



Action Plan on Flood Defence



Internationale Kommission zum Schutze des Rheins
International Commission for the Protection of the Rhine

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Contents

Preface	Page 5
I Initial situation	7
II Mandate and work so far	8
III Principles of the Action Plan	11
IV Action targets	14
V Categories of measures	15
VI Implementation, financing and effectiveness assurance	22
Final remark	24
Annexes	
Annex 1: Assignment of flood retention effects on floodings in the Rhine basin	26
Annex 2: Implementation of measures	27

Preface

The alarming pictures of the disastrous floodings of the River Oder in the summer of 1997 recalled the last great floodings of the Rhine in 1993 and 1995. What happened on the Oder was what people were afraid of in the Dutch Rhine delta in January 1995, but did luckily not happen there. At different locations the dikes along the River Oder did not resist the enormous water pressure. Large areas were flooded in Czechia, Poland and to a lesser extent in Germany. More than 100 people lost their lives, flood damages amounted to billions of ECU. The population reacted with an unprecedented wave of solidarity for the flood victims.

Floodings and flood damages remain present-day problems. It is well-known that man has increased the risk of river floodings due to hydraulic interventions, intensive building activities and the use of all areas in the vicinity of rivers. To aggravate the situation, today's knowledge on the effects of climatic changes points out that there will probably be a general rise of risks from floodings in the next century, thus including the Rhine. Improved flood prevention and protection remain indispensable and will in future be more in demand than ever.

On January 22, 1998 the 12th Conference of Rhine Ministers adopted the "Action Plan on Flood Defence" in Rotterdam, implying expenses of up to 12 billion ECU. This Action Plan aimed at the improvement of precautionary flood protection will be implemented within the next twenty years.

For the first time there is international demand to give considerably more expanse to the Rhine in case of floodings. In the course of the last two centuries the Rhine lost more than 85% of its natural alluvial areas, as man used them for settlements or agriculture. Present countermeasures, such as the assignment of alluvial areas, their preservation and expansion and improved water storage in the entire catchment area must simultaneously aim at an ecological improvement of the Rhine, its valley and its catchment area.

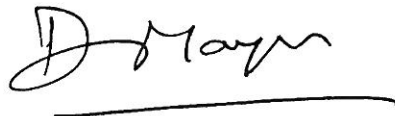
But man must again learn to live with floodings. According to current estimates, the total assets possibly affected in areas at flood risk may amount to about 1500 billion ECU. In future, if floodplains cannot be kept free, flood risks must be taken into account when fixing land use and spatial planning projects. Risk awareness must be improved and private precaution by people, trade and industry must be strengthened. This is a good means of avoiding or reducing damages by adapted constructions in areas which are normally protected but nevertheless at risk of extreme floodings. The new Atlas of the Rhine presents the flood-prone areas and thus the problems related to floodings.

The most important targets of the Action Plan on Flood Defence are to reduce damages up to 10 % by the year 2005 and up to 25 % by 2020. Extreme flood levels downstream of the regulated Upper Rhine are to be reduced up to 30 cm by 2005 and up to 70 cm by 2020. These ambitious targets can only be reached if all flood protection protagonists will closely and constructively co-operate. The hitherto practised sector based way of thinking must be replaced by integrated reflection and action on a local, regional, national and international scale. First of all, the policy areas related to water management, spatial planning, nature protection, agriculture and forestry are concerned.

On January 22, 1998 the Rhine-Ministers explicitly asked all those responsible to implement the necessary flood preventing measures with priority, even in times of financial bottlenecks.

Therefore, I am quite confident that the Action Plan on Flood Defence will be rapidly implemented and that it will be understood as a great forward-looking target which can only be accomplished in solidarity. Let us actively begin with this great task and bear in mind that any action must go hand in hand with a great sense of responsibility for all those people in the Rhine basin.

Time will show whether we are capable of preventive and concerted reflection and action.



A handwritten signature in black ink, appearing to read 'D Moyon', with a horizontal line underneath it.

Dominique Moyon
President of the ICPR
February 1998

I Initial situation

During the floodings of 1993 and 1995, many cities along the Rivers Rhine, Moselle and Meuse were again flooded. In 1995 dikes were at risk of bursting in the Netherlands. As a matter of precaution, several hundreds of thousands of people were evacuated. Damages are estimated to several billion ECU.

These events made clear

- that floodings are natural events, which must be periodically reckoned on,
- that man has aggravated the maximum flood level and the travel time of floods by land development in the catchment area, by river development and by reducing natural flood storage areas,
- that embankments and other flood protection structures along the Rhine cannot grant absolute protection,
- that settlements and other uses in flood-prone areas present a particular damage risk.

Therefore, the Ministers of Environment of France, Germany, Belgium, Luxembourg and the Netherlands declared on February 4, 1995 in Arles that they deemed necessary to reduce flood-related risks as rapidly as possible. It was not acceptable to them that situations as came up at that time put people's lives and property and the environment at such great risks. Prior to its adoption this declaration had been agreed upon with Switzerland.

The Action Plan on Flood Defence will be put into a phase programme. Thus progress under the programme can be evaluated and the measures required for the next phase and their financing can be ensured.

II Mandate and work so far

In the Declaration of Arles, the EU-Ministers of environment in charge of the Rivers Rhine and Meuse underlined that measures are not only required in the field of water management, but also in the fields of spatial planning and land use, e.g. in connection with agriculture and forestry, nature protection, development of settlements and recreational use.

The river basin commissions for the Rhine, the Sarre/Moselle and the Meuse were charged to draft action plans on flood defence integrating measures in the field of spatial planning.

In February 1995 the International Commission for the Protection of the Rhine (ICPR) commissioned the project group "Action Plan on Flood Defence" to draft an action plan for the Rhine and its catchment area. The ecological improvement of the Rhine and its floodplains were to be integrated and continued in this Action Plan. At the same time, parallel action was started for the Rivers Sarre/Moselle and Meuse.

As far as spatial planning is concerned, the responsible Ministers in France, Germany, the Netherlands, Belgium and Luxembourg seized the opportunity of interdisciplinary and transboundary co-operation and declared in their Strasbourg declaration of March 30, 1995 to set up a transnational working group "Spatial planning and preventive flood protection Rhine/Meuse". The European Union supported these activities within the European Union initiative INTERREG II C. The operational programme developed on this basis under the name of IRMA (INTERREG-RHINE-MEUSE-ACTIVITIES) contributes to a forced implementation of specific measures in the field of flood prevention along the Rhine and the Meuse in the years 1997 to 2001.

Considerable international activities on flood defence and flood prevention have been started or carried on in other fields of policy or society. These were also used as a basis for the Rhine basin Action Plan:

- Hochwasser-Studienkommission für den Rhein – Schlußbericht (February 1978)
- ICPR – Grundlagen und Strategien zum Aktionsplan Hochwasser (December 1995)
- Internationale Arbeitsgruppe: Hochwasserschutz an Mosel und Saar – Hochwasser an Mosel und Saar, Synthese der hydrologischen Un-

tersuchungen und Vorschläge für vorbeugende Strategien (December 1995)

- Transnationale Arbeitsgruppe: Raumordnung und vorbeugender Hochwasserschutz Rhein/Maas – Zwischenbericht (October 1996)
- Gemeinsames operationelles Programm IRMA im Rahmen der Gemeinschaftsinitiative INTERREG II C (January 1997, adopted December 1997)
- EU-Landwirtschaft und Umwelt: Hefte zur gemeinsamen Agrarpolitik (January 1997)
- ICPR – Hochwasserschutz am Rhein – Bestandsaufnahme (März 1997)
- ICPR – Bestandsaufnahme der Meldesysteme und Vorschläge zur Verbesserung der Hochwasservorhersage im Rheineinzugsgebiet (March 1997)
- ICPR – Rhein-Atlas; Ökologie und Hochwasserschutz (January 1998)
- ICPR – Ökologisch wertvolle Gebiete und erste Schritte auf dem Weg zum Biotopverbund am Rhein (January 1998)
- ICPR – Wirkungsabschätzung von Wasserrückhalt im Einzugsgebiet des Rheins (publication 2nd semester 1998, see encl. 1)
- Transnationale Arbeitsgruppe: Raumordnung und vorbeugender Hochwasserschutz Rhein/Maas – Abschlußdokument (beginning 1998)
- Transnationale Arbeitsgruppe: Raumordnung und vorbeugender Hochwasserschutz Rhein/Maas – Comparative review of policy making related to spatial planning and flood protection in Belgium (Flemish and Walloon Region), France, Germany, Luxembourg, the Netherlands and Switzerland (beginning 1998)

The above mentioned international initiatives are being completed by numerous national activities and lead to an Action Plan on Flood Defence in joint responsibility. The action plan ensures that all protagonists concerned by flood protection will be involved and that the plans will be co-ordinated.

The action plan aims at improving the protection of people and goods against floodings while integrating ecological improvements of the Rhine and its floodplains.

III Principles of the Action Plan

Floodings are natural phenomena. The natural variation of water levels is part of the feature of rivers. It is the basis for river flow dynamics and the development of a typical floodplain profile. Extreme floodings occur when intensive precipitation falls on soils, which are already saturated due to former precipitation or which are frozen and can thus not absorb any water. Extreme floodings may only be influenced to a limited extent. Various human interferences have clearly altered the river regime. Thus, the starting point is to take back these human interferences with the river regime, as far as possible. This means above all to increase water storage on the surfaces and in the floodplains, but also to reduce the damage risks in flood-prone areas.

Flood damages are created by the interplay of two independent mechanisms. Nature – supported by man – gives the high-water levels. At the same time, man increases the values along the river and the damage risks. At a given time, the combination of floodings and the accumulation of values in areas at risk create a more or less great damage.

The measures of the Action Plan must go hand in hand with on-going or planned measures for the protection and restoration of aquatic and terrestrial habitats in general, particularly in the Rhine valley. The improvement of the ecological situation must equally be integrated into all interdisciplinary plans in order to compensate for the ecological deficits of the past.

The demands of the Arles and Strasbourg Declarations take integrated reflection and action on a local, regional, national and transnational scale for granted. In this connection, contributions of water management, spatial planning, nature protection, agriculture and forestry are required.

The contribution of water management

- reduce discharge peaks by improving the soil seepage capacity, by storing water and by reactivating flood zones
- ensure runoff capacities and – where required – increase them by river development
- reduce the flow velocity by renaturation measures in streams in the catchment area
- flood defence by dikes and walls
- prolong early warning times by improved forecasting

The contribution of spatial planning and urban development

- Preventive consideration of flood aspects when fixing land development and spatial planning
- Protection of existing and potential runoff and storage areas
- Limit damage risks by keeping areas at flood risk free of unsuited uses and by increasing risk awareness
- Integrate streams into urban development; storage and seepage of precipitation in urban settlements
- Reduce discharge peaks by protecting and developing free areas and equivalent land development

The contribution of nature protection

- Reduction of discharge peaks by reactivating floodplains and re-naturing water bodies
- Reduction of discharge peaks by preserving and restoring wetlands capable of storing water in the entire catchment area

The contribution of agriculture and forestry

- Reduce discharge peaks by improving the seepage capacity of agricultural areas
- Reduce discharge peaks by opening areas for flooding
- Reduce erosion by suitable forms of agriculture
- Reduce discharge peaks by natural forest development and afforestation

Close co-operation of these policy areas will allow the planning of measures which serve several aims at the same time. Not all measures may be justified by the aims of flood prevention. But they are justified due to their positive effects in several fields of policy.

If flood damages are to be sustainably limited, it is important to influence the uses along water bodies. This will lead to success far more rapidly than the sole effort to sustainably influence floodings. Often, damages may be reduced easier than flood stages.

Apart from the action of different policy areas it is important to strengthen precautionary measures. This issue directly addresses all those possibly concerned by floodings: citizens, industry and trade.

The contribution of private precaution

- Reduce damages by adapted constructions even in those areas which are normally protected but which may be at risk of rare extreme floodings
- Avoid or reduce damages by appropriate measures in industry or trade
- Avoid water pollution in cases of floodings by appropriate in-house measures (e.g. emergency plans)

As in other areas of life, assurances may constitute a supporting instrument of private precaution.

Five guiding principles in matters of preventive flood protection:

- 1. Water is part of the whole*
- 2. Store water*
- 3. Let the river expand*
- 4. Be aware of the danger*
- 5. Integrated and concerted action*

- 1 Water is part of the whole* – Water is part of the natural ecological cycle of all surfaces and of land use and must be taken into account by all fields of policy.
- 2 Store water* - Water must be stored in the catchment area and along the Rhine as long as possible.
- 3 Let the river expand* – we must let the river expand so that the runoff may be slowed down without any danger
- 4 Be aware of the danger* – inspite of all efforts a certain risk remains. We must again learn to live with this risk
- 5 Integrated and concerted action* – integrated and concerted action in the entire catchment area is a prerequisite for the success of the Action Plan.

IV Action targets

Precisely defined action targets with closely related contents to be simultaneously pursued have been defined for the Action Plan. The measures connected with these targets are listed in the following chapter and must be carried out in successive stages. The Action Plan aims at prevention of all flood situations, not only of extreme events. The targets are ambitious but realistic. They demand considerable efforts, financial efforts as well as efforts of political implementation in order to change present ways of thinking and of use.

Four action targets

- 1. Reduce damage risks*
- 2. Reduce flood stages*
- 3. Increase awareness of floodings*
- 4. Improve the system of flood forecasting*

The Action Plan sets the following targets (reference year 1995)

- 1. Reduce damage risks* - no increase of damage risks until the year 2000, reduction up to 10 % by 2005 and up to 25 % by 2020.
- 2. Reduce flood stages* – 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.
- 3. Increase awareness of floodings* – increase the awareness of floodings by drafting risk maps for 50 % of the floodplains and the areas at flood risk by the year 2000 and for 100 % of these areas by the year 2005.
- 4. Improve the system of flood forecasting* - 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.

These political targets are based on an estimation of the effects of a package of measures¹. The measures have been listed according to categories, expenses and effects.

¹ See ICPR report „Wirkungsabschätzung von Wasserrückhalt im Einzugsgebiet des Rheins“ (publication 2nd semester 1998)

V Categories of measures

In the following, the expected effects and expenses for five categories of measures are being compared. There are separate comparisons for the years 2000, 2005 and 2020. In order to have a clear overview, effects and expenses are presented for the entire period, starting in 1998.

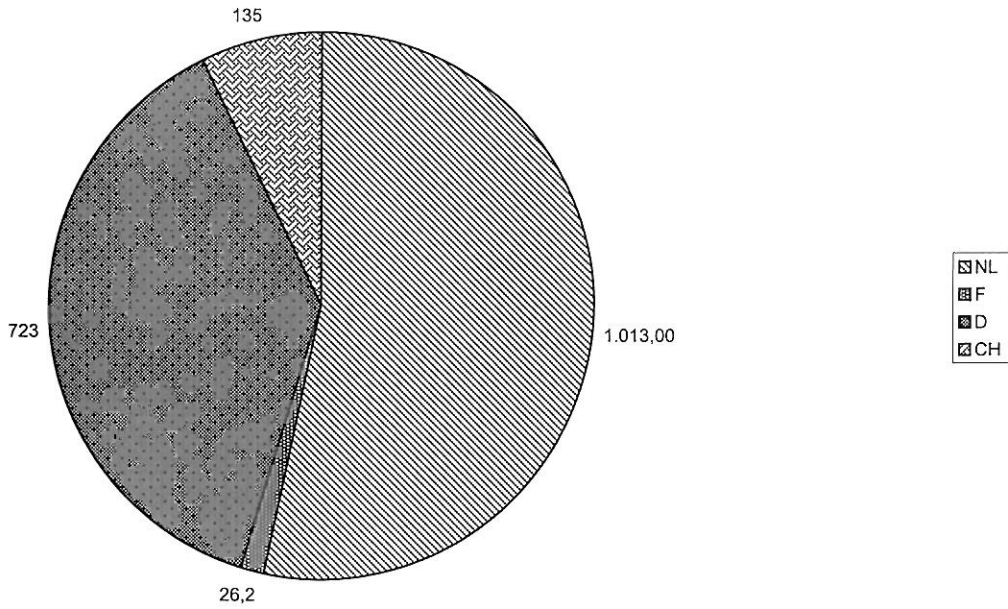
The measures do not have the same effects in all cases of floodings along the entire Rhine. Therefore, the effects of the different measures cannot simply be added, but the range of local and spatial effects must be accumulated in order to obtain the precise sum of effects for a specific flooding at a particular place.

Today's knowledge of the effects of climatic changes show that in the next century, a generally greater risk of floodings – also along the Rhine - must be expected. Due to the existing uncertainties, all measures on flood protection to be taken from now on should simultaneously serve as many targets as possible. Some measures are not only justified due to their effects in flood protection, but they also serve important targets in other fields of policy, as is the case of the renaturation of streams. This policy of “no regret” opens for great flexibility when choosing measures.

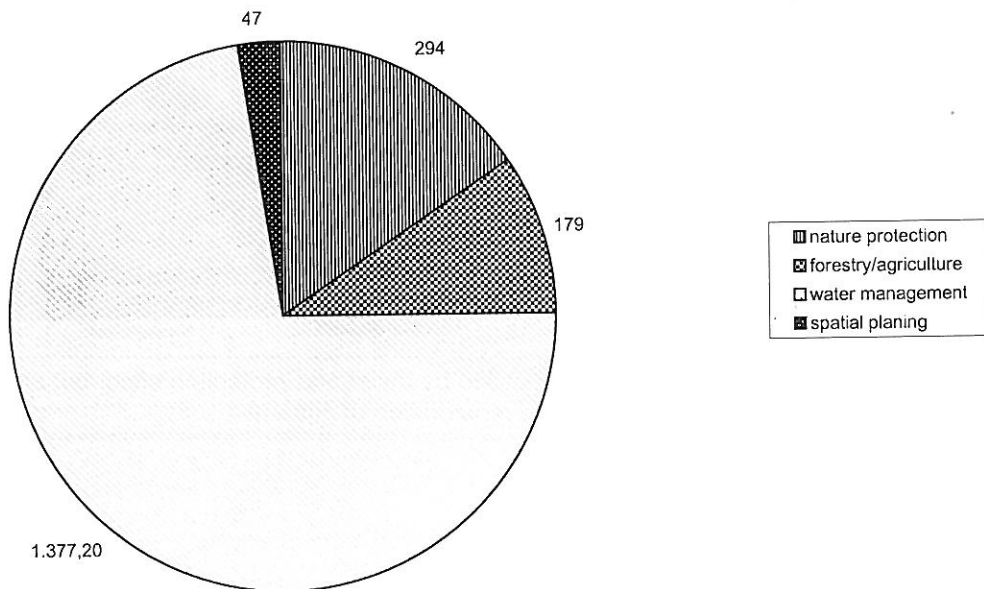
The effects concerning flood protection have been quantified as far as possible. For some categories of measures, it is however necessary to limit oneself to a qualitative description of the effects of flood protection and of other effects. The expenses of the Action Plan are presented in pie charts for the three periods in order to point out the part the states and the policy fields play in the Action Plan.

Rhine Action Plan on Flood Defence Survey of measures 1998 - 2000			
Categories of measures	Flood defence effects	Other effects	Estimated expenses [million Ecu]
(1) <u>Water storage in the Rhine basin</u> - renaturation (1.280 km) - reactivation of flood zones (100 km ²) - extensification of agriculture (800 km ²) - nature development, reforestation (450 km ²) - unsealing (90 km ²) - technical flood storage (4 Mio. m ³)	- little effect in the surroundings	- restoration of aquatic and terrestrial habitats	129
	- local effect	- recharge of water table, restoration of aquatic and terrestrial habitats	250
	- little effect in the surroundings	- recharge of water table, new habitats	135
	- little effect in the surroundings	- recharge of water table, new habitats	88
	- little effect in the surroundings	- relief of sewer and wastewater treatment plants	70
	- local effect	- creation of new habitats	50
		<u>722</u>	
(2) <u>Water storage along the Rhine</u> - reactivation of flood zones (5 km ²) - technical flood storage (33 million m ³)	- local effect	- recharge of water table, restoration of aquatic and terrestrial habitats	60
	- reduction of flood level: 5 cm	- creation of new habitats	136
		<u>196</u>	
(3) <u>Technical flood protection</u> - maintenance and enforcement of embankments, adaption to level of protection (730 km)	- reduction of damage risks	- increase of security for people directly involved	965
(4) <u>Preventive measures in the area of planning</u> - uses adapted to the risk of floodings - drafting of maps of flood-prone areas and areas at risk	- no increase of damage risks	- avoid soil erosion	13
	- for 50 % of the floodplains and flood-prone areas	- increased awareness of flood risk	
(5) <u>Flood forecasting</u> - improved forecasting - improved co-operation	- prolonged forecasting period: 50 %	- increased security for the riverine population	4
	- improved systems of announcement		
Sum	Flood reduction 5 cm (1) (2)		1.900
Different categories of measures are not only justified by their flood protection effect but also achieve targets in other policy fields, as e.g. the renaturation of streams.			

Estimated expenses per country in the period 1998 - 2000 (mio. ECU)

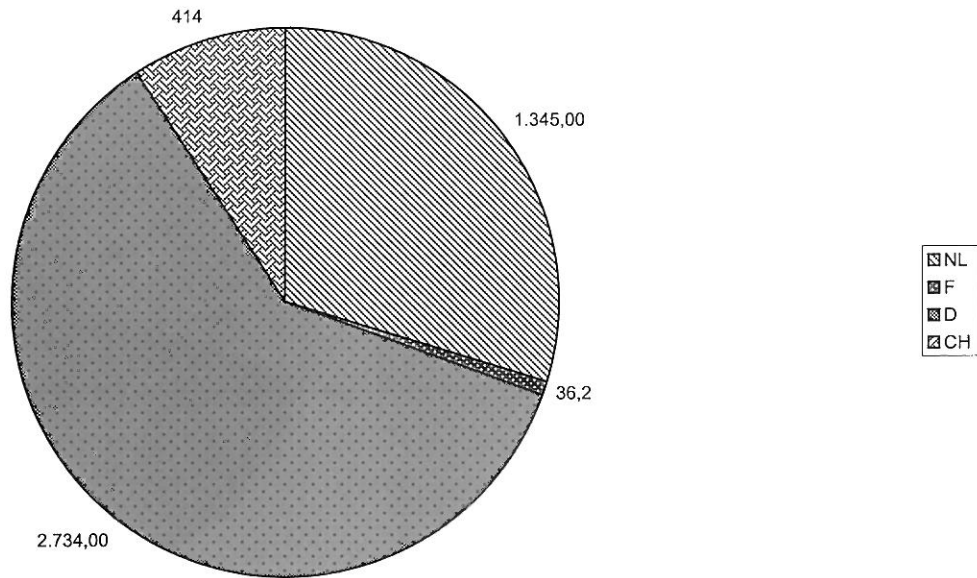


Estimated expenses per political domain in the period 1998 - 2000 (mio. ECU)

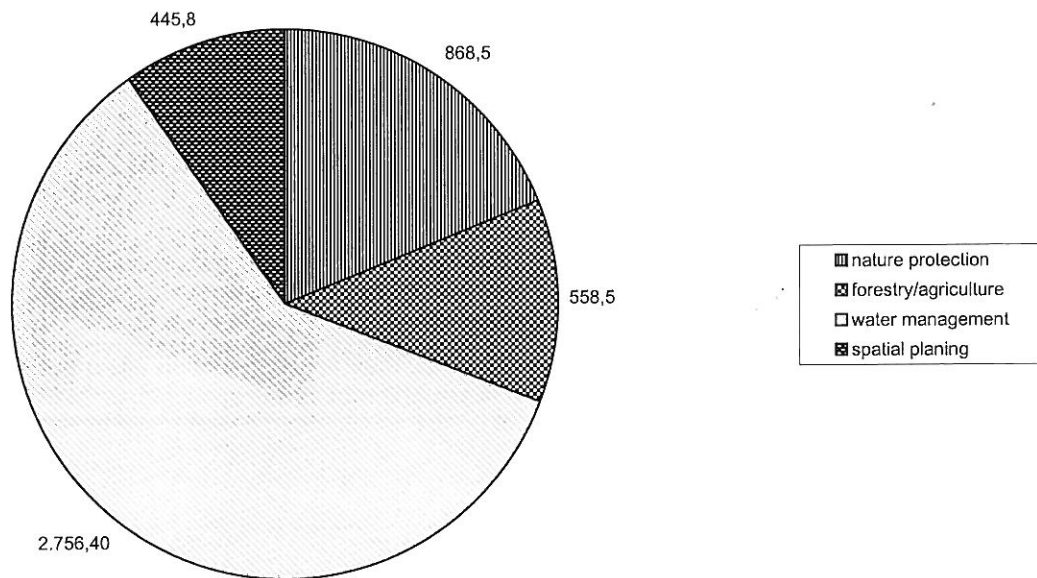


Rhine Action Plan on Flood Defence Survey of measures 1998 - 2005			
Categories of measures	Flood defence effects	Other effects	Estimated expenses [million ECU]
(1) <u>Water storage in the Rhine basin</u> - renaturation (3.500 km) - reactivation of flood zones (300 km ²) - extensification of agriculture (1.900 km ²) - nature development, afforestation (1.200 km ²) - unsealing (800 km ²) - technical flood storage (26 million m ³)	- little effect in the surroundings - local effect, little effect along the Rhine - little effect in the surroundings - little effect in the surroundings - little effect in the surroundings - local effects, little effects along the Rhine <hr style="width: 50%; margin-left: auto; margin-right: 0;"/> flood reduction ca. 5 cm	- restoration of aquatic and terrestrial habitats - recharge of water table, restoration of aquatic and terrestrial habitats - recharge of water table new habitats - recharge of water table new habitats - relief of sewer and wastewater treatment plants - creation of new habitats	340 750 440 237 615 333 <hr style="width: 50%; margin-left: auto; margin-right: 0;"/> 2.715
(2) <u>Water storage along the Rhine</u> - reactivation of flood zones (20 km ²) - technical flood storage (68 million m ³)	- flood reduction: ca. 5cm - flood reduction: 15-20 cm	- recharge of water table, restoration of aquatic and terrestrial habitats - creation of new habitats	385 290 <hr style="width: 50%; margin-left: auto; margin-right: 0;"/> 675
(3) <u>Technical flood protection</u> - maintenance and enforcement of embankments, adaptation to level of protection (815 km)	- reduction of damage risks	- increased security for people directly involved	1.090
(4) <u>Preventive measures in the area of planning</u> - uses adapted to the risk of floodings - drafting of maps of flood-prone areas and of areas at risk	- no increase of damage risks - for 100 % of the floodplains and for the flood-prone areas	- avoidance of soil erosion - increased awareness of flood risk	38
(5) <u>Flood forecasting</u> - improved forecasting - improved co-operation	- prolonged forecasting period: 100 % - improved announcement systems	- increased security for riverine population	12
Sum	Flood reduction 25-30 cm (1) (2)		4.530
Different categories of measures are not only justified by their flood protection effect but also achieve targets in other policy fields, as e.g. the renaturation of streams.			

Estimated expenses per country in the period 1998 - 2005 (mio. ECU)

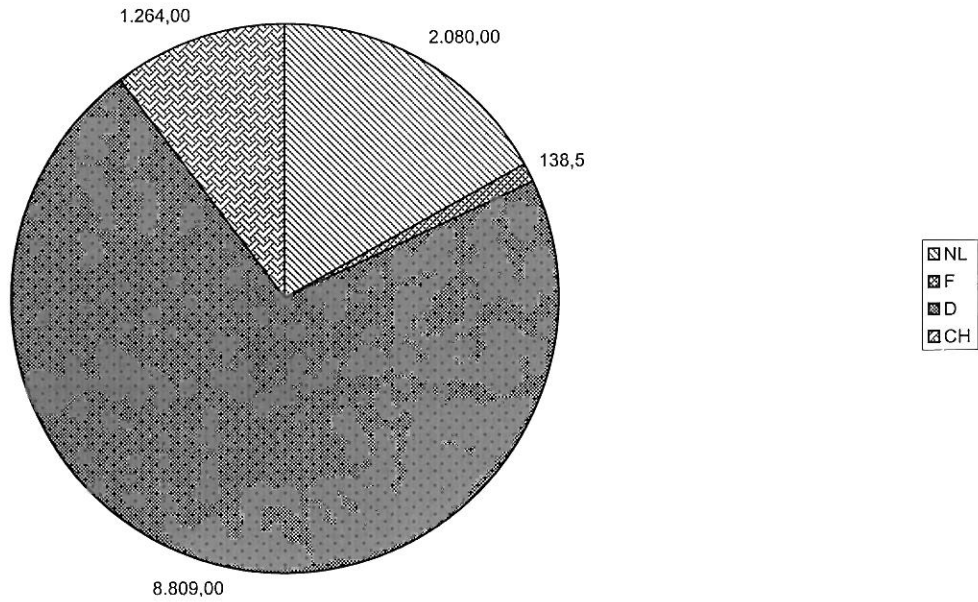


Estimated expenses per political domain in the period 1998 - 2005 (mio. ECU)

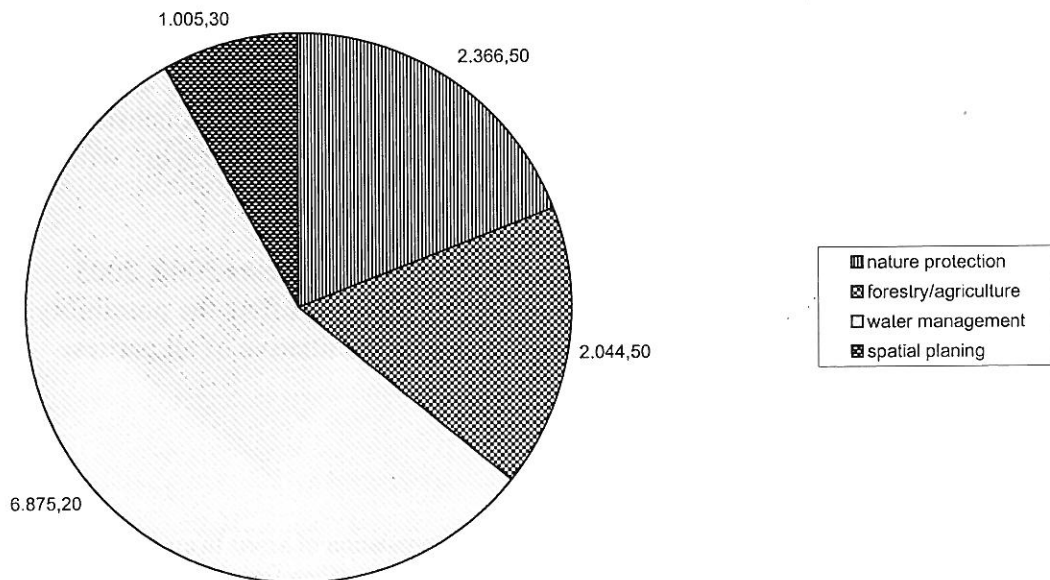


Rhine Action Plan on Flood Defence Survey of measures 1998 - 2020			
Categories of measures	Flood defence effects	Other effects	Estimated expenses [million ECU]
(1) <u>Water storage in the Rhine basin</u> - renaturation (11.000 km) - reactivation of flood zones (1.000 km ²) - extensification of agriculture (3.900 km ²) - nature development, afforestation (3.500 km ²) - unsealing (2.500 km ²) - technical flood storage (73 million m ³)	- little effect in the surroundings	- restoration of aquatic and terrestrial habitats	1.160
	- local effect, little effect along the Rhine	- recharge of water table, restoration of aquatic and terrestrial habitats	2.030
	- little effect in the surroundings	- recharge of water table new habitats	1.705
	- little effect in the surroundings	- recharge of water table new habitats	680
	- little effect in the surroundings	- relief of sewer and wastewater treatment plants	1.890
	- local effect, little effect along the Rhine	- creation of new habitats	935
	Flood reduction ca. 10 cm		8.400
(2) <u>Water storage along the Rhine</u> - reactivation of flood zones (160 km ²) - technical flood storage (364 million m ³)	- flood reduction: 15-25 cm	- recharge of water table, restoration of aquatic and terrestrial habitats	1.450
	- flood reduction: 45-60 cm	- creation of new habitats	960
			2.410
(3) <u>Technical flood protection</u> - maintenance and enforcement of embankments, adaptation to level of protection (1.115 km)	- reduction of damage risks	- increase of security for people directly involved	1.418
(4) <u>Preventive measures in the area of planning</u> - uses adapted to the risk of floodings - drafting of maps of endangered areas and of areas at risk	- no increase of damage risks - for 100 % of the flood-prone areas and for areas at risk	- avoid soil erosion - increased awareness of flood risk	60
(5) <u>Flood forecasting</u> - improved forecasting - improved co-operation	- prolonged forecasting period: 100% - improved systems of announcement	- increased security for the riverine population	12
Sum	Flood reduction: 60-70 cm (1) (2)		12.300
Different categories of measures are not only justified by their flood protection effect but also achieve targets in other policy fields, as e.g. the renaturation of streams.			

Estimated expenses per country in the period 1998 - 2020 (mio. ECU)



Estimated expenses per political domain in the period 1998 - 2020 (mio. ECU)



VI Implementation, financing and effectiveness assurance

Being adopted by all Rhine bordering countries, the Action Plan on Flood Defence is the basis of future flood protection policy along the Rhine. The total expenses for the implementation of the three staged Action Plan until the years 2000, 2005 and 2020 are estimated to about 12 billion ECU. In comparison, the values in the areas at flood risk along the Rhine are estimated to about 1.500 billion ECU. The Action Plan comprises measures to be carried out by the different states as well as measures to be carried out by others than the states. In this case it is up to the states to create the required general political conditions.

The implementation of the measures of the Action Plan demands a supranational and supraterritorial political appreciation not oriented towards local success of isolated measures but towards the overall aim set for the entire Rhine. Nevertheless, each single activity must be evaluated with respect to its expenses and effects.

On condition that the corresponding political emphases have been set, the implementation of the Action Plan is realistic, even though a commitment concerning the allocation of financial means cannot be expected for the long term of the Action Plan up to the year 2020. Regardless of this reservation each of the riverine states is called upon a consequent implementation of the activities of the Action Plan within its competence.

Finances are however not a limiting factor for all measures. The control of uses in areas at flood risk which is particularly important e.g. for the influence on future damage risks and the improvement of preventive strategies of citizens and state institutions, affords no future expenses if all modifications or maintenance work planned for the future are carried out so that areas concerned become less vulnerable by floodings. This field is a touchstone to find out in how far the societies of the Rhine bordering countries are willing to face the demand to control damage risks².

The classification of the action targets in periods to the years 2000, 2005 and 2020 opens for success control underway and thus offers the possibility of forcing certain categories of measures in a joint initiative of all parties.

² Damage risks are a product of floodings and the accumulation of assets in areas at risk, which means that floodings cause more or less great damage. Therefore, uses in these areas should in future be controlled. In these areas assets should not be increased, they should be adapted to the risk or be reduced. Society may only expect increased safety by raising or reinforcing dikes in exceptional socio-economic circumstances.

The Action Plan must not be interpreted as a self-contained set of measures, but as a framework target the contents of which is continuously being put in concrete terms on the basis of experience. In 2001 a first balance will be made up, then after a further five and ten years. Flood alleviation effects and damage limiting effects of a range of often and seldom occurring floodings will be the standard. The proof of the efficacy of protective and preventive measures taken or introduced is given by a number of model floods which imitate the flood compartment in the Rhine catchment area.

Since the first success control and the evaluation of the effects achieved will already be carried out by the end of the year 2000, a set of model floods giving evidence of the success of the planned measures will be immediately developed. The ICPR has been charged to present such a concept by 1999. The Action Plan aims at mobilising all social forces for the implementation of the demanded measures. In a first step, non-governmental organisations from different fields of policy have participated in the drafting of this Action Plan. The implementation of the measures of the Action Plan aimed at improving flood protection will require large scale information and exchange of information with those locally affected. Therefore, offensive and informative public relations must be brought on the way. With a view to preparing and achieving broad acceptance of the measures, future participation of the public on all levels, that is in the entire catchment area, on a European, regional as well as local scale must be planned.

The Action Plan is thus a synthesis of the activities of governmental as well as non-governmental organisations in the Rhine bordering countries in the most important fields of policy concerned by flood protection along the Rhine. The combination of activities, in particular in the fields of water management, spatial planning, nature protection, agriculture and forestry is the basis for successfully reducing future expected damages due to floodings of the Rhine. A further decisive factor for the success of the Action Plan will also be the extent to which we will succeed in sustainably embodying the required changes of awareness of all riparian states, such as they have been put down in the five guidelines so that they will be part of real day-to-day decisions.

Final remark

The targets as well as the means to reach them point out that an improvement of flood prevention and protection may only be obtained with the help of close co-operation of the fields of water management, spatial planning, nature protection, agriculture and forestry. The complex character of the flood problems demands integrated action of these fields of policy. Isolated measures will not lead to success; sets of measures which these fields of policy have agreed upon are necessary. In many cases flood prevention measures have different functions at the same time and have an effect upon different aspects (management of water quantity, water quality, drainage of settlements, ecological upgrading, etc.).

Annexes

Annex 1 Assessment of flood retention effects on floodings in the Rhine basin <input type="checkbox"/> improvement of flood situation Effect of:		Effect in the															
		immediate surroundings on								whole river on							
		minor				major				minor				major			
		floodings								floodings							
		travel time	vo-lume	peak	dura-tion	traval time	vo-lume	peak	dura-tion	travel time	vo-lume	peak	dura-tion	traval time	vo-lume	peak	dura-tion
Vegetation	wood / fallow land / meadow																
	intensive grazing / farmland																
Soil	sealed and compacted surfaces																
	frost																
	ecological soil management																
Terrain	settlement																
	forest dieback (large surface)																
	unsealing / seepage of rain water																
River network	small storages																
	renaturation																
	local flood protection																
	channel widening																
	technical storages along affluents																
	relocation of dikes - winter dike - summer dike																
	reclaimed summer land																
	technical storage (weirs and flood storage areas)																
	lowering of groynes																
	removal of local bottlenecks; construction of lateral channels																
	expansion of foreshores																
	lowering of foreshores																

Annex 2

Categories of measures	Implementation :	by 2000	by 2005	by 2020
Storage in the catchment area				
• Renaturation of streams (km)	CH	40	160	760
	F	100	600	1.500
	D	800	2.000	7.000
	NL	350	700	1.800
• Legal protection of existing floodplains and regulation of uses		----->	----->	----->
• Reactivate floodplains along affluents (km ²)	F	0	0	16
	D	100	300	800
	NL	0	0	200
• Increase water storage on farm land by an exhaustive implementation of agricultural management encouraging the infiltration capacity of soils, that is by avoiding soil compaction etc. (km ²)	F	0	0	0
	D	450	1.500	3.500
	NL	0	0	0
	CH	360	380	380
• Increase water storage by nature development and by supplementary afforestation measures, if necessary on previous farm land, initial forestation, etc. (km ²)	CH	50	200	600
	F	0	0	0
	D	250	500	1.000
	NL	240	550	1.900
• Limit future sealing and regulate infiltration in built-up rural areas by placing an obligation on farmers to improve rain-water seepage capacities on their properties (as far as possible);		----->	----->	----->
• Levies on sealing measures or creation of compensation surfaces				
• Adapt traffic and built-up areas so as to allow for rainwater seepage by encouraging infiltration (km ²)	CH	0	0	0
	F	0	0	0
	D	90	700	2400
	NL	0	90	90
• Technical flood storage (million m ³)	CH	0,1	1	3
	F	0	0	0
	D	4	25	70
	NL	0	0	0

Categories of measures	Implementation :	by 2000	by 2005	by 2020
Water retention along the Rhine				
• Compile existing technical means allowing to steer and to optimize storages		----->		
• Legal protection of existing floodplains and regulation of their uses		----->	----->	----->
• Technical flood storage along the Rhine (million m ³)		CH 0 F 8 D 25 NL 0	0 8 59 0	0 24 170 150
• Reactivate former floodplains along the Rhine (km ²)		CH 0 F 0 D 1 NL 4	0 0 15 6,5	0 0 75 87
Technical flood protection				
• Maintain and preserve existing flood protection constructions which continue to be indispensable, e.g. maintain the stability of embankments, if necessary strengthen embankments, etc. (km)		CH 0 F 0 D 45	0 0 130	0 0 430
• Adapt the level of protection to the assets to be protected (km)		NL 685	685	685
Preventive planning measures				
• Obligation to limit possible damages in case of floodings, e.g. by suitable construction and cultivation in floodplains of the Rhine valley and of the affluents		----->	----->	----->
• Draft maps of flood-prone areas along priority streams and of already built-up areas according to criteria yet to define: probability, flood peak and duration, flow velocity		----->	----->	
• Draft maps of risk for flood-prone areas by estimating the risks of damage (density of settlements: industry, trade, homes (number of enterprises, inhabitants), agricultural use: farming, pastures, use of meadows taking into consideration their sensitivity to floodings)		----->	----->	

Categories of measures	Implementation :	by 2000	by 2005	by 2020
<ul style="list-style-type: none"> • Draft protection plans on different levels, based on maps of flood-prone areas: gradual development of protection targets 		----->	----->	----->
<ul style="list-style-type: none"> • Inform the population of the risks and the means of limiting them; integrate information into education 		----->	----->	----->
<ul style="list-style-type: none"> • Measures limiting risks, e.g. by constructing in line with flood requirements and adapting the development of settlements and towns to the risk 		----->	----->	----->
Improvement of flood warning and forecasting systems				
<ul style="list-style-type: none"> • Set up a communication network for hydrological and meteorological data 		----->	----->	
<ul style="list-style-type: none"> • Extend the network of real-time precipitation measuring screens including improved quantitative radar recording of precipitations and access to the corresponding up-to-date data 		----->	----->	----->
<ul style="list-style-type: none"> • Further development and employment of the necessary hydrological forecasting models for the Rhine and its affluents 		----->	----->	
<ul style="list-style-type: none"> • Intensify operational co-operation between the flood forecasting centres and elaborate a standardized terminology for drafting flood reports 		----->		
<ul style="list-style-type: none"> • Immediately draft an international standard concerning: Principles for the free exchange of data and information (hydrological and meteorological services concerned, extent of data, expenses, general conditions) Co-operation and harmonization of the different flood warning and forecasting centres 				
<ul style="list-style-type: none"> • Drafting of flood models 		----->		
<ul style="list-style-type: none"> • Deduction of flood probability on the basis of standardized principles 		----->		
<ul style="list-style-type: none"> • Further investigation into man-made flow modifications (e.g. due to hydraulic engineering measures) 		----->		

Imprint

Publisher: ICPR
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Date of publication: March 1998

Project group "Action Plan on Flood Defence"

Departments involved: Bundesamt für Wasserwirtschaft, Biel; Landeshydrologie und -geologie, Bern; Direction Régionale de l'Environnement de Lorraine, Metz; Service de la Navigation de Strasbourg, Strasbourg; Direction Régionale de l'Environnement d'Alsace, SEMA, Horbourg-Wihr; Services Techniques de l'Agriculture, Luxembourg; Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Bonn; Bezirksregierung Trier, Trier; Ministerium für Umwelt und Verkehr Baden-Württemberg, Stuttgart; Ministerium für Umwelt, Raumordnung und Landwirtschaft Nordrhein-Westfalen, Düsseldorf; Bundesministerium für Verkehr, Bonn; Rijkswaterstaat, Hoofddirectie van de Waterstaat, Den Haag; Rijkswaterstaat (RIZA), Lelystad; Ministerie van Verkeer en Waterstaat, Directie Gelderland, Arnhem; Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, Den Haag

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