5 Analysis and Evaluation of the Fields of Action of Preventive Flood Protection

5.1 Fields of Action of Preventive Flood Protection

The flood events of the last years have demonstrated in a most impressive way that technical flood protection measures cannot guarantee absolute protection. Flood protection installations can „fail" either when the foreseen level of protection is exceeded or when technical systems no longer function (breach).

A sustainable reduction of flood danger can only be achieved if the many different actors and disciplines work together. Water management cannot solve these problems alone. It must be able to rely on very different planning fields and various other actors within society as a whole.

Today, comprehensive flood protection directs its efforts in two directions in particular:

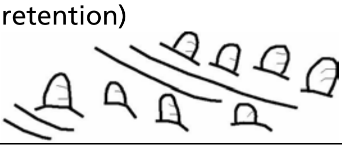
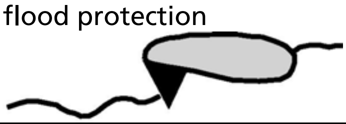
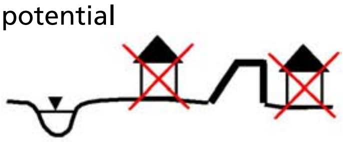
- Preventive areal safeguarding, use and development,
- Reduction of the damage potential in areas with a flooding risk.

Generally, the tasks of flood protection can be subdivided into the following six fields of action:

- Retention of precipitation water in the catchment (areal retention)
- Retention through technical flood protection
- Preservation and safeguarding of current retention areas
- Creation and extension of retention areas
- (Object-)protection using technical flood protection measures
- Minimisation of the damage potential

In the following table, these fields of action are assigned to concrete measures. The symbols shown should ease the recognition of the individual fields of action.

Table 8: Fields of Action and Measures in Preventive Flood Protection

Field of Action		Measure
1.	Retention of precipitation water in the area (areal retention) 	- Management of rain water in settlement areas, - Limitation of land sealing, - Land use and cultivation which reduces flow-off, - Forest management reducing flow-off, - Renaturalisation of streams and ditches
2.	Retention through technical flood protection 	- Building and management of: - Reservoirs - Retention basins
3.	Preservation and safeguarding of current retention areas 	- Keeping current flooding areas free of buildings - Preservation of current polders
4.	Creation and extension of retention areas 	- Dike relocations, - Setting up polders, - Renaturalisation of large waters, - Keeping water meadows free, - Deepening of retention areas
5.	(Object) protection by using technical flood protection measures 	- Dikes and dams, - Increasing height of dikes, - Flood protection walls, - Improvement of flow-off conditions, - Diversion channels
6.	Minimising the damage potential 	- Precautions in the area (control of flood sensitive land use), - Precautionary measures on buildings, - Measures affecting behaviour (flood forecast and warning, public information, creation of problem awareness, emergency services)

In all six fields of action, one can differentiate between on the one hand technical and non-technical (planning) tasks, and on the other hand short, medium and long term tasks.

Technical solutions are the primary responsibility of water management. Regional planning for its part is responsible for the preventive planning-related tasks in flood protection. Particularly clear examples here can be seen in connection with the long term safeguarding of open areas (e.g. for the extension of retention areas, for damage protection or also for decentral retention). In these tasks, these are particularly the conflicts between nature conservation, water management and other claims to use land which have to be solved. The balancing of these interests is one of the prime tasks of spatial planning and requires a high degree of cooperation.

Another example which affects many different responsible bodies is the field of action „minimising the damage potential" by measures of preventive behaviour. The required creation of awareness of all participants can only be achieved by a complex interaction of, among others, public relations work, politics, planning and water management.

5.2 Basic Effectiveness Analysis of all Measures for Flood Protection

The following table provides an overview of the basic efficacy of measures which can be employed in flood protection. The analysis was made regarding the achieving of five goals:

- Flood peak height reduction,
- Damage reduction,
- Environmental effects,
- Shipping and
- Flood awareness of those affected.

Here a differentiation is made between desired and undesired effects. Undesired effects occur when, as well as achieving the main desired purpose, negative consequences for other categories occur. Also, in some categories no effects of the measures can be expected whatsoever.

Table 9: Matrix of the Effect of Different Measures in Flood Protection

Field of Action	Examples of Measures	Flood Height Reduction	Damage Reduction	Environ-ment	Shipping	Flood Aware-ness
1.	Renaturalisation of waters	(+),(-)	(+),(-)	(+)	(o)	(o)
	Promotion of seepage	(+)	(+)	(+)	(o)	(+)
2.	Reservoirs, retention basins	(+)	(+)	(-)	(+)	(-)
	Alteration of the regulation of reservoirs / Increase of flood protection area	(+)	(+)	(-)	(-)	(-)
3.	Control of town planning and land use in the areas endangered by flooding, precautionary measures on buildings	(o)	(+)	(+)	(o)	(+)
	Attention given to flood danger in spatial planning	(o)	(+)	(+)	(o)	(+)
4.	Building of controlled polders	(+)	(+)	(+),(-)	(o)	(-)
	Building of uncontrolled polders	(+),(-)	(+),(-)	(+)	(o)	(-)
	Dike relocations	(+)	(+)	(+)	(o)	(-)
5.	Dike building / plateau building / building control facilities	(-)	(+)	(-)	(+)	(-)
	Raising dike heights	(-)	(+)	(-)	(o)	(-)
	Building diversion channels	(+)	(+)	(+)	(o)	(-)
6.	Qualified flood forecasting	(+)	(+)	(o)	(+)	(+)
	Definition of danger zones, information of those affected	(o)	(+)	(+)	(o)	(+)
	Key: (+): desired effect (-): undesired effect (o): no effect expected					

5.3 Possible Conflicts of Interest

Flood protection can be in contradiction to other targets and interests. A general overview of the conflicts which can result from this situation are shown in the following diagram. Subsequently, the individual areas are explained in more detail.

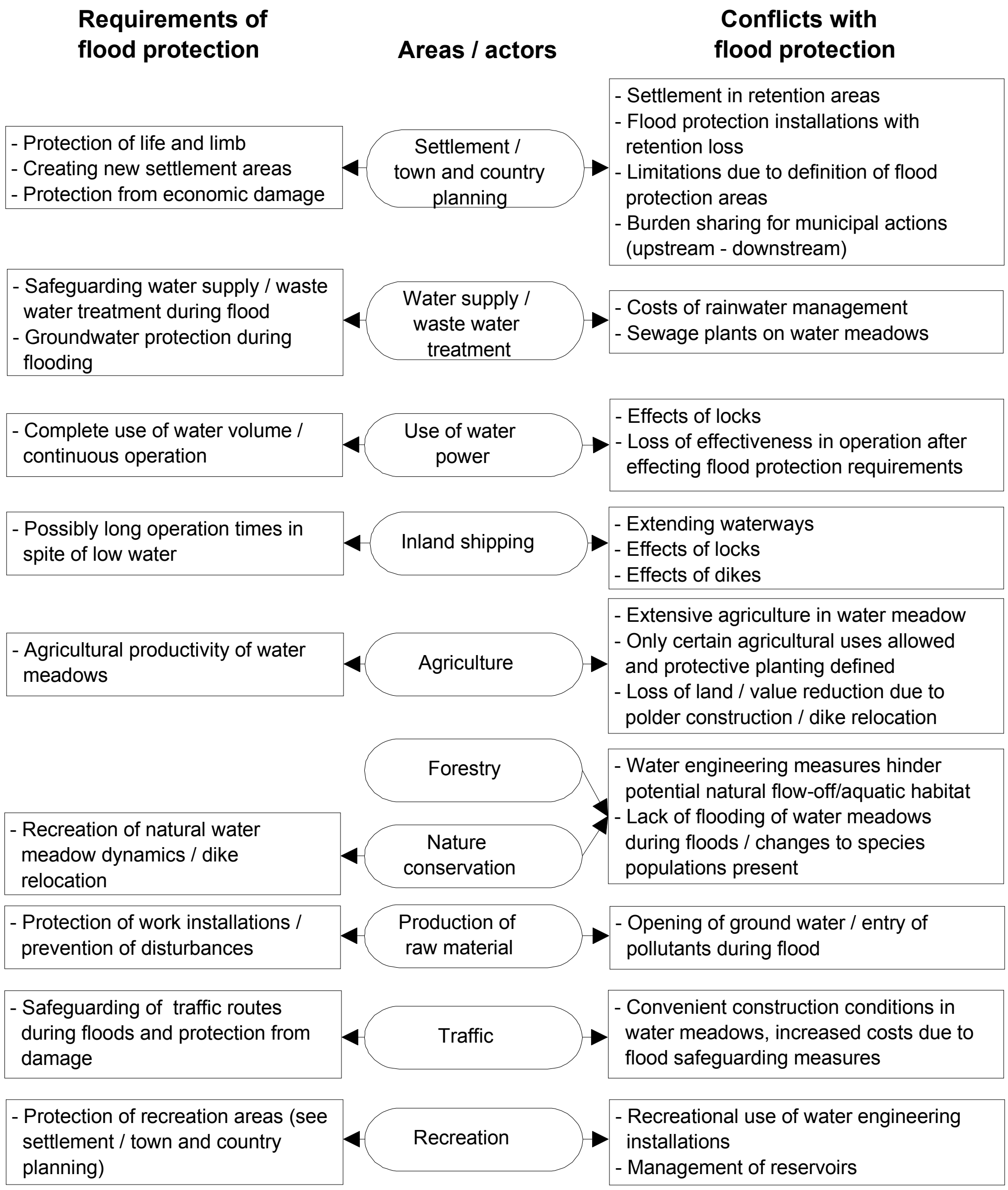


Figure 8: Requirements and Conflicts of Different Bodies / Actors with Flood Protection (from HEILAND/DAPP 1999; amended)

5.3.1 Water Management Field

In the field of water management, which is made up of water management for settlement areas, the use of water power and inland shipping, particularly the following areas of conflict and collisions of interest can occur:

- In so far as the management of a reservoir is optimised for flood protection, the flood protection capacity of the reservoir is also increased. But the space available to be used for the provision of drinking water, for producing energy or to increase the water levels of waterways will be therefore reduced.
- All stationary, technical flood protection measures (reservoirs, retention basins, dikes etc.) reduce the awareness of the flood danger of those affected. Those affected are first surprisingly confronted with the flood danger, as soon as the technical flood protection failures when extreme events occur.
- All stationary, technical flood protection measures such as dikes, dams and flood protection walls influence up to the relatively high protection targets (for example HQ100) the course of the flooding and disturb the natural flow dynamics.
- The construction of locks and the dikes on waterways in the course of improving shipping facilities cuts off the waterway from its natural flooding area in the water meadows. Retention space is lost, the duration of the flood wave is reduced and the height of the flood is increased for the downstream areas.

5.3.2 Land Use Field

For many centuries, due to their in many respects advantageous position (good traffic connections, fruitful land, easy access to water supply and waste water disposal) intensive settlement has taken place in the water meadows of large rivers.

In the catchment area of the Oder, those areas where in future high prosperity and therefore considerable settlement pressure is expected are of great importance. Among such areas are the larger metropolitan regions themselves such as Wrocław and Poznan, but also the following development axes:

- Berlin - Szczecin,
- Berlin - Frankfurt/Słubice - Pozńan - (Warsaw) and
- Berlin - Cottbus – Wrocław - Opole - Ostrava - (Cracow).

This process will be increasingly accelerated by the development of east-west relations.

This can, among others, lead to conflicts of interest with flood protection in the areas of settlement / town and country planning, agriculture, transport and nature conservation:

- The increased settlement activity in the water meadows has considerably increased the flood danger, also due to the short "flood disaster memory" within the population. In recent years this is particularly the case due to the building of industrial complexes and infrastructure installations on river banks. As a result it is not only human life which is threatened but also enormous material assets.

  The increasing settlement has also affected the flooding itself. The natural flood development is increased additionally by the sealing of land. Larger flow-off volumes form within a shorter time. This effect is relevant particularly for small to medium floods. But with larger events, such as e.g. in Summer 1997 on the Oder, this effect declines in importance.
- The type of agricultural use also affects the flow-off formation in areas endangered by flooding and therefore also affects the length of the flooding period and the height of the water. Particularly with local flooding events, agricultural use parallel to the slope with spaces at the side left fallow or a change from crop-growing use to open grazing land but above all reforestation produce positive effects.

  In flood endangered areas the conflicts with agricultural users are somewhat different. Due to the primarily fruitful land in such areas, a summer flood will cause economic losses to the farmer concerned. On the other hand, agriculture must recognise and accept the requirements of flood protection on the agricultural land. The catchword here is „space for the river". In the considerations regarding the type of land use, for example for measures such as building back dikes and creating polders, solutions must be found which provide agriculture with compensation.
- The topographical advantages alone are reason enough to build roads and railroads in the water meadows. This creates conflicts in two directions. First of all the (rail-)roads themselves have to be protected from flooding and secondly the narrowing of the valley cross-section leads to a worsening of the flood situation.
- Renaturalisation measures offer basically the possibility of combining nature conservation and flood protection in an ideal manner. A partial re-establishing of the natural flow dynamics gives more of the natural flooding plain back to the river. Furthermore natural water meadows are very important as habitats and also have functions as stepping stones and

corridors in nature conservation. The national parks „Lower Oder Valley“ and „Slonsk“ are impressive examples of this.

A flow-off hindrance in the greater catchment area is a desirable effect although only small effects will be achieved in extreme precipitation events. The same applies to flow-off hindrance in side waters without any competing use in the area endangered by flooding.

However, insofar as hindrances to flow-off result from renaturalisation measures - for example through rows of trees or bush growth, conflicts can also occur e.g. when this leads to locally higher water levels, and thus to damage in urban areas, conflicts will result.

5.4 Demarcation of Action Areas

The project *ODERREGIO* takes an action and realisation-oriented approach. The area under study is basically the catchment area of the Oder including the River Warta and the Stettiner Haff (see Figure 9 "Planning Area (Map No. 1)"). Within the scope of the *ODERREGIO* project, uniform digital map material was produced for this planning area (compare Figure 9 to Figure 17 (Maps No. 1-9)).

An evaluation of action possibilities for preventive flood protection requires a differentiated approach depending on the locality in question.

For this reason, the area under study was divided up into a total of nine sub-regions – so-called action areas. For these, the realisation potentials and the effects of measures were analysed.

The demarcation of the action areas was made according to the relatively homogeneous problems situation involved in a sub-region and therefore the possibility of similar action possibilities.

The hydrological subdivision of the Oder catchment area was only of subordinate importance in the demarcation of the action areas. This was particularly the case for regions with particular flood characteristics such as for example the River Warta area and the Lusation Neisse. Also, the Bóbr and Kotlina Kłodzka require special separate consideration.

Spatial planning action however is not only limited by defined areas of action but it is also determined by regional responsibilities. Therefore, in Figure 10 (Map No. 2), the administrative subdivisions of regional planning responsibility are shown. These allow an initial allocation of the recommended actions (see chapter 6.2) to the responsible regional planning actors.

Within the scope of this Interreg IIC project, the analysis of the action areas is concentrated on the main river, the Oder as far as Szczecin and its subsidiaries (without the River Warta). This is where the largest problems occurred during the 1997 summer flood. An extension to cover the areas „Stettiner Haff“ and „Warta“ should be carried out in later phases.

In the upper valley of the Oder itself and in the upper valleys of its tributaries, there are also action possibilities for decentral measures in the area affecting the flood formation (flow-off formation). Here, the action areas (A and B) relate to the total partial catchment area and are not limited to the areas endangered by flooding.

In some cases, flood endangered areas with a high damage potential ("Hot Spots") lie in the flow direction at the lower end of the action area. Therefore, the action options to relieve these "Hot Spots" must take place up-river from them.

5.5 Description of the Action Areas

The demarcated 9 action areas are described with the letters A to I (see Figure 13 and Figure 17 (Maps No. 5 and 9)):

- A – Czech tributaries
  The area of the Czech tributaries covers the Opava in the West, the Olše in the East and the upper valley of the Oder itself. These relatively steep tributaries present a considerable dynamic and short term flood danger because in this mountainous region the whole area has very steep inclines.
- B – Polish tributaries (Sudetes Mountains)
  This action area covers the Oder tributaries from the Sudetes Mountains from the Nysa Kłodzka in the Southeast to the Bóbr in the Northwest. These relatively steep gradient tributaries present a considerable dynamic flood danger. This mountainous region, reaching in the north to Pogorze and Przedgorze Sudeckie (Uskok Sudecki), is characterised by steep inclines which determine the nature of the water flow-off and the formation of the flooding.
  The region of the Kotlina Kłodzka is treated as a separate action area B1. Extremely severe floods with very short warning periods occur in this valley enclosed by mountains. Currently, the flood protection system is only composed of two dry storage basins.
  In the upper partial catchment area of the Bóbr (action area B2) the gradient is very steep resulting in frequent and considerable rises in the water level. The existing flood protection system, a combination of small reservoirs, dry basins and dikes, is already relatively well developed.
- C – Lusation Neisse
  The action area of the Lusation Neisse is hydrologically part of the Oder catchment area. It stretches from the source of the Lusation Neisse to its

mouth in the Oder. The source is situated in the west part of the Sudetes Mountains and the river flows in the upper valley through a region with a steep gradient.

- D - Ostrava - Opole (Oder)
  The potentially endangered flooding areas of the Oder between Ostrava and Opole and the lower course of the Opava and Olse are of importance for this action area, tends to have only medium to slight gradients.
- E - Opole - Wrocław (Oder)
  There is a medium population density in the area between Opole and Wrocław endangered by floods. The action area lies along the Oder between the two towns and also includes the lower valley of the Nysa Klodzka. The area is characterised by only slight gradients.
- F - Wrocław – to the mouth of the Lusation Neisse
  The potentially flood endangered area on the Oder and the lower valley of the Bobr are included together in the action area "Wrocław – mouth of the Lusation Neisse. This area of action is characterised by extensive agricultural use and has a moderate population density and only a slight gradient on the Oder.
- G – Mouth of the Lusation Neisse - Szczecin (Oder)
  The action area between the mouth of the Lusation Neisse and Szczecin covers the area along the Oder potentially endangered by flooding including the Oderbruch lowland. The area of action encloses particularly large areas used for agriculture behind the dikes and also a few municipal centres.
- H - Stettiner Haff / Zalew Szczecinski
  I - Warta
  The action areas H and I include the Stettiner Haff as well as the complete partial catchment area of the River Warta up to its mouth in the Oder. Both areas could not yet be examined within the scope of this work.

5.6 Analysis of the Flood Danger

An analysis of the flood danger is the basis for action recommendations for preventive flood protection. For this, for the total catchment area of the Oder, a method was developed.

Generally, the judgement of flooding danger without a firm hydrological and hydraulic information basis can only be founded on assumed flood scenarios.

We consider the „Worst Case“ scenario to be when dikes fail or are flooded over during extreme flooding events. In this case, at the first approach, one can use the area of the geomorphologic water meadows to define the endangered area. This method, which has already proved successful with other rivers, was also chosen for the *ODERREGIO* project.

For this, among other measures, charts of the hydrological atlas of Poland [IMGW 1987] were evaluated and digitised. The result was a chart of the potentially endangered flood areas (Figure 12 "Map No. 4"). In this way, potential flooding areas amounting to a total of 6,678 km^2 were detected.

In order to ensure the quality of this information, the boundaries of these areas were compared with the flood limits of the 1997 flood and the potential water meadows identified in the Oder-Auen-Atlas [WWF 2000]. The results show that the chosen procedure – corresponding to the scale of this study – permits a sufficiently accurate definition of the area endangered by flooding.

The flooding danger potential was established using the real land use data – so-called "Corine-Land-Cover" data. The total of 44 use categories were summarised into six different categories which permit enough differentiated information for the flooding picture. These are the categories: settlement areas, industrial areas, infrastructure, agricultural land, forestry and natural areas. These categories can be differentiated fundamentally both in terms of the type and the amount of potential damage. They are documented in Figure 11 (Map No. 3).

The flood danger potential (Figure 13 "Map No. 5") was estimated by the combination of the

- land use "Corine-Land-Cover" data (Figure 11 "Map No. 3") with
- areas of potential flood risk (Figure 12 "Map No. 4").

So the following towns on the Oder could be identified as particularly endangered ("Hot Spots"):

- Ostrava (330,000 inhabitants), (as for the other towns only a part of the town is endangered by floods, not the whole population)
- Bohumín (23,000 inhabitants),
- Racibórz (100,000 inhabitants),
- Kędzierzyn-Koźle (68,000 inhabitants),
- Opole (125,000 inhabitants),
- Brzeg (40,000 inhabitants),
- Oława (33,000 inhabitants),
- Wrocław (640,000 inhabitants),
- Brzeg Dolny (13,000 inhabitants),
- Głogów (74,000 inhabitants),
- Nowa Sól (128,000 inhabitants),
- Krosno Odrzańskie (61,000 inhabitants),
- Eisenhüttenstadt (45,000 inhabitants),
- Słubice (17,000 inhabitants) / Frankfurt /Oder (74,000 inhabitants),

- Cedynia (ca. 5,000 inhabitants),
- Schwedt (40,000 inhabitants),
- Szczecin (419,000 inhabitants).

To these we must add towns along the tributaries with a particular damage potential:

Olše

- Karvina (67,000 inhabitants).

Opava

- Krnov (26,000 inhabitants),
- Opava (62,000 inhabitants).

Nysa Kłodzka

- Kłodzko (30,000 inhabitants),
- Nysa (50,000 inhabitants).

Lusation Neisse

- Jablonec nad Nisou (46,000 inhabitants)
- Liberec (100,000 inhabitants)
- Zgorzelec (37,000 inhabitants),
- Forst (25,000 inhabitants),
- Guben (26,000 inhabitants).

Kaczawa

- Legnica (109,000 inhabitants).

Bóbr

- Wlen (2,000 inhabitants),
- Lwówek Śląski (19,000 inhabitants),
- Boleslawiec (44,000 inhabitants).

The population of the towns only give an impression of the town size they do not reflect the real damage potential. It is only in exceptional cases when the whole town population is directly affected by the flooding.

Therefore, further enquiries should be made on the basis of more precise knowledge of flooding limits to estimate the amount of potential damage. In this connection, the actual asset values must be determined more precisely. In this work, a differentiation should be made according to the six defined land use categories.

5.7 Potential and Effectiveness Analysis of Possible Measures

Here the types of action listed in chapter 5.1 and the allocated measures of preventive flood protection are analysed and evaluated according to their implementation potential and their effects. The analysis is carried out in three steps:

- Potential analysis -
  What is the basic potential for the realisation of measures in the individual action areas?

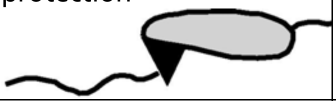
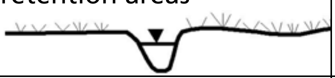
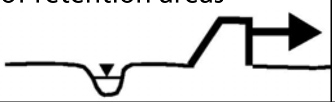
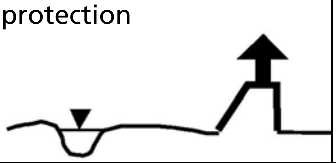
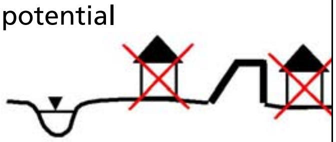
- Effectiveness analysis -
  What contribution to preventive flood protection do the measures provide in the individual action areas?

- Effectiveness analysis for downstream areas -
  What contribution to preventive flood protection do the measures also provide for the downstream action areas (D – G)?

5.7.1 Potential Analysis

In the first step, the realisation potential for the various types of action are considered. The focus is placed on the principle feasibility of a measure whereby the initial situation, i.e. the measures in place or the current stage of realisation, is not relevant.

The following criteria are used to evaluate the potential:

Field of Action		Criteria for Potential
1.	Retention of precipitation in the area where it falls (areal retention) 	- Degree of gradient - Share of forest and agricultural areas - Degree of soil erosion - Share of settled areas with a potential for unsealing and rain water management
2.	Retention through technical flood protection 	- Degree of gradient - Size of catchment area - Suitability of location
3.	Preservation and safeguarding of current retention areas 	Share / area / number / volume of current retention areas Degree of usage competition
4.	Creation and extension of retention areas 	- Share / area / number of extension possibilities for retention areas - Degree of usage competition
5.	(Object) protection by using technical flood protection 	- Number of objects to be protected (including danger to life) - Extent of the endangered areas
6.	Minimising the damage potential 	- Size of current potential damage in particular in settlement areas

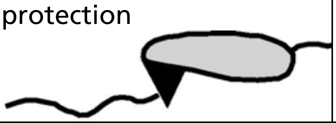
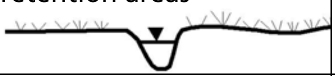
In the analysis, a differentiation is made between three classes (high, average and low realisation potential). The results of the evaluation are shown in the Figure 17 "Action Options - Analysis of Potential and Effects (Map No. 9)" for the action areas A – G.

5.7.2 Analysis of Effectiveness

The effectiveness of measures is also dependent on the nature of the flood event concerned. In this study, we are presuming medium to extreme events (similar to flood event in 1997).

It should be pointed out that object protection by technical measures in particular is carried out in the expectation of flood events of a certain probability. If the calculated expected flood level is exceeded, the protection task can no longer be fulfilled and the protective measures lose their effect.

The following criteria were used for the evaluation of effectiveness:

Field of Action		Criteria for Effectiveness
1.	Retention of precipitation in the area (areal retention) 	- Volume and intensity of precipitation - Achievable retention volume - Volume and intensity of flow-off formation ⇒ Reduction of water level (target)
2.	Retention through technical flood protection 	- Volume and intensity of precipitation - Achievable retention volume - Increasing warning time - Volume and intensity of flow-off formation ⇒ Reduction of water level (target)
3.	Preservation and safeguarding of current retention areas 	- Deceleration of the flood waves - Achievable retention volume ⇒ Reduction of water level (target)
4.	Creation and extension of retention areas 	- Deceleration of the flood waves - Achievable retention volume ⇒ Reduction of water level (target)
5.	(Object) protection by using technical flood protection 	- Reduction of the damage potential
6.	Minimising the damage potential 	- -Reduction of the damage potential

The evaluation of effectiveness is also carried out in three classes (high, average and low effectiveness).The results for the various action areas (A – G) are shown in the Figure 17 "Action Options - Analysis of Potential and Effects (Map No. 9)" in the form of a table.

5.7.3 Analysis of the Effectiveness of Measures for Downstream Areas

During the flow-off of a flood wave in the river, this wave is „stretched out". Without any additional water from the partial catchment areas in the lower valley, the flood wave crest would continuously decrease. A similar effect occurs when flow-off reduction takes place due to flood protection measures reducing the flood crest height. The effect achieved is much reduced further down the river in the lower part of the valley. From this we can deduce the following principles:

- The main beneficiaries of flood protection measures are the next areas directly downstream from them.
- The areas far down the valley only feel the results of protection measures in the upper valley to a greatly reduced effect.

In the following analysis both the positive and the negative effects of measures on the downstream locations are considered.

Here, in a roughly quantitative evaluation, ranges for the lowering of the water level are given (centimetre, decimetre up to metre). The estimated ranges quoted here were obtained from the experience of the authors on the effects of measures carried out in other river valleys (Rhine, Main and Moselle catchment areas). These estimates will be confirmed as a trend by the first model calculations in the parallel project ODER-LISFLOOD . In order to make more accurate statements, more detailed scenario observations must be carried out.

5.7.3.1 A- Czech Tributaries

Measures in the area A – Czech tributaries Effect on	Retention of precipitation water in the catchment 	Retention through technical flood protection 	Preservation and safeguarding of available retention areas 	Creation and extension of retention areas 	(Object) protection by using technical flood protection 	Minimising the damage potential 
A – Czech tributaries	*medium*	*medium to high*	*low*	*low*	*medium*	*medium*
D – Ostrava – Opole	low [centimetre]	medium [decimetre]	low [centimetre]	low [centimetre]	! negative effect	low (environment)
E – Opole - Wrocław	no effect	low [centimetre]	no effect	no effect	! negative effect	low (environment)
F – Wrocław – mouth of Lusation Neisse	no effect	no effect	no effect	no effect	no effect	low (environment)
G – Mouth of Lusation Neisse – Szczecin	no effect	no effect	no effect	no effect	no effect	low (environment)

5.7.3.2 B – Polish Tributaries

Measures in area B – Polish tributaries Effect on	Retention of precipitation water in the catchment 	Retention through technical flood protection 	Preservation and safeguarding of available retention areas 	Creation and extension of retention areas 	(Object) protection by using technical flood protection 	Minimising the damage potential 
B – Polish tributaries	*medium*	*medium to high*	*low*	*low*	*medium*	*medium*
E – Opole - Wrocław	low [centimetre]	high [decimetre to metre]	medium [decimetre]	low [centimetre]	! negative effect	low (environment)
F – Wrocław – mouth of Lusation Neisse	low [centimetre]	medium [decimetre]	low [centimetre]	low [centimetre]	no effect	low (environment)
G –Mouth of L. Neisse – Szczecin	no effect	low [centimetre]	no effect	no effect	no effect	low (environment)

5.7.3.3 C - Lusation Neisse

Measures in area C – Lusation Neisse Effect on	Retention of precipitation water in the catchment	Retention through technical flood protection	Preservation and safeguarding of available retention areas	Creation and extension of retention areas	(Object) protection by using technical flood protection	Minimising the damage potential
C –Lusation Neisse	*medium*	*medium to high*	*low to medium*	*low to medium*	*medium*	*medium*
G – Mouth of Lusation Neisse – Szczecin	no effect	medium [decimetre]	low [centimetre]	low [centimetre]	! negative effect	low (environment)

5.7.3.4 D - Ostrava-Opole (Oder)

Measures in area D – Ostrava-Opole Effect on	Retention of precipitation water in the catchment	Retention through technical flood protection	Preservation and safeguarding of available retention areas	Creation and extension of retention areas	(Object) protection by using technical flood protection	Minimising the damage potential
D – Ostrava-Opole	*medium*	*high*	*medium*	*medium*	*medium to high*	*high*
E – Opole - Wrocław	low [centimetre]	high [decimetre to metre]	medium [decimetre]	medium [decimetre]	! negative effect	medium to high (environment)
F – Wrocław – Mouth of Lusation Neisse	no effect	medium [decimetre]	low [centimetre]	low [centimetre]	! negative effect	low (environment)
G – Mouth L. Neisse – Szczecin	no effect	medium [decimetre]	low [centimetre]	low [centimetre]	no effect	low (environment)

5.7.3.5 E - Opole - Wrocław (Oder)

Measures in the area E – Opole-Wrocław (Oder) Effect on	Retention of precipitation water in the catchment	Retention through technical flood protection	Preservation and safeguarding of available retention areas	Creation and extension of retention areas	(Object) protection by using technical flood protection	Minimising the damage potential
E – Opole - Wrocław	*medium*	*low*	*high*	*high*	*high*	*high*
F – Wrocław – mouth of Lusation Neisse	low [centimetre]	medium [decimetre]	high [decimetre to metre]	high [decimetre to metre]	! negative effect	low (environment)
G – Mouth of Lusation Neisse – Szczecin	no effect	low [centimetre]	medium [decimetre]	medium [decimetre]	no effect	low (environment)

5.7.3.6 F - Wrocław – Mouth of Lusation Neisse

Measures in area F Wrocław-Mouth of Lusation Neisse Effect on	Retention of precipitation water in the catchment	Retention through technical flood protection	Preservation and safeguarding of available retention areas	Creation and extension of retention areas	(Object) protection by using technical flood protection	Minimising the damage potential
F – Wrocław – Mouth of Lusation Neisse	*medium*	*low*	*high*	*high*	*medium*	*high*
G – Mouth of Lusation Neisse – Szczecin	low [centimetre]	low [centimetre]	medium [decimetre]	medium [decimetre]	! negative effect	low (environment)

5.7.3.7 G - Mouth of Lusation Neisse - Szczecin

Measures in area G – Mouth of Lusation Neisse - Szczecin	Retention of precipitation water in the catchment	Retention through technical flood protection	Preservation and safeguarding of available retention areas	Creation and extension of retention areas	(Object) protection by using technical flood protection	Minimising the damage potential
G –Mouth of Lusation Neisse - Szczecin	*low*	*low*	*high**	*high**	*high*	*high*

* *high* upstream Słubice / Frankfurt/Oder, *medium* downstream Słubice / Frankfurt/Oder

The evaluation tables show that the measures not only have effects within the corresponding action area but that there are also effect relationships with the downstream areas.

For example, a flood height reduction through measures of technical retention in action area D (in particular the planned reservoir at Racibórz) will be felt along the whole Oder valley.

Also, the creation and extension of retention areas in the region between Opole and the Lusation Neisse (action areas E and F) will have a relieving effect on the situation along the lower Oder as far as Szczecin (action area G).

There still exists the necessity to carry out flood protection in the action areas itself. This concerns the "downstream" action area G especially. There are effective fields of action, like widening the flow-off profiles, which are described in the table above.

The relieving effect for the environment stated here occurs because, as well as other effects, fewer private oil tanks are flooded over which could damage water quality.

Negative effects for downstream areas due to the technical protection measures (dikes, flood protection walls) are to be expected.

The interrelation of effects between the action areas demonstrates the close connection between local measures in upstream areas and their possible effects in downstream regions of the river. This upstream-downstream problem complex must therefore be considered for all action projects.

3 The Initial Situation in the Oder Catchment Area

3.1 Hydrological and Water Management Framework Conditions

3.1.1 Overview of the Water System and the Partial Catchment Areas

The River Oder (in Czech and Polish: Odra) originates at a height of 634 m. above sea level in the Oder Mountains, the eastern part of the Czech Sudetes Mountains. It flows into the Baltic Sea via the Stettiner Haff (Polish: Zalew Szczeciński). The 854 km length of the Oder, up to its mouth in the Stettiner Haff, has a catchment area of about 118,861 km^2. This catchment area is to 89 % situated in the Republic of Poland, to 6 % in the Czech Republic and to 5 % in the Federal Republic of Germany.

The Oder catchment area is limited in the east by the catchment area of the River Vistula, in the south by that of the Danube and by that of the Elbe in the west. According to its geomorphology, the Oder can be divided up into three large partial catchment areas:

- Upper Oder (source to Wrocław)
- Central Oder (Wrocław to mouth of the Warta)
- Lower Oder (mouth of the Warta up into the Stettiner Haff)

The following table shows the most important tributaries of the Oder:

Table 1: Important Tributaries of the Oder [IDNDR 1998]

From the West Bank (left)		From the East Bank (right)	
Name	Catchment Area [km^2]	Name	Catchment Area [km^2]
Opava	1,835.0	Ostravice	811.0
Osobloga	993.3	Olze (Olsa)	1,117.6
Nysa Kłodzka	4,565.7	Kłodnica	1,084.8
Olawa	1,002.7	Mała Panew	2,131.5
Ślęża	971.7	Widawa	1,716.1
Bystrzyca	1,767.8	Barycz	5,534.5
Kaczawa	2,261.3	Warta	54,528.7
Bóbr	5,876.1	Ina	2,189.4
Lausitzer Neiße / Nysa Łużycka / Luzicka Nisa	4,297.0		

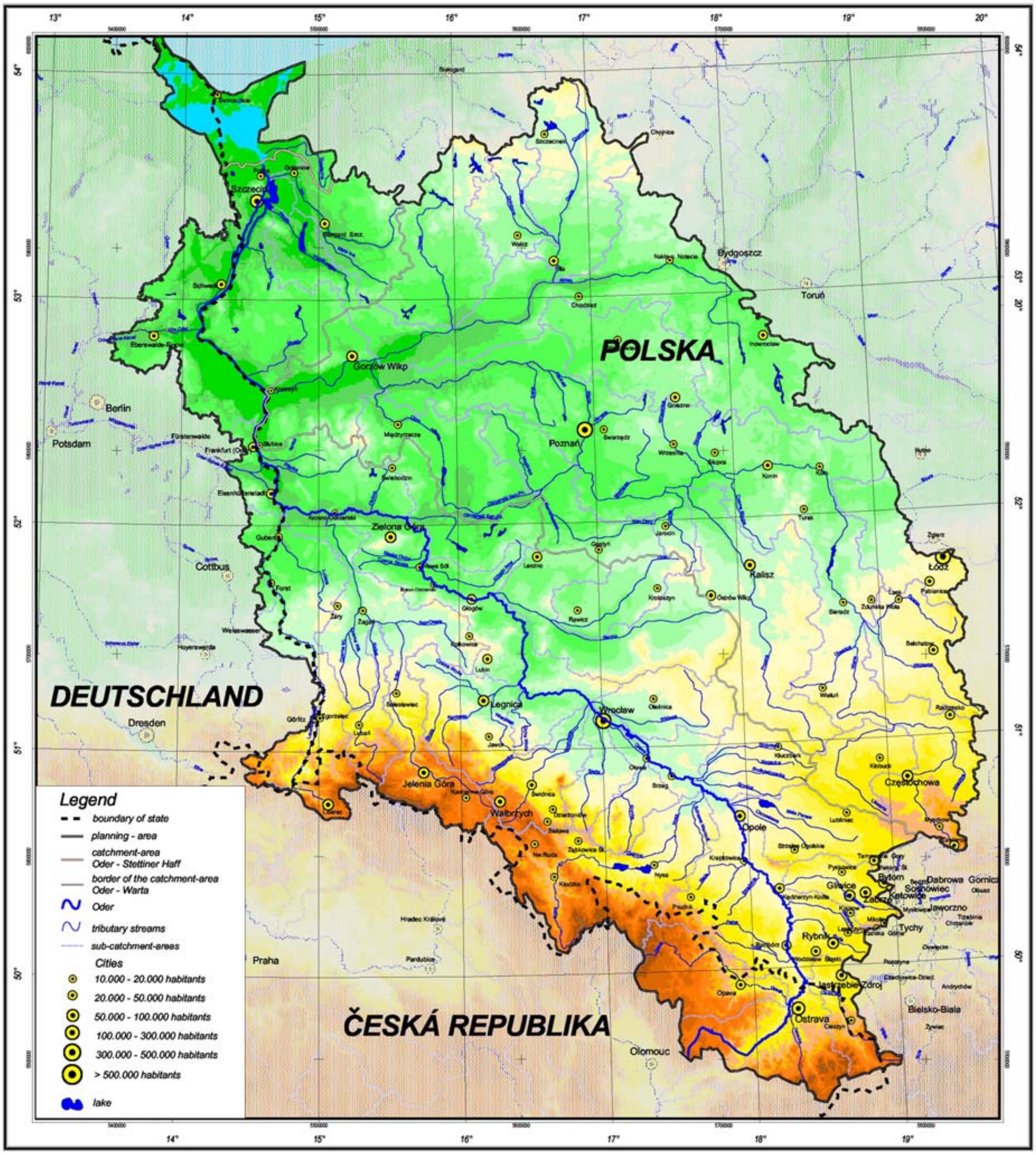


Figure 2: Catchment Area of the Oder with the Most Important Tributaries

3.1.2 Overview of the Flow-off Conditions and the Historical Floods up to the 1997 Oder Flood

The flow-off behaviour of the Oder is characterised by increased water levels in spring due to melting snow and a reduced volume of water in summer. In comparison with other river basins further to the west, the Oder has a relatively low surface water volume with a mean flow-off rate at the Hohensaaten-Finow measuring station of 4.76 $l/(s \bullet km^2)$. On average, in the catchment area, 600 to 700 mm of precipitation fall annually. The highest annual precipitation of 1,000 to 1,400 mm occurs along the southern ridges of the mountain areas.

In the upper and central basin of the Oder (Beskides mountain streams and the south-eastern and north-western tributaries), during the summer, extremely heavy rain can cause short, high flood waves. In winter the combination of melting snow and ice flows cause a particular flow-off behaviour which is a source of danger for the flood protection installations.

Of very particular importance are the so called Vb weather situations. During a Vb weather pattern, as a result of a massive influx of cold air over western Europe, first of all a low-pressure area forms over Northern Italy. This then moves in a northerly or north-eastern direction carrying warm and humid Mediterranean air. When it meets the cold air it ascends and on the edge of these two air masses extensive heavy rain occurs.

As a result of Vb weather situations in these medium altitude mountains -over the past 110 years- repeatedly very heavy rainfall has caused long-lasting and extensive flooding in the Oder basin (for example in July 1903, 1915, 1924, November 1930, August 1977, 1997).

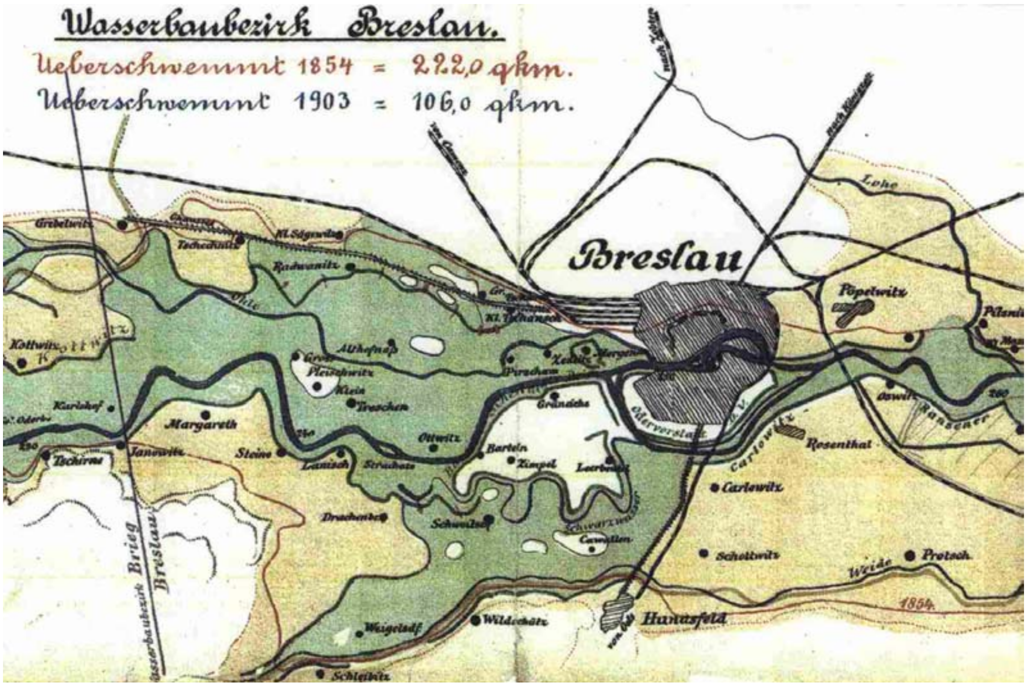


Figure 3: Flooded Areas during the Historical Floods of August 1854 and July 1903 on the Oder near Wrocław [TBO 1903]

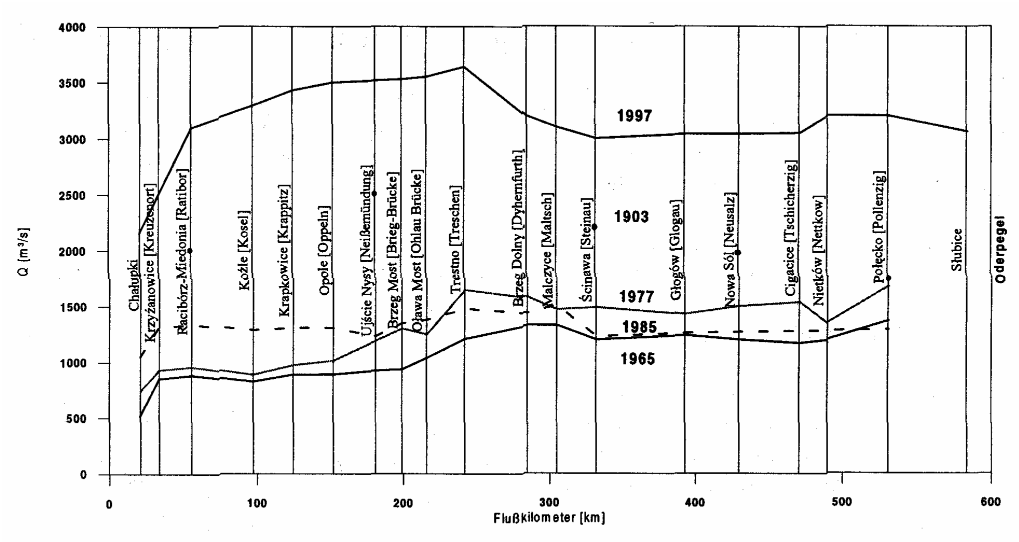


Figure 4: Maximum Flow-off of Large Floods on the Oder in the 20th Century [IDNDR 1998]

At the beginning of July 1997, the low pressure area called „Xolska“ over the Balkans led to the transport of warm and humid air masses towards the north. This air then met with the cold air from the Baltic region. This Vb weather pattern caused two successive very heavy rainfall periods in the Carpathian Forest and Riesengebirge causing the 1997 summer flood. The heaviest rainfall measured amounting to 568 mm fell between 04. and 09.07.1997 at the Czech meteorological station at Lysa Hora (Kahlkopf) in the western Beskedes Mountains. This represented one third of the annual rainfall in 1997.

Table 2: Precipitation Volumes during the 1997 Summer Flood [LUA 1998a]

Station	Country	Catchment Area	Precipitation from 04.07.97, 6:00-a.m. to 08.07.97, 6:00 a.m.	Precipitation from 18.07.97, 6:00-a.m. to 21.07.97, 6:00 a.m.
Liberec	CZ	Lusation Neisse	67 mm	82 mm
Lysa Hora	CZ	Oder	586 mm	147 mm
Praded	CZ	Nysa Kłodzka	454 mm	107 mm
Ostrava	CZ	Oder	234 mm	54 mm
Jelenia Góra	PL	Bóbr	175 mm	133 mm
Lódź	PL	Warta	166 mm	36 mm
Ratibor	PL	Oder	244 mm	-
Śnieżka	PL	Bóbr	67 mm	124 mm

This extraordinarily heavy rain caused the water levels of the headwaters of the Oder and the rivers in the central and northern Sudetes Mountains to increase dramatically leading to widespread flooding. The following figures show the recorded course of flow-off of historical floods in comparison with the summer flood of 1997.

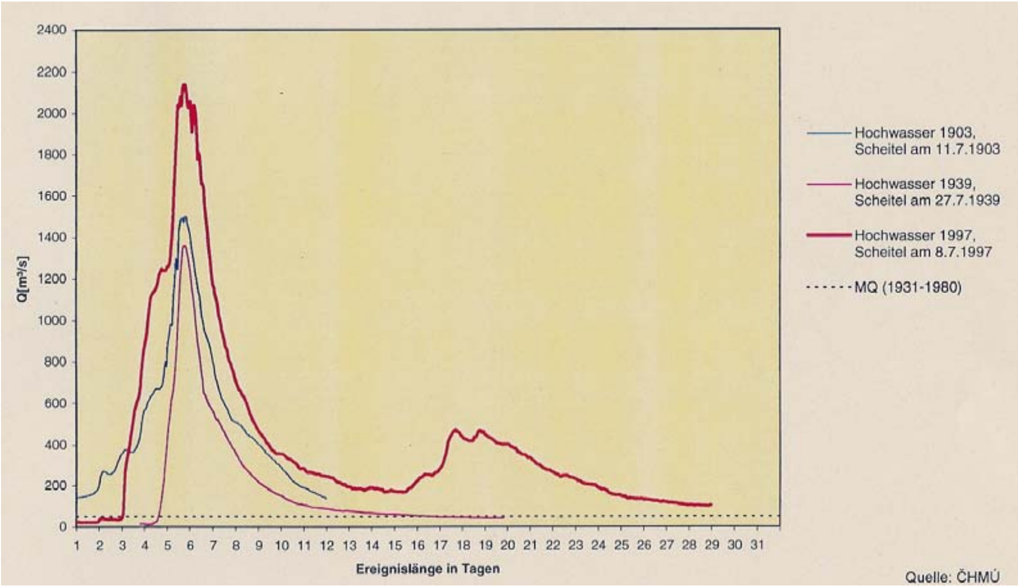


Figure 5: Course of Flow-off of the Flooding Events in 1903, 1939 and 1997 for the Water Level Measuring Point at Oderberg (Bohumin) on the Oder [IKSO 1999]

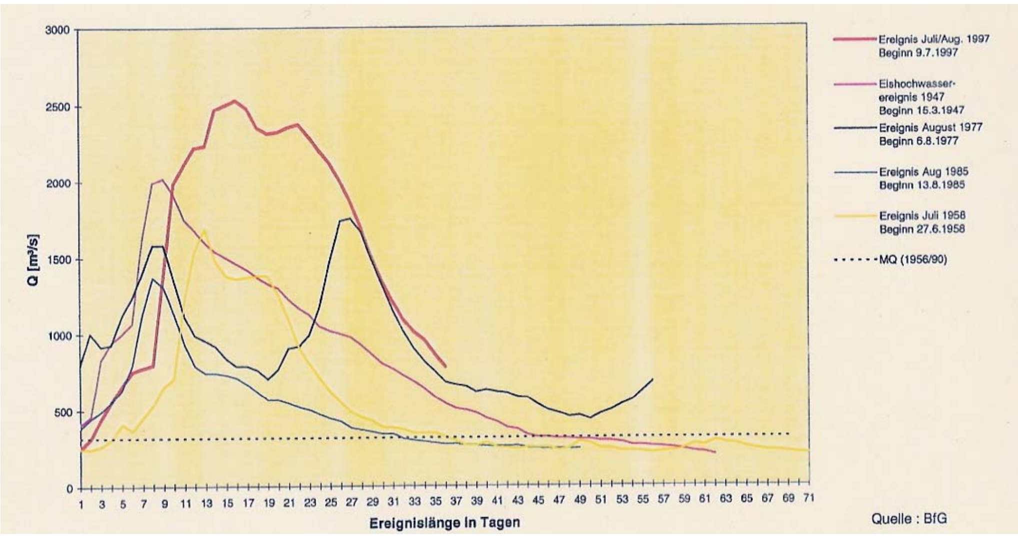


Figure 6: Course of Flow-off of the Flooding Events in 1947, 1958, 1977, 1985 and 1997 for the Water Level Measuring Point at Eisenhüttenstadt on the Oder [IKSO 1999]

The summer flood of 1997 was the largest flood on the Oder during the 20th century. This applies to all aspects: the crest of the flood waves (measured water levels), the volumes of the flood waves, the duration of the flooding and the extent of the area affected. In the upper reaches of the Oder, at the measuring point in Racibórz-Miedonia, a flow-off rate of 3,100 m^3/s was estimated. This corresponds to a flow-off volume of 460 $l/(s \bullet km^2)$. At the German measuring point in Eisenhüttenstadt a flow-off rate of about 2,600 m^3/s was estimated and the figure for the Polish measuring point at Slubice was about 2,870 m^3/s.

The repeat interval of the summer flood of 1997 is about 100 years for the Czech water level of the Oder. For the Polish water level a repeat interval of >500 years was estimated in some places. The repeat interval for the German water level of 80 –120 years is clearly greater than the repeat interval for the floods since 1921.

3.1.3 Areas Endangered by Flooding

Since the 13th century, the Oder downstream from Wrocław has been used as a shipping route. In the 18th century, extensive engineering work was carried out to improve the river for shipping. A large number of cuts were made to remove meanders which reduced the distance travelled by about 160 km (20 % of the total length of the Oder); this shortening work on the Oder corresponds to similar projects on other large European rivers. At the end of the 19th century, the construction of 12 locks on the Oder ensured a permanent shipping lane depth of 1.5 m. The engineering work on the Oder to create a shipping route for larger barges together with dike construction for flood protection have caused a reduction in the wetlands freely available for flooding from previously about 3,700 km^2 to about 860 km^2 .Therefore are now only roughly 23% of the former potential flooding areas available. As well as the Oderbruch area of about 800 km^2, particularly potential flooding areas in the upper and central Oder valley were protected by dikes.

The following Figure 7 shows the areas which are potential flooding areas in the water meadow areas of the Oder valley.

Figure 7: Potential Flooding Areas in the Water Meadows of the Oder Valley

3.1.4 Current Flood Protection System and Degree of Protection

The present technical flood protection system in the Oder catchment area consists of the following main features:

- Retention in storage reservoirs (reservoirs and retention basins),
- Polders along the Oder,
- Flood dikes along the Oder,
- Diversion channels on the Oder.

3.1.4.1 Retention in Storage Reservoirs

The reservoirs and storage basins in the Oder catchment area have different – sometimes competitive – purposes. They serve in particular

- Provision of drinking water,
- Increasing water levels when necessary,
- Hydroelectric power and
- Flood protection.

Additionally, they are also of, in some cases, considerable value for recreation purposes.

In the Polish catchment area of the Oder, there are at present 21 reservoirs with a total volume of 968.5 mill. m^3, of these, currently about 329 mill. m^3 are designated for flood protection. Additionally, along the left bank tributaries in the central Oder valley there are 12 retention basins with a total volume of 29 mill. m^3 in operation.

In the Czech Oder catchment area, after the retention basin Slezka H. on the Moravice has been completed, a total dam volume of 386.4 mill. m^3 will be available, of this, 56 mill. m^3 is designated for flood protection. Further planned flood retention basins in the Czech catchment area of the Oder can provide a further 100 mill. m^3 of storage volume.

An exact documentation of the available reservoirs and their locations in the catchment area of the Oder is shown on Figure 14 „Flood Protection Structures in the Oder Catchment Area (Map No. 6)".

As the following table shows, some of these reservoirs were able to effect a considerable reduction of the flood crest level during the 1997 summer flood events.

Table 3: Inflow and Outflow of the Reservoirs during the Summer Flood in July 1997 [IDNDR 1998]

Reservoir	River	1. Flood Wave		2. Flood Wave		Comments
		max. Inflow [m³/s]	max. Outflow [m³/s]	max. Inflow [m³/s]	max. Outflow [m³/s]	
Nysa	Nysa Klodzka	2,594	1,500	925	600	Sum of the inflow to both reservoirs [1]
Otmuchow	Nysa Klodzka	2,156	1,103	692	420	
Mietkow	Bystrzyka	201	30	303	230	
Słup	Nysa Szalona	99	6	263	146	
Dobromierz	Strzegomka	36	16	131	124	
Bukowka	Bobr	62	8	24	8	

[1)] The retention basins Otmuchow and Nysa are directly next to each other, their joint effect is the flow off of the Nysa reservoir

3.1.4.2 Flood Dikes along the Oder

The dike building along the Oder goes back to the 16th and 17th centuries and reached its provisional height at the end of the 19 th century. Always, after extreme flood events, increased efforts were made to extend and improve the dike system.

After examinations of the dikes in 1995 the conclusion was drawn that the majority of the dikes after at least 100 years of operation no longer fulfilled they technical requirements of HQ100 regarding compression, the permeability of the dike body and foundations and the height of the crown of the dike above the water level.

The current dike system does not represent a uniform flood protection system along the River Oder. Responsible for this are:

- the different age of the dikes,
- the different cross-sections of the dikes,
- the different freeboard and
- the still lacking uniform hydrological measurement basis.

After the flood in the summer 1997 there have been considerable efforts for restoration and rehabilitation of the dikes on the Polish and German sections affected. The immediate repairs have already been completed. Further medium to long term measures will continue until 2010 [LUA 1998b].

The position of the current dikes in the Oder catchment area can be seen on Figure 15 „Navigability of the Oder (Map No. 7)".

3.1.4.3 Polders along the Oder

Along the Oder there are numerous overflow polders with a total capacity of about 280 mill. m^3 in the German and Polish parts of the river. Over the last 20 years, work has started to equip the previously uncontrolled polders with inflow and outflow control installations. However, in the past some of these polders were not flooded because they

(a) do not have controllable inlet and outflow installations, which means that a planned reduction of the flood wave crest is not possible, and because

(b) due to an intensification of the land use of the polder areas there was a growing pressure not to flood them.

The following tables show available and planned potential polders in Poland and Germany.

Table 4: Polders on the Oder in Poland

Available Polders

	Polder Name	River Kilometre	Bank L – left R – right	Polder Area [ha]	Polder Volume [mill. m³]
1	Buków	60	R	710	62
2	Obrówiec	117.5-121.0	R	287	3.65
3	Bąków	120,0	L	420	5.4
4	Żelazna	155.0-158.0	L	222	3.3
5	Czarnowąsy	158.5-162.0	R	215	3.65
6	Rybna	178.5-187.0	R	810	12.0
7	Zwanowice	185.0-189.0	L	147	2.0
8	Kruszyna	193.0-194.0	L	41	1.6
9	Brezezina	201.0-204.0	L	297	3.5
10	Oława-Lipki	205.7-223.0	R	3,000	30.0
11	Oławka	238.0-247.0	L	1,070	12.0
12	Blizanowice-Trestno	237.5-243.0	L	221	3.8
13	Kiełcz-Tarnów Bycki	416.9-424.7	L	815	15.0
14	Połupin	491.4-516.0	L	4,125	70.0
15	Krzesin-Bytomiec	534.0-543.0	R	1,200	20.0
16	Widuchowa (5)	About 703	R	2,540	19.0
17	Gryfino (4)	About 715	R	2,360	10.0
18	Szczecin (3)		R	790	2.7
			Total:	13,580	280

Planned Polders

	Polder Name	River-Kilometre	Bank L – left R – right	Polder-Area [ha]	Polder-Volume [Mill. m³]
1	Opole		R	1,050	25
2	Żelazna II		L	1,180	18
3	Chróścice		R	1,320	20
4	Kotowice			1,950	24
5	Domaszów-Tarchalice		L	658	4.9
6	Bieliszów-Lubów		R	386	9.9
7	Dobrzejowice-Czerna		L	240	3.8
8	Otyń-Bobrowniki	435 – 442	L	[1]	[1]
9	Milsko	444 – 450	L	[1]	[1]
10	Urad	555 – 565	R	[1]	[1]
11	Świecko	573 – 578	R	[1]	[1]
12	Słubice	586 – 602	R	[1]	[1]
			Total:	8,794*	About 132*

*)incomplete, [1] no information available before printing

Table 5: Polders on the Oder in Germany

	Polder Name	Bank L – left R – right	Polder-Area [ha]	Polder-Volume [mill. m³]
1	Kienitzer Polder	L	150	4
2	Criewener Polder (A)	L	1,400	53
3	Schwedter Polder (B)	L	1,300	40
4	Fiddichower Polder (10)	L	1,700	35
		Total:	4,550	132

The German polders on the Oder have a total volume of 132 mill. m^3.

On the areas endangered by flooding of the Oder in Brandenburg, an additional potential retention area with a volume of about 188 mill. m^3 has been identified.

Table 6: Potential Retention Areas on the Oder in Germany

	Polder Name	Bank L – left R – right	Polder-Area [ha]	Polder-Volume [mill. m³]
1	Parts of the Neuzeller lowland	L	1,500	45
2	Parts of the Ziltendorfer lowland	L	1,500	38
3	Sophienthaler Polder	L	500	15
4	Lunow-Stolper dry polder	L	1,600	70
5	Friedrichsthaler Polder (5/6)	L	650	15
6	Gartzer Bruch	L	1.000	4
7	Staffelder Polder (8)	L	40	0.6
		Total:	6,790	188

The position of the available polders in the Oder catchment area are shown on Figure 14 „Flood Protection Structures in the Oder Catchment Area (Map No. 6)“.

3.1.4.4 Diversion Channels on the Oder

In the process of modernisation of the dikes and the improvement of the shipping route for larger ships on the Oder, three diversion channels have been built to date:

- Diversion channel in Racibórz,
- Diversion channel in Opole with a flow-off capacity of 600 m³/s,
- Diversion channel north in Wrocław with a flow-off capacity of 870 m³/s.

In the case of a flood, a certain part of the flow from the main river is directed into the diversion channel. Thus the flood danger for the particularly endangered "bypassed" areas is reduced.

3.2 Land Use

An overview of the current types of land use is available on Figure 11"Land Use in the Oder Catchment Area (map 3)". Here the so-called Corine-Land-Cover data for the Oder catchment area are shown.

3.2.1 Overview of the Agricultural and Forestry Activities in the Catchment Area

The parts of the catchment area of the Oder used for forestry and agriculture can be roughly characterised using the relief pattern and the nature of the soil. In the valley and lowland areas mainly greenland agriculture is carried out. Arable farming is principally carried out on the loess and fruitful sandy soils in the hilly areas and in some places also in the water meadow areas (e.g. in the Oderbruch). The less fruitful sandy soils are mostly covered with forest (mixed deciduous forest, coniferous forest). The medium altitude ridges of the Sudetes Mountains are covered to about 30 % by forest whereby coniferous trees dominate. Along the River Oder itself, in some places, there are still some remnants of the natural wetland forest.

3.2.2 Settlement and Infrastructure

Throughout the complete Oder catchment area, there is a clear gradient from south to north with regard to population density. Whereas there is a relatively high population and settlement density in the medium altitude hilly districts in the south, the farther north in the lowland area with its extensive plane is clearly towards less dense settlement.

Some settlement areas, due to their location directly on the water meadows, are particularly important for flood protection. The following towns with more than 50,000 inhabitants are situated directly on the Oder:

- Ostrava (330,000 inhabitants),
- Racibórz (100,000 inhabitants),
- Kędzierzyn- Koźle (68,000 inhabitants),
- Opole (125,000 inhabitants),
- Wrocław (640,000 inhabitants),
- Głogów (74,000 inhabitants),
- Nowa Sól (128,000 inhabitants),
- Krosno Odrzańskie (61,000 inhabitants),
- Frankfurt /Oder (74,000 inhabitants),
- Szczecin (419,000 inhabitants).

Further towns in the Oder catchment area which are important because of their size are:

- Liberec (Lusation Neisse),
- Legnica (Kaczawa),
- Częstochowa, Poznań und Gorzów Wielkopolski (Warta).

A flooding hazard exists in these settlement areas for both housing and industry as well as other technical infrastructure facilities such as landfills, sewage plants, drinking water works and roads which are all potentially endangered objects.

The gravel pits along the lower Oder valley are also relevant from the flooding point of view. On the one hand, flow-off can be hindered by gravel quarrying and on the other hand the potential damage is increased.

Along the Lusation Neisse in particular, there are abandoned open cast lignite mines and some installations which are still in operation. Filling the remaining craters left by the mining operations with water can have considerable effects on the water situation – also during a flood event. The flooding aspects in the abandoned lignite open cast mines must therefore be examined in their development plans.

3.2.3 Nature Conservation

In comparison with other West European rivers, in spite of the many man made inroads to regulate the river, the Oder still possesses relatively large areas of almost natural wetland water meadow areas as well as extensive open plains of meadows and grassland. The remaining wetland forest areas can be classified as an almost natural landscape.

This is reflected in the large network of protected areas in particular along the lower Oder valley. In this part of the valley, the World Wildlife Fund (WWF) has carried out extensive inventories in both the planned and the existing nature reserves [WWF 2000a].

A comprehensive compilation and description of the existing and planned reserve areas for the complete upper valley of the Oder in Poland is contained in the supplement „Nature“ of the program „ODRA 2006“ [ODRA 2006].

In the lower Oder valley region two protected areas are particularly important:

- the national park „Unteres Odertal“ (Lower Oder Valley) and
- the nature reserve „Słońsk”.

The cross-border national park „Lower Oder Valley“ (about 12,000 ha) continues on the Polish side through the landscape park Cedynski. The national park includes the wetland landscape of the lower Oder valley and the bordering dry grass and forest areas. The polder areas which are regularly flooded are well equipped with biotope complexes with a large variety of different species.

The „Słońsk” nature reserve extends over 4,244 ha and due to the wealth of fauna (250 species of birds) is considered one of the most valuable nature conservation areas in Poland. „Słońsk” is the central part of the landscape park „Ujście Warty” at the mouth of the Warta. It is of primary international importance as the habitat of wading birds and other aquatic birds and is therefore subject to the RAMSAR agreement.

3.2.4 Condition of the Flooding Areas along the Oder

The most up to date and complete overview of the condition of the flooding areas along the Oder is provided by the Oder-Auen-Atlas [WWF 2000b]. For this atlas, based on a geomorphological subdivision of the Oder valley, an evaluation of the natural flooding areas in 11 sections of the Oder was carried out from an expert nature conservation point of view.

The following proportion of the area were taken into account as criteria:

- Proportion of biotopes, valuable for nature conservation, on the current water meadows and on the old water meadows,
- Proportion of forest, valuable for nature conservation, on the current water meadows and the old ones and
- Proportion of the current water meadows of the natural flooding area.

Further qualitative evaluation criteria used were bioindicators, the presence of old river arms and the extent to which fish have free access along the waters. The overall evaluation was summarised in three categories (poor, satisfactory, good).

The findings of the Oder-Auen-Atlas are summarised below for the four areas of action which were defined along the river (see chapter 5.4).

3.2.4.1 Evaluation of Ecological Condition Ostrava - Opole

The ecological condition of the Oder valley from Ostrava to Opole was judged as follows:

- High areal proportion of the current water meadows on the natural flooding plain,
- Low areal proportion of biotope types, which are valuable from a nature conservation point of view (apart from forest) on the current water meadows,
- Low areal proportion of forest in the current water meadows which are valuable for nature conservation,
- Low to very low areal proportion of biotope types valuable for nature conservation on the old water meadows (including forest).

In spite of the high proportion of current water meadows in the natural flooding area, this section of the river was among those with the worst evaluation along the valley.

The surface watercourses are well structured but along the whole section there are not always open passages to the Oder. The natural flooding area is very badly damaged along 130 river kilometres. Therefore the condition was judged as poor.

3.2.4.2 Evaluation of Ecological Condition Opole - Wrocław

General estimation:

- Low proportion of current water meadows on the natural flooding plain,
- High areal proportion of biotope types valuable for nature conservation (apart from forest) on the current water meadows,
- Low areal proportion of forest valuable for nature conservation on the current water meadows,
- Low to very low areal proportion of biotope types valuable for nature conservation on the old water meadows (including forest).

Southeast of Wrocław, in the Mała Panew – Wrocław section, there are important biotope types which are valuable for nature conservation and also the largest forest areas concentrated in a few water meadow areas directly near the river. Here, in some parts the natural condition is good and the connections between the water meadows and the river are also partially intact. This good result must be qualified however by the lack of free access along the river for fish.

The overall condition of the current water meadows and the old river meadows is judged as satisfactory.

3.2.4.3 Evaluation of the Ecological Condition Wrocław – Mouth of the Lusation Neisse

The evaluation of the judgement criteria showed the following scenario:

- Low areal proportion of current water meadows on the natural flooding plain,

- High areal proportion of biotope types valuable for nature conservation (apart from forest) on the current water meadows,
- Medium to high areal proportion of forest valuable for nature conservation on the current water meadows,
- Low to very low areal proportion of biotope types valuable for nature conservation on the old water meadows (including forest).

Parts of the Wrocław - Kazcawa section are in good condition with partially functioning connections between the water meadows and the river. The lack of access for fish along the river and the danger of wetland forest drying out downstream from the lock at Brzeg Dolny mean that the overall evaluation cannot be described as good.

In the Obriżenie Ścinawskie, Pradolina Głogowska and Kotlina Kargowska sections, the condition of the current and the old water meadows can be described as good to satisfactory. There is a functioning connection between the water meadows and the river and access for fish is also guaranteed along the river. Also, in this area, there is the largest share of forest in the current water meadows in the whole Oder valley.

The section upstream from the confluence of the Neisse is also characterised by a high proportion of forest and a functioning connection between river and water meadows. The condition of the old water meadows is good.

In total, the condition of the current water meadows is good throughout the complete section and the access for fish along the river is guaranteed.

3.2.4.4 Evaluation of the Ecological Condition Mouth of the Lusation Neisse - Szczecin

General judgement:

- Low areal proportion of current water meadows on the natural flooding plain (high proportion however in the Dolina Dolnej Odry section),
- High areal proportion of biotope types valuable for nature conservation (apart from forest) on the current water meadows,
- Low areal proportion of forest valuable for nature conservation on the current water meadows, ,
- Low to very low areal proportion of biotope types valuable for nature conservation on the old water meadows (including forest).

Directly downstream from the confluence of the Neisse the proportion of forest is low and the old water meadows are in poor condition. The current water meadows are in good condition and the access for fish along the river is guaranteed.

In the Lubuksi Przełom Odry and Kotlina Freienwalde sections the river is accessible for fish. There is a functioning connection between the river and the water meadows. The current water meadows are in good condition but the old water meadows are in poor condition. In comparison with the other sections, the old water meadows are in the poorest condition here.

All in all, the condition of the natural flooding areas is judged to be satisfactory.

A separate evaluation for the conditions in the Dolina Dolnej Odry section must be made. Here, there is a high proportion of current water meadows on the natural flooding plain. The condition is evaluated as good. In comparison with the other sections, the old water meadows have relatively little damage and their condition can be judged as satisfactory. The functional connection between river and water meadows is guaranteed. The overall evaluation of the natural flooding area is satisfactory to good.

3.3 Recognisable Planning Intentions, Strategies and Goals

As in the past, the recent floods in 1972, 1985 and the summer flood in 1997 were the prime motivation for the increased planning activities. A central document which is the result of many of these planning intentions is the ODRA 2006 Program „Strategy for modernisation of the Oder watercourse system“ [ODRA 2006]. Joint positions on this program were agreed between Brandenburg and Poland and subsequently published [AG „Oder 2006“ 2000].

a) The following planning priorities can be deduced for the field of „Technical Flood Protection“ from the Program ODRA 2006.

- Removal of flood damage to the water engineering infrastructure,
- Improvement and reinforcement of the dike system with a protection target >100 years („determining flow Q_m=HQ100“) on the Oder and its tributaries,
- Creation of retention volume with the following measures:
    - Reservoirs and retention basins (defined additional potential retention volume 100 mill. m^3),
    - Polders (defined potential retention volume at new polder locations 216 mill. m^3),
    - Dike relocations,
    - Documentation of the ownership rights on the areas endangered by flooding and
- Building of diversion channels.

b) As well as these principally engineering tasks of technical flood protection, the ODRA 2006 program proposes a series of measures which are not directly connected with building work:

   - Definition of danger zones,
   - Information of institutions and inhabitants regarding danger areas and evacuation routes,
   - Steering of the decisions regarding building conditions (building development plan) and commercial use of the areas endangered by flooding,
   - Definition of guidelines for the production of regional programs and spatial planning studies on flood protection,
   - Establishment of measure priority list,
   - Improvement of the general data situation including forecasting in case of a flood occurrence.

Furthermore, strategies and principles regarding the improvement of flood protection were already formulated at international level [IKSO 2000]. They serve as the basis for the draft of the action program of the IKSO for flood protection in the Oder catchment area [IKSO 2001].

Here too, very concrete measures are proposed to improve flood protection in the Oder basin. These confirm the measures proposed in the ODRA 2006 program and extend these with the following items:

- Renaturalisation of waters,
- Encouragement of seepage by extensive land use.

With regard for the targets of the International Commission for the Protection of the Rhine (IKSR), concrete quantified action goals are currently being prepared for the action program of the IKSO:

- Reduction of the damage risk,
- Reduction of the high water levels,
- Increase in the awareness of flooding danger for those affected,
- Improvement of the flood reporting system.

These measures are to be completed within a fixed time period.

4 Spatial Planning Tasks in Preventive Flood Protection

The prerequisites for successful strategies of preventive flood protection are an integrated philosophy and corresponding actions at the local, regional, national and transnational levels. It is essential that the political entities of water management and spatial planning make contributions.

Even if it is not possible to make an exact demarcation between activities belonging to spatial planning and those belonging to water management, the following main focuses of activity can be named:

The contribution of water management can be described as follows [IKSR 1998 and IKSO 2001]:

- Reduction of flow-off wave crests through encouragement of seepage, by retention and the reactivation of flooding areas
- Safeguarding flow-off capacity and – where necessary – increase it through water engineering measures
- Reduce flow-off speed by renaturalisation of the watercourses in the catchment area
- Flood protection with dikes and walls
- Increase warning times of flooding by improving forecasting

The following tasks in preventive flood protection belong to spatial planning – in agreement and coordination with the water management bodies:

- Collaboration in the determination and description of flood dangers, definition of the requirements of map material, calculations and data
- Description and safeguarding of current and potential flooding areas and sites for retention measures in regional plans
- Control of municipal planning and building plans in flood areas and areas protected by dikes to minimise the damage potential
- Determination, evaluation and integration of the flood danger in individual spatial plans and decisions in particular regarding settlement and infrastructure development
- Spreading information on the hazard situation in areas endangered by flooding (risk areas), improvement of flood awareness

The realisation regarding the special importance of spatial planning tasks has developed in particular during the many years of attempting to improve the flooding situation on the Rhine (see IKSR). There, between 1997 and 2002, a separate program of spatial planning activities in flood protection is running within the scope of INTERREG IIC. The program International Rhine Meuse

Activities (IRMA) has a funding sum of 144 mill . Through IRMA, the activities and focuses of technical flood protection, which were supported in particular by the action plans of the individual river commissions, could be controlled according to the strategies and principles of a spatial planning conception. The positive experience gained here should also be exploited for the catchment area of the Oder [see IRMA 2000, INFRASTRUKTUR & UMWELT 2000].

4.1 Overview of Spatial Planning in Germany, Poland and the Czech Republic

4.1.1 Federal Republic of Germany

4.1.1.1 Legal Framework

The federal spatial planning in Germany is limited to creating the framework for spatial planning (Spatial Planning Act = Raumordnungsgesetz (ROG) dated 18.08.1997). The amendment of the Act, which was carried out under the impression of the flooding on the Rhine in 1993 and 1995, clearly states that flood protection is a task of spatial planning.

On the one hand § 1 paragraph ROG contains the obligation to co-ordinate the different requirements placed on land use. On the other hand, the following spatial planning principle is set out in ROG:

> "Preventive flood protection ... must be carried out inland particularly by safeguarding or restoring water meadow areas, retention areas and areas endangered by flooding " (§ 2 paragraph 2 No. 8 ROG).

No plans for land use are produced at the federal level.

The principles of ROG are to be concretised at the state and regional planning level. State planning laws usually also contain fundamental regulations on flood protection. The central instruments of state and regional planning for the precautionary control of land functions and uses are the regional plans. According to the Spatial Planning Act (ROG), they comprise of the „Spatial Plan for the Area of the State“ (§ 8 ROG) as well as plans for sub-regions of the states („Regional Plans“, § 9 ROG). The uses and functions can be controlled using the following instruments within the plans:

- Binding targets for the subordinated planning levels (§ 4 paragraph 2 ROG), spatial definition of „priority areas“ (Vorranggebiete); this means restrictions / prohibition for other planning bodies (municipalities, other technical planning bodies).
- Principles to control the balancing of interests of subordinate planning levels (§ 3 paragraph 3 ROG), spatial concretisation of „reservation areas“ (Vorbehaltsgebiete); this means consideration / instructions for other planning bodies.

- Notification to inform subordinate planning levels (§ 7 paragraph 3 ROG).

The regulations and plans at state and regional level have the character of setting up a framework. They contain obligatory administrative regulations for the municipalities and other technical planning bodies. They do not contain a direct binding character towards private entities. Therefore, at this level, mainly precautionary effects regarding land use can be achieved, i.e. in this case the restriction of land uses which are in competition with flood protection. At this level, a decision regarding a change in land use or the setting up of installations or buildings is not possible as a general rule.

Concrete area use decisions which are also binding for private entities are first made at municipal level. The instruments are the

- land use plan (Flächennutzungsplan - scale 1:5,000 - 1:10,000)
  - binding for public authorities - and the
- building development plan (Bebauungsplan - scale 1:500 - 1:1,000)
  - binding for everyone - ,

which are legally defined in the German building code (Baugesetz-buch BauGB).

Thus the town and district authorities, with consideration for the principles and targets of the state and regional planning, decide how the specific areas of the locality are used or if they are to be kept free.

4.1.1.2 Planning Practice

The evaluation of planning laws and spatial plans throughout Germany [Böhm / Heiland / Dapp 1999] has shown that most plans do include the principles of flood protection and define targets in writing, but also, however, that there is considerable need for improvement with regard to spatial concretisation. Then it is first this binding definition in the spatial plans which leads to the desired effect of controlling land use.

The greatest realisation potential for the necessary measures is found at the municipal planning level. In order to control this a targeted manner, a clear presentation of the priority and conditional areas for flood protection is essential. The investigations also show that there are also a series of definition possibilities for the municipalities with regard to preventive flood protection but that these possibilities are hardly ever exploited [Böhm / Heiland / Dapp 1999].

On overview is provided by the four regional plans relevant to the area under consideration and the two state development plans in appendix 11.1.1.

The action recommendations of the Conference of Ministers for land use have established themselves as a more far reaching new standard for spatial planning in preventive flood protection [MKRO 2000].

4.1.2 Republic of Poland

4.1.2.1 Legal Framework

In Poland the second stage of the area and administration reform was completed on 1st January 1999 [in detail NAJNIGIER 2000]. Since then, there is a three stage system of self-administration. The previous 49 Wojewods (counties) were partially united to form now 16 Wojewods. Also, 373 local district units (Powiats) were founded. The 2,489 municipalities remain unchanged.

The legal basis for spatial planning is the Land Use Management Act (7th July 1994).

4.1.2.2 Planning Practice

There are now five Wojewods along the Oder. In all these areas, intensive preparatory work has begun to create regional plans. The status of the work and the various responsibilities are shown in appendix 11.1.2.

With regard to questions concerning flooding, there is an interregional consultation procedure between the Wojewods [SPO 2000]. The results are expected at the end of 2001.

At present a handbook of action recommendations is being prepared for the planning activities of the municipalities.

Especially because Poland has by far the largest catchment area of the Oder, it is necessary to accompany the development of the spatial planning system more intensively and to collaborate with regard to a joint procedure.

4.1.3 Czech Republic

4.1.3.1 Legal Framework

Spatial planning is regulated in the Czech Republic mainly under the Spatial Planning and Building Regulation Act (No. 50/1976 Coll., as last amended by Act No. 132/2000 Coll., on changes and cancellation of some acts in connection with acts on regions, municipalities, district offices and on Capital Prague). The system of spatial planning disposes of three principal tools:

- spatial planning groundwork,
- spatial planning documents and
- land use permits.

Spatial planning groundwork represents the state level of planning drawn up by Ministry for Regional Development and covering the whole territory of republic.

Spatial planning groundwork serves especially as a background for working out of spatial planning documents. Spatial planning documents are divided into three principal levels:

- spatial plans of great territorial units (územní plány velkých územních celků),
- spatial plans of communities (územní plány obcí) and
- regulation plans (regulační plány).

The administrative structure was reorganized considerably in recent years. At first just after 1990 and lastly since the 1 January 2001. The last change was particularly motivated by efforts to adapt system of spatial planning to the EU framework of areal planning policy. This process has not yet been fully completed – establishing of new regional structures is just running; the full establishment is expected by the end of 2001. The fundamental aim is to create a clear structure of planning levels and responsibilities.

System of spatial planning is under the supreme responsibility of Ministry for Regional Development. By the end of 2000 was this Ministry responsible for the spatial plans of great territorial units through its regional departments. Working out of spatial plans of communities and regulation plans was under the responsibility of district offices (75) and individual municipalities.

The new administrative structure, which came into force since 1 January 2001, consists especially in formal establishment of new regions (Constitutional Act No. 347/1997 Coll.) and in determining of their responsibilities (Act No. 129/2000 Coll. and Act No. 132/2000 Coll.). The relevant acts concerning municipalities and Prague Capital were changed concurrently.

The responsibility for working out of spatial plans of great territorial units was delegated by those acts into new regions (14 including Prague Capital) and Ministry for Regional Development works out the spatial plans of great territorial units only under special circumstances determined in the law The responsibility of district offices for working out of spatial planning documents was cancelled (further full responsibility of individual municipalities). The district offices are further responsible for supervision of spatial planning process on the level of municipalities but it is intended to cancel them by the end of 2003 and delegate their responsibilities especially into regions.

4.1.3.2 Planning Practice

The existing spatial plans of great territorial units (regional plans) cover one or more districts or large protected areas. The current regional plans for the Oder catchment area are up to date (see appendix 11.1.3). Their scale (basic graphic document) is 1:25 000 or 1:50 000. Standard flooding boundaries of HQ_{100} are shown in the maps since 1999 on the basis of Ministry Regulation No. 131/1998 Coll. (obligation to mark out flood zones).

All in all, in Czech regional planning, the tendency is evident that the needs of flood protection are being increasingly shown. But separate spatial planning categories and plan requirements are not yet used sufficiently.

4.1.4 Overview Comparison of the Spatial Planning Systems

In all three countries under consideration, the planning levels for land use basically covers the levels

- state Planning,
- regional planning,
- municipal planning,

whereby the basic features, the range of instruments provided and their binding character are very different. With the instruments one must differentiate between formal binding effects and informal effects such as for example „creation of awareness of the flood danger.

The following can only provide a rough overview of the spatial planning structures in the three countries involved.

Basically, over the last years, the spatial planning structures regarding targets and responsibilities in the three countries have become more and more similar.

In Germany, spatial planning has changed very little in its basic structure over the past decades. The system which had become established there was taken over by the new German states after reunification.

In the Republic of Poland and the Czech Republic, the spatial planning system has changed basically in recent years. These changes were and are also being accompanied by comprehensive administration reforms. Therefore, within the framework of this report, we must meet the challenge that due to this on-going reorganisation (laws only in bill form, no complete implementation of the structures and no experience with their operation) the description cannot be complete in all details. Here, there are still considerable requirements before an effective systematic comparison can take place.

A recent comparison of the regulations regarding water and flood protection law between the Czech Republic, Germany and Poland comes to the conclusion:

> „The spatial planning framework of the Czech Republic and Poland are still in a development and orientation phase. Especially in the case of the Czech Republic, a coordination of the programs and plans between the various levels and with the technical planning can not yet be guaranteed by comprehensive plans."[KRAMER 2000, S. 227]

The following table shows a first overview of the different systems of spatial planning in the three countries on the banks of the Oder.

Table 7: Overview of the Planning Levels and Instruments of Spatial Planning in the Catchment Area of the Oder

	Republic of Poland		Federal Republic of Germany		Czech Republic	
Planning level	Area / Administration	Planning Instruments	Area / Administration	Planning Instruments	Area / Administration	Planning Instruments
National	State (Ministry for Regional Development and Building)	• Land Management Act (7. July 1994 • Koncepcja polityki przestrzennego zagospodarowania kraju • no plan	State (Ministry for Spatial Planning)	• Spatial Planning Law (1998), Principles • Raumordnungsbericht (Report) • no plan	State (Ministry for Regional Development)	• Spatial Planning and Building Regulatin Act (No. 50/1976 Sb) • Spatial planning groundwork • no plan
Regional	County (Województwo)	• Plan zagospodarowania przestrzennego województwa	Federal State (Bundesland)	• Landesentwicklungsplan	Region (new)	• Územní plán velkého územního celku (ÚPN VÚC)
			Region (larger District)	• Regionalplan	District (old)	
	Local District (Powiat)	(none)	Local District (Kreis)	*(none)*		
Municipal	Community	• Studium zagospodarowania przestrzennego gminy	Community	• Flächennutzungsplan	Community	• Územní plán obce (ÚPN obce)
		• Plany zagospodarowania przestrzennego gminy		• Bebauungsplan		• Regulační plán

4.2 Role of International Spatial Planning Policy and the Erection of Transnational Structures

Preventive flood protection depends on an interactive network of factors which cannot end on national borders and therefore logically it has been made a target of European spatial planning policy. This occurs through cooperation of the responsible ministers of the member states and the EU Commission. In particular the committee of the regions participates in the coordination process as well as other institutions of spatial planning in Europe.

Joint spatial planning targets and guiding concepts are firmly established in the European spatial development concept [EUREK 1999] which the member states and the Commission conclusively agreed in May 1999.

Regarding flood protection the following is stated there:

> „...endangered areas must be recognised as a main feature of urban and rural regions. ... Decisions concerning territorial development must take potential risks such as floods ... into account. Preventive risk reducing measures should be considered in particular in regional and transnational dimensions." [EUREK 1999, Rd-No. 142].

It continues

> „... Particularly at the transnational level, spatial planning can make an important contribution towards the protection of the population and the reduction of the flood risk. Preventive flood protection can be combined with nature conservation development and rehabilitation measures. In this respect, the INTERREG II C - program for preventive flood protection shows the first possible approaches." [EUREK 1999, Rd-No. 146].

The realisation of EUREK is to be furthered considerably by the INTERREG initiatives. In this connection, in future as well, within the scope of the integration efforts in Central and Eastern Europe, the targets and guiding principles of EUREK will be particularly important for corresponding projects in these regions.

Concrete tasks for the international cooperation are

- international coordination of the working approaches and concepts in the river catchment areas,
- creation of a mutual problem-understanding of the causes, the effects and the evaluation of the consequences,
- agreement on concrete measures, their financing and realisation time frames,
- determination and agreement of approaches to compensate for the economical (and political) burdens which arise between upstream and downstream areas.

Furthermore, there are important and extensive water management tasks to be accomplished such as agreement on damming regulations, shipping routes and flood reporting systems.

Flood protection is comprised of a whole series of transnational projects and it can only be effective and successful under a common roof with transnational co-operative structures.

In detail, for preventive flood protection on the Oder, this means that a successive pyramid of various

- fundamental international agreements and declarations,
- concrete working groups or commissions (water management, spatial planning etc.) including the administrative levels,
- concrete transnational planning and measures,
- internationally agreed national planning and measures,
- financing programs and
- transnational payment agreements

must be developed.

The initiation of further independent transnational structures (e.g. interregional cooperation in the spatial planning field) should take place simultaneously.

6 Transnational Conception of Preventive Flood Protection

6.1 Fundamental Principles and Targets

Considerable dangers can arise from the combined effect of extreme precipitation events and man made alterations to the natural flow-off characteristics or land use changes of the flood plains. The extreme flooding in Summer 1997 showed this all too clearly. The overall increase of extreme flood events on other rivers over the last years has drastically reminded us of the validity of the following facts:

- Floods are natural events and one must always expect them from time to time (irrespective of the periodicity).
- Man has contributed to worse course of floods by land use changes in the catchment area, by improving waterways and by reducing the natural retention area. This increases the height of floods and the flow-off speed.
- Dikes and other technical flood protection measures cannot guarantee absolute protection.
- Settlement and other land uses sensitive to flooding in flood plains or other threatened low areas represent a very high damage potential.

The following 5 fundamental principles concerning all policies are generally recognised in preventive flood protection:

I. Solidarity and Integration of Actions

A sustainable improvement of flood prevention can only be achieved through an integrated approach from the political bodies of water management, spatial planning, industry, nature conservation, forestry and agriculture and emergency services.

Alone the structure of the catchment area which extends across three states Republic of Poland, Czech Republic and Federal Republic of Germany requires solidarity of action and a jointly supported medium to long term strategy to improve flood protection.

II. Water is an Essential Part

In all areas, water is an integral part of land use and must therefore be taken into consideration by all relevant political bodies.

III. Keep Water Back

The principle of water retention in the catchment basin of the river must be realised throughout the area in specially adapted measures.

IV. Space for the River

The flow-off capacity of the Oder must be preserved and increased. Space must be made available for a delayed, danger-free flow-off.

V. Knowledge of the Danger

The awareness of the population for flood dangers must be increased and find its expression in the endangered areas in a correspondingly adapted land use.

The central objective of joint preventive flood protection along the Oder must include two aspects:

- the protection of life of man and animals as well as property and
- a sustainable development of the Oder valley.

From this the following targets of flood prevention can be formulated:

- The natural retention capacity of the soil, vegetation and waters in the catchment area must be increased. For this, reforestation, less intensive agricultural use, rainwater management in urban areas including unsealing activities can make important contributions.
- Current retention areas must be conserved and protected from contradictory types of land use, in particular building and infrastructure measures sensitive to flooding. For this, the principles of preventive flood protection must be adopted by all spatial programs and plans and put into practice.
- As far as possible and economically reasonable, potential retention areas must be won back. The spatial planning prerequisites for this have to be created.
- Overall, those bodies responsible for spatial planning at the transnational, national, regional and local levels must create the planning prerequisites for preventive flood protection. This means that when land use and the function of areas are determined by planners floods must always be taken into account in these plans.
- Technical retention measures (water reservoirs and retarding basins, in particular with optimised flow control) contribute to reduce the flood flow-

off. The realisation of these projects have to take the requirements of nature conservation into account.

- The natural dynamics of the waters in flood plains and their ecological importance is to be increased through the connection and regeneration of the flood plains.
- Flood-sensitive land uses in endangered areas are to be protected by technical flood protection means (dikes, dams, flood walls and the improvement of flow conditions). Here, economic feasibility considerations must be part of the decision criteria. The desired degree of protection must be differentiated according to the sensitivity and the volume of potential damage.
- Technical flood protection measures and water engineering measures for safeguarding and improving shipping may not have the effect of increasing the flood danger for downstream areas.
- The damage potential has to be effectively reduced by an adapted land use (control of sensitive uses), precautionary measures on buildings, measures affecting behaviour (flood forecast, warning, information to the public, creation of an awareness of the problem, emergency services). Here, an examination must also be made to ascertain whether medium to long term possibilities exist to remove current sensitive uses from areas endangered by floods.
- A differentiated approach to flood protection has to be made taking the local conditions into account and choosing, under the circumstances, the most effective measures without increasing the flood danger for downstream areas.

6.2 Recommendations for Action Possibilities

On the basis of

- the rough estimation of the danger potential (identification of the so-called "Hot Spots") and
- an evaluation of the effectiveness and the potential of measures for the individual fields of action

the following high priority necessary measures for the action areas (A to G) are recommended.

6.2.1 A – Czech Tributaries

Description of the Danger Potential

The Opava, the Olše and the upper valley of the Oder itself present a considerable dynamic flood danger. Due to the short warning times, in this action area there is also a particular threat to life.

The following two towns were identified as „Hot Spots" in the valleys of the tributaries:

- Karvina (Olse),
- Krnov (Opava).

Recommendations

Here, the measures for technical retention have a high potential (reservoirs, retention basins) and a high effectiveness. The controlling systems for the existing reservoirs and basins must be re-examined. If necessary they should be optimised to meet the formulated flood protection goals (achieving a good long distance effect). This also concerns the interlinked operation of those facilities. The building of new reservoirs and retention basins must be speeded up (Nove Herminovy on the Opava and Bukovec and Horni Lomna in the Olse catchment basin) if the flooding danger can be clearly reduced by the proposed new retention volume for floods. To determine this, further examinations are necessary where, for different scenarios and profiles, the water level reductions are estimated and also economic effects are considered. Water engineering extensions must take the concerns of environmental protection into account, in particular aquatic ecology (connecting waters).

In order to improve the retention of precipitation in the region in those areas with substantial forest damage and with a high share of arable land on the slopes, such sites must be subjected to the following priority measures:

improvement of the forest condition in the existing forest land, conversion of arable land into permanent grassland as far as possible and (re-)forestation according to the local suitable conditions.

The extension of the flood reporting system and therefore the associated improvement in flood forecasting must have a high priority. As a prerequisite, the flow times of the individual Czech tributaries should be long enough to allow a warning period longer than 6 hours. This time period is a minimum for a sufficient reaction time.

An examination of endangered objects must be carried out to ascertain whether they can be removed. In some cases, small scale technical measures to improve the protection of objects must be carried out because in this area they also serve to protect human life. Such measures must not cause a worsening of the flood danger for downstream areas (in particular in the action area "D - Ostrava-Opole"). Any action taken here must be compensated by suitable measures like creating new retention volume.

6.2.2 B – Polish Tributaries (Sudetes Mountains)

Description of the Danger Potential

The valley of Kotlina Klodzka (action area B1) is closed in by mountains and has typically extreme flood events with very short warning times. The technical flood protection system is very poorly developed here.

Also in the upper partial catchment area of the Bóbr (action area B2) with its steep gradient, there are also sudden, heavy flood events. However, here, the existing flood protection system, a combination of storage reservoirs, dry basins and dikes, is already well developed. There is a need to optimise these however.

Overall, the area of action of the Polish tributaries, due to the building structure and the narrow valley cross-sections, is characterised by a considerable dynamic flood danger – in particular for human life. Also, if the upstream retention basin fails, the town of Nysa is threatened.

The „Hot Spots“ within the area of action of the Polish tributaries are:

- Kłodzko (Nysa Kłodzka),
- Legnica (Kaczawa),
- Wlen (Bóbr),
- Lwówek Śląski (Bóbr),
- Boleslawiec (Bóbr).

Recommendations

As with the area of action of the Czech tributaries, the measures for technical retention (reservoirs, retention basins) here too are also highly effective and have a good potential. Here too, the control systems for the existing reservoirs and retention basins should be reviewed and if necessary optimised to meet the formulated flood protection goals (achieving a good long distance effect). The building of new reservoirs and retention basins must be speeded up if the flooding danger can be clearly reduced by the proposed new retention volume for floods. To determine this, further examinations are also necessary for the Polish tributaries where, for different scenarios and profiles, the water level reductions are estimated and also economic effects are considered. Water engineering extensions must take the concerns of environmental protection into account, in particular aquatic ecology (connecting waters).

As in the area of the Czech tributaries, in order to improve the retention of precipitation in the region, those areas with substantial forest damage must be reforested according to the local suitable conditions.

Here too, due to the short warning times, the extension of the flood reporting system and therefore the associated improvement in flood forecasting must have a high priority. The flow times of the individual Polish tributaries should allow a warning period longer than 6 hours to obtain enough time for reacting.

In this action area as well, an examination of endangered objects must be carried out to ascertain whether they can be removed. In some cases, small scale technical measures to improve the protection of objects must be carried out because in this area they also serve to protect human life. Such measures must not cause a worsening of the flood danger for downstream areas (in particular in the action area "E – Opole - Wrocław"). Any action taken here must be compensated by suitable measures. This can be obtained, e.g. by creating new retention volume.

6.2.3 C – Lusation Neisse

Description of the Danger Potential

As with the Czech and Polish tributaries, the upper part of the Lusation Neisse is characterised by a dynamic flood danger.

Along the further course of the river there is a danger of an extended longer lasting flooding. This can be stated as „static flood danger“. The share of urban areas, industrial areas and infrastructure installations comprises about 10 % of the area endangered by flooding.

The following towns on the Lusation Neisse are particularly endangered by floods:

- Liberec,
- Jablonec nad Nisou,
- Zgorzelec,,
- Forst,
- Guben.

Recommendations

The main focus of recommended actions for flood protection is placed on technical retention measures (reservoirs, retention basins). Some technical retention measures with a local effect were implemented as a reaction to catastrophic flood disaster in 1897 within the Jizera Mountains in the first two decades of 20th century. In future the retention functions of the former lignite open-cast mining works (Olbersdorf and Berzdorf) should be proved, and in the medium term, the currently operating open-cast mining facilities at Turow should be included.

Additionally, the damage potential in the lower valley of the Lusation Neisse must be lessened by precautionary measures. These are control of land use, precautionary measures on buildings and measures affecting behaviour. Particular attention must be given to transnational agreement on flood forecasting and warnings.

Small scale technical measures to improve the protection of objects here serve to protect human life. If such measures cause a worsening of the flood danger for downstream areas (in particular in the action area "G – Mouth of the Lusation Neisse - Szczecin") there must be a compensation by suitable measures.

6.2.4 D - Ostrava - Opole (Oder)

Description of the danger potential

In the area of action Ostrava-Opole there is a „static“ flooding danger. The share of urban areas, industrial areas and infrastructure in the flood endangered region here is about 13 % - the highest along the complete Oder valley. This intense settlement means of course that the damage potential is also very high.

The „Hot Spots“ are in particular the following towns:

- Opava (Opava river),
- Ostrava,
- Bohumín,
- Racibórz,

- Kędzierzyn- Koźle,
- Opole.

Recommendations

The high damage potential in this area means that the whole range of possible action instruments must be used to combat this.

The first priority is to keep and safeguard the current retention areas. Furthermore, further retention space must be created – insofar as the intensive agricultural use and dense settlement permit this from a space point of view. It is necessary to restrict agricultural activities to gain new retention areas. There should be compensation for this using special funds.

The building of a new reservoir near Racibórz is judged to provide particular effectiveness for Racibórc itself and for Opole and indeed also relieve Wrocław (in the decimetre range). The building of several small new controlled polders should support this effect further.

The problems which occur upon building retention basins in the field of water ecology (interruption of the free flow) and the retention of detritus (increased downstream erosion) must be minimised.

The extension of the flood reporting system and therefore the associated improvement in flood forecasting must have a high priority of completion. Without reliable flood predictions, the polders (with their good long distance relief effect) cannot be controlled in an optimum manner.

The improved (object) protection through necessary technical measures is problematical in this area because the flood situation for the downstream region (here: area of action "E - Opole-Wrocław") can be worsened. Examples of this are the extension of the diverting channel at Opole and also the dike system which protects the town of Bohumin. Both measures are very effective locally. The negative effects for the downstream regions however must be ascertained and compensated for.

Rainwater management measures to ensure the retention of precipitation in the area could provide some additional flood reduction.

Care must be taken to make sure that engineering measures to improve shipping conditions on the Oder up to Ostrava do not increase the flooding danger for downstream areas (in particular the area "E - Opole-Wrocław"). Any negative effects for flooding caused here must be avoided.

6.2.5 E - Opole - Wrocław (Oder)

Description of the Danger Potential

The area of action Opole-Wrocław is also strongly threatened by a „static" flooding danger. The share of the area with a high damage potential (urban areas, industrial areas, infrastructure) is particularly high as well, at about 12%.

The prime "Hot Spot" here on the Oder is:

- Wrocław (640,000 inhabitants).

Further hot spots are:

- Brzeg,
- Oława,
- Brzeg Dolny,
- Nysa (Nysa Kłodzka).

Wrocław, with about 640,000 inhabitants, is by far the largest urban area on the Oder and it is particularly endangered by flooding. This becomes all too clear when one considers how much of the built up area was flooded by water and the damage caused in the summer 1997 flood.

Due to the Wocławski Węzeł Wodny (Wrocław water junction), a particular situation is created at the lower end of this area of action. Starting from the lock near Brzeg Dolny, at times of high water, backwater effects can occur as far as Wrocław. Therefore the area directly downstream from Wrocław must be included in the examinations if a better flow-off of floodwater from the Wocławski Węzeł Wodny is to be achieved.

Recommendations

This area requires particularly differentiated flood protection measures. The focuses of action must therefore be placed on the following factors:

The already numerous existing retention areas must not only be safeguarded and preserved, they must also be extended. Furthermore, new retention areas must be created (e.g. Kotowice, Chrościce, Żelazna II) whereby here a compensation for the current agricultural use is necessary. The polders must be controlled so that they can be used to cut off the flood peaks thus reducing the flood danger for Wrocław considerably. The inlet and outlet control installations of the current polders must also be correspondingly equipped for this task.

The extension of the flood reporting system and therefore the associated improvement in flood forecasting must be followed up with the highest priority.

The very large damage potential must be clearly reduced using special flood protection concepts for the Wocławski Węzeł Wodny. These concepts must be made up of a whole selection of measures involving precautionary measures on buildings, precautions in the area and measures affecting behaviour.

Due to the large damage expectations for Wrocław, the chosen technical flood protection level here should be particularly high (recurrence interval 200 years). This makes improved object protection by using technical measures necessary. The negative effects for the downstream areas (in particular area "F - Wrocław-mouth of the Lusation Neisse") must be compensated by suitable measures.

6.2.6 F - Wrocław – Mouth of the Lusation Neisse

Description of the Damage Potential

The area endangered by flooding in this area of action is characterised by agricultural use (58%) and, in comparison with other areas of action, a particularly large area of forest (37%). The share of urban areas for which a „static“ flood danger exists, is relatively low at 3%.

The following towns have been identified as particular „Hot Spots“:

- Głogów,
- Nowa Sól,
- Krosno Odrzańskie.

Recommendations

Throughout this region, there are large almost natural retention areas and they must be kept and safeguarded.

Furthermore, here it is particularly important that additional almost natural retention areas are created. The water meadows along the Oder, as natural flood areas, must be increasingly connected to the river. In this way, flood protection and nature conservation can be combined in an optimum form. This also involves the relocation and removal of current dike lines or lowering them. In this area there is a great potential to achieve this. As in the other areas, the possibilities of compensation for limitations on agricultural use must be exploited.

The retention measures proposed here also have a great beneficial effect on the downstream area "G – Mouth of the Lusation Neisse-Szczecin" (peak flow-off reduction).

The extension of the flood reporting system and therefore the associated improvement in flood forecasting must be enforced with the highest priority.

The damage potential must be reduced additionally by a precautionary flood concept focussing on precautions in the area and precautionary measures in buildings - particularly in the area of Głogów and Nowa Sól. Alternative uses of the land endangered by flooding is to be examined.

The extension of the Oder as a waterway in this area and the improvement up to a maximum of shipping class III must not be allowed to increase the flooding danger for the downstream area "G – Mouth of the Lusation Neisse - Szczecin". Negative effects on flood protection must be avoided.

6.2.7 G – Mouth of the Lusation Neisse - Szczecin (Oder)

Description of the Damage Potential

In this area of action there is also a „static“ flooding danger. The land uses (urban areas, industrial areas, infrastructure) with a particularly high damage potential are protected by dikes. Their share of the flood endangered area is about 7%.

The particular „Hot Spots“ are the following towns:

- Eisenhüttenstadt,
- Słubice / Frankfurt/Oder,
- Cedynia,
- Schwedt,
- Szczecin.

Recommendations

The object protection through technical measures, which are largely already in place or are to be reinstated, is very effective in this area. As well as the dike renovation measures to improve flow-off behaviour are particularly effective here.

As well as the preservation and safeguarding of the current retention areas, the possibilities for creating new retention room and extending existing areas must be used throughout the action area. The possibilities which are presented of winning more flood areas should be exploited, even when this causes restrictions in agricultural use.

The extension of the flood reporting system and therefore the associated improvement in flood forecasting must be followed up with the highest priority in this area as well.

The damage potential must also be minimised by suitable precautionary measures on buildings and measures affecting behaviour behind the dikes as well.

6.2.8 H - Stettiner Haff / Zalew Szczeciński

6.2.9 I - Warta

Both areas of action were not yet included in the considerations to date, due to the time limit and the limited financial means. Their treatment must be delayed until a later point in time.

For both regions there is a requirement for special examinations due to the individual factors affecting the flood problem (Stettiner Haff – backwater effects due to wind and ice jams, Warta – flat land water with corresponding flood characteristics).

The transnational concept of preventive flood protection in the whole Oder catchment area should also be extended to both these areas of action.