast a land area of about 7 km² was formed.				

*) unkown: -

Annex 2: Measures for local and nation-wide improvements of flood protection mentioned in the national reports received (cf. Overview on the documents received)

State	Proposed measures
UK	– -Improve methods and systems of flood forecasting; – Ensure dissemination of forecasts by publication of forecasting stations, their activities and modes of operation; – Create awareness among those at risk; – Formulate a national guideline for determining HQ_n and a guideline for the operation of hydraulic models; – Improve flood-risk maps; – Improve hydrological measuring systems (e.g. measurements of extreme values); – Improve or ensuring of existing flood protection systems;
I	– Improve cooperation between different authorities; – Review land uses and adapt them to necessities, respective to opportunities; – Improve dimensioning of flood defences in municipalities and communities and adjust them accordingly;
A	– The submitted documents do not include any direct demands. However, the repeated reference to jams (flotsam in river profiles) suggests that improved maintenance of watercourses and removal of buoyant material would be necessary;
CH	– Active measures [technical structures, afforestation, biological slope stabilization]; – Passive measures [e.g. building bans, reducing damage potentials, property protection]; – Change concepts on damage prevention [accept small damage, prevent large damage];- Establish risk maps; – Include erosion and mud flow/land slides in project planning; – Intensify basic research; – Organize disaster relief, alarming, property protection, take out insurances;
F	– Produce better flood-risk maps supported by basic research; – Preserve existing areas for controlled flooding/retention; – Improve cooperation between different authorities; – Respect nature and the environment, avoid inappropriate land uses by agriculture and tourism;

Annex 2: Measures for local and nation-wide improvements of flood protection mentioned in the national reports received (cf. Overview on the documents received)

State	**Proposed measures**
NL	– Provide information and formulate rules of conduct for riparian dwellers; – Protect important properties; – Increase discharge cross sections (widening and/or deepening); – Make contingency plans (e.g. for evacuation);
D	– Improve coordination of activities between different authorities (Federal States, international) along the river; – Improve forecasting; – Produce better maps; – Increase awareness of flood risks; – Create water retention capacities along watercourses and in areas; – Reduce damage potentials in areas at risk of flooding;
RO	– The submitted documents do not include any direct demands, however, the positive statements about existing forecasts suggests that more and better forecasts are expected.
SP	– The Spanish Automatic Hydrological Information System (SAIH) network has been implemented in the major part of Spain. The implementation nation wide is one of the soon to be objectives (data recording, regional data concentration, processing and decision centre, forecasts)
IS	– Demands are not made, but intensive efforts to improve forecasting are described.

Annex 3: Overview on the documents received

Italy:

- Memorie Descrittive della Carta Geologica D'Italia (Vol. XLVII) Geological and Geoenvironmental Failure from the Post-War to 1990
  Servizio Geologico Nazionale,
  Roma 1992
- Flooding in Northern Italy, A report of the 1994 floods in Piemont and an assessment of future risk,
  Alexander Howden Group Ltd./Manzitti-Howden Beck S.p.A.
  Insurance & Reinsurance Brokers
  Milano 1994
- October 2000 floods in Nothern Italy
  Aon Group Ltd./Aon Re Italia SpA
  London/Milano 2000

France:

- Les événements hydropluviométriques intenses récemment observés sur le Sud-Est de la France
  Actes de la journée scientifique
  Comité National Français des Sciences Hydrologiques
  Aix-en-Provence 1994
- Hochwasserberichte über Ereignisse
  - Sept. 1992, Ost-Pyrenäen
  - Sept./Okt. 1993, Provence-Alpes
  - Okt. 93 bis 94, Provence-Alpes
  - Okt./Nov. 1993, Korsika
  - Nov. 1194, Provence-Alpes

United Kingdom:

– Easter 1998 Floods, Volume I and II
Board of the Environment Agency,
1998

– Policy and Practice for the Protection of Floodplains
Environment Agency,
1997

– Flood Estimation Handbook
- Volume I (Contents)
- Volume II (Seite 80 – 82)
- Volume III (Contents)
- Volume IV (Contents)
- Volume V (Contents)

– Environment Agency Response to the Independent Report on the Easter 1998 Floods, Action Plan, November 1998

Austria:

– Mitteilungsblätter des Hydrographischen Dienstes in Österreich:
- Nr. 49: HW Juli 1977 in Tirol
- Nr. 56: HW August 1985 in Tirol
- Nr. 57: HW Juli 1987 im Saalbachtal, HW August 1987 im Oberpinzgau
- Nr. 59: HW März 1988 in Oberösterreich

– Mitteilungen des Hydrographischen Zentralbüros
Hochwasserereignisse im Jahre 1991 in Österreich, Analyse und vergleichende Darstellung

– Hochwasser Juli 1997 in Niederösterreich
Amt der Niederösterreichischen Landesregierung
St. Pölten 1997

– Beiträge zur Hydrologie Niederösterreichs, Bd 3

Hochwasserereignisse der Jahre 1978 und 1979 in Niederösterreich
Wien 1981

- Hydrographischer Dienst in Österreich, Mitteilungsblatt 76
  Ein Überblick über die Hochwasserereignisse 1997 in Österreich
  Wien 1998
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