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THE MANAGEMENT OF THE DEFENSE AGAINST FLOODS PAST, PRESENT AND FUTURE

Discussion paper transmitted by the Government of Romania [1]

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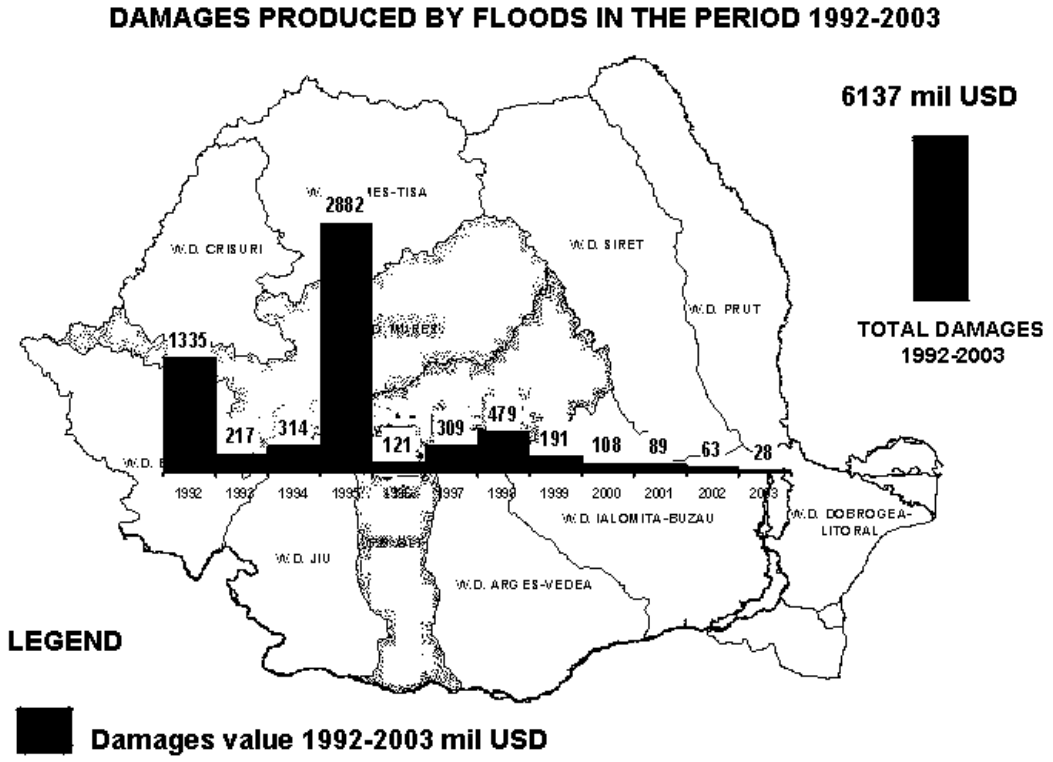
1. Introduction

Water is a unique element of the environment and certainly the most valuable resource. For society, water in suffice quantity and good quality means health, wealth, security and beauty. Water is also of major significance in the economy, as it represents the source for light and power, it is a transport route and a raw material.
Water in excess – high floods – is the most significant natural disaster that causes high damages and human casualties.
In Romania, high floods have represented a hydrologic phenomenon present on our territory for our entire existence. The chroniclers have regularly recorded during the ages catastrophic high floods: 10 in the 16th century, 19 in the 17th century, 26 in the 18th century and 42 in the 20th century.
The frequency of floods and their size have increased mainly due to the changes of the weather and the reduction of the shipping capacity of riverbeds by the general development of localities in the main bed of waterways.
The largest flood in Romania was recorded in 1970 when the registered damages exceeded USD 1,000 million. Image 1 shows the most important high floods that occurred on the territory of Romania since the settlement of systematic hydrologic monitoring.

IMAGE 1

The largest high floods on the Danube occurred in May 1932, April 1940, July 1942, May 1955, June 1970 and June 1988.
Floods that occurred within the period 1992 – 2003 caused on the territory of the country damages exceeding USD 6,137 million. See image no. 2. We mention that within the same

period, the total amount of the investments from the funds of the State Budget and external credits for defense works was of approximately 11% from the total value of the damages.
IMAGE 2



2. THE CAUSES FOR THE OCCURRENCE OF FLOODS, THEIR FREQUENCY AND EFFECTS IN ROMANIA

Floods are caused by random Acts of God, accidental phenomena or human activities. Floods may be classified in Romania, according to their genesis, as follows:

- Floods caused by Acts of God: overflows of rivers, water originating from precipitations and melting of snow (frequently), congestion or dripping from slopes (frequently), rising of underground waters over the level of the ground due to infiltrations (sometimes), marine tempests (rarely) or typhoons, submarine volcano eruptions (no record).
- Floods caused by accidental phenomena: breaking or deterioration of dams or of other hydro-technical constructions (2 cases at dams, Vidraru 1974, the deterioration of bottom discharge and Belci 1991 – deterioration of the dam body by over-discharge), maneuvers that are erroneous or non-compliant with the hydrologic status of the hydrographic basin when evacuating accretions (rarely), the sudden sliding of slopes in the lake basin (1 case – Raul Mare – Retezat – 2002, without effects downstream of the dam, but 14 casualties in the workers' colony on the lake bank).
- Floods caused by human activities: guided flooding by intentionally cutting the defense dykes (rarely, as a protection measure of very significant downstream objectives), floods caused by earthquakes induced in accretions (no record).

The total floodable surface in Romania is of approximately 2.12 million ha, representing 8.9% from the total surface of the country. Out of the 2.12 million floodable hectares, approximately 1.89% million ha are agricultural lands, representing 18.9% from the approximately 10 million ha of total farmland.

The total number of the floodable localities is of 2,613 out of which 54 municipalities, 161 cities and 2,398 communes,
The main floodable objectives are: 367,000 dwellings, 7,700 km of roads and highways, 1,400 km of railways, 1,400 bridges, 1,820 industrial objectives, 2,830 social objectives, 1,680 agricultural objectives.
Potential damages are of approximately USD 1,721 million

3. THE LEGISLATION ON THE MANAGEMENT FOR THE DEFENSE AGAINST FLOODS

In regard to the legislative frame, the first normative document that regulated the defense against floods was the first Law on Waters that was issued in the year 1924, comprising also elements of measurement, evidence and arrangement of waters.
After the year 1950, the legal frame was enhanced in 1953 by the adoption of Decree 143 on the rational use and protection of the water quality and in the year 1974, the Law on Waters.
Law no. 1 on the National Program for the arrangement of hydrographic basins from Romania was adopted in 1976 and Law no. 5 on the rational management, protection and assurance of the water quality in 1989.
The Law on Disasters no. 124/1994 was approved in 1994 and it regulated the action manner, the liabilities of the State and local bodies on types of disasters, both natural (floods, droughts, earthquakes, etc.) and industrial ones.
A new Law on Waters 107/1996 was promulgated in 1996, bringing significant elements to the current legislation in the domain, i.e.:

- The reorganization on modern principles of the system for the defense against floods and accidents at hydro-technical constructions;
- Basin Committees ensuring the participation of all players involved in decision-taking in the domain of waters.
- The economic mechanism composed of prices, tariffs, penalties and bonuses in order to protect the water resources and the efficient administration of water management systems.

The Development Strategy in the domain of water management was approved in the year 1996, a strategy that has a separate chapter on the defense against floods.
A new sustainable Development Strategy was issued in the year 2003 in the domain of water management and it has a separate chapter on the defense against floods, comprising the latest principles in the domain.

4. PRINCIPLES ON THE DEFENSE AGAINST FLOODS APPLIED TO THE WATER MANAGEMENT SYSTEMS

- Floods are Acts of God. They have always occurred and they shall continue to occur. Man’s intervention in natural processes should be limited in the future and the impact of the intervention should be as small as possible and not cause irreversible perturbations upon ecosystems.
- The strategy on fighting against floods should be issued at the level of the hydrographic basin and it should promote a coordinated development and management of the actions undertaken in the domain of waters, territorial arrangement and of other resources.

- Having regard to the evolution and tendencies in the occurrence of floods, it is necessary to pass from defensive actions against disasters to risk management and to the concept of “learning to live with floods”, having regard to the fact that the prevention of floods should not be limited only to disasters that have a high rate of occurrence, but it should also include those with a low rate of occurrence.
- International efforts for the reconstruction of rivers shall be intensified in order to recreate the natural conditions of humid areas and floodable ones, to withhold water and ameliorate the effects of floods.
- The use of floodable areas by Man should consider the hydrological regime of rivers. Adequate measures and tools shall be developed for all issues related to floods: high floods, rising of the level of underground waters, erosion, depositing of sediments, land slides, torrents, defaults of the sewerage system, pollution, etc.
- Non-structural measures tend to be the most efficient and lasting solutions of solving issues related to waters and they should be developed to reduce the vulnerability of human life and goods exposed to the risk of floods.
- The structural measures shall remain important elements and they should be focused on protecting humans and their safety, as well as such of material goods. We should be aware that the protection against floods is never complete and this could generate an erroneous perception upon safety.
- The warning and forecast of high floods is absolutely necessary to reduce damages caused by floods. Their efficacy depends upon the preparation level and the manner of accomplishing the proposed measures. Authorities in charge should supply in due time warnings and reliable forecasts on floods.
- An action of warning, salvaging and safety measures should be planned and implemented at all levels, inclusively the public one, by supplying basic information and permanent preparation activities. By means of the information received in due time and the preparation activities that were fulfilled, any citizen who could suffer from disasters should take his own precaution measures and thus limit the negative effects.
- Solidarity is essential and liabilities related to water management should not be transferred from one unit to another and from one area to another. The necessary strategy comprises three stages: withholding, depositing and evacuating water. Firstly, all efforts should be made to withhold precipitations within the area where they fell, the local depositing of the water surplus and finally its drainage to a waterway. The prevention of floods should be mainly based on precaution.
- Flood-affected victims should benefit of a compensation system in order to cover the economic damages and in order to recover their life level within the shortest time possible. Solutions, such as public or private insurance or State subsidies, should be promoted.
- Measures to reduce the impact upon aquatic and terrestrial ecosystems, such as water or soil pollution, should be taken in areas with a high flood risk.

5. THE BEST PRACTICES TO PREVENT, PROTECT AND REDUCE THE EFFECTS OF HIGH FLOODS

Experience shows that efficient measures of prevention and protection against high floods should be taken at the level of the basin and concurrently one should have regard to the interdependency and interaction among the effects of individual measures implemented along waterways.

For international basins it is necessary to issue national defense plans against floods agreed with riparian countries, comprising measures to solve emergency cases at the level of the hydrographic basin.
An optimal combination of prevention, structural and operative measures during the high flood is necessary in order to prevent floods, protect against it and reduce its negative effects: the issuance of the legislation on the interdiction of constructions within areas with a high flood risk, the correct use of lands, the adequate arrangement of main riverbeds, fast warning systems, the awareness of the population on the risk of flood occurrence and its readiness to act within the period of the flood.
The Master Directive in the domain of waters and its associated Directives are the base for the implementation of the regulations on main riverbeds of waterways in issuing the Management Plans of Hydrographic Basins, in order to reach a proper chemical and ecological condition of the humid areas and main riverbeds.
It is necessary to accomplish an interdisciplinary cooperation at central and local level in order to coordinate the sectorial policies in the domain of waters and environment protection, the usage of lands, the development of agriculture, the transport and urban infrastructure and the coordination of all issues related to the risk management: the estimation of the risk, the plans to ameliorate the effects and implement the measures.

An ecological management strategy of floods is based on the enhancement of the manner of using lands within the hydrographic basin, the prevention of torrent occurrence and the increased efforts to recover the natural humid areas. It is aimed at recreating the natural conditions of the humid areas and the major riverbeds in order to ameliorate high floods. Furthermore, such measures lead also to other benefits, respectively: the preservation of biodiversity, re-supply of underground aquifers, cleaner waters, recreation areas, touristic opportunities, etc.
The main non-structural prevention measures are:

- The preservation, efficient protection and, where possible, the restoration of the vegetation, forests and orchards.
- The preservation, efficient protection and, where possible, the restoration of the degraded humid areas and major riverbeds, including certain meanders of rivers. The maintenance of the vegetation on the banks of waterways is necessary in regard to the biodiversity of the environment and as a protection against floods.
- The enhancement of the manner of using lands by reducing the draining works, arranging certain meanders and consolidating the banks. All works related to the drying of moor areas and the draining of humid areas may be deemed to have objectives contrary to the prevention of floods.
- The change of the destination of former major riverbeds and lakes by moving certain dykes, the elimination of natural dams and the creation of links with the lowest land sections in order to change these natural areas into withholding areas. The controlled discharge of surplus waters to such withholding areas.
- The assurance of the correct use of the lands within areas with a high risk of flooding and erosion by grassing the banks and floodable lands, the change of farmland into pastures in order to reduce the dripping of nutrients and pesticides into rivers.
- The creation of polders that shall be used especially as pastures or to restore the alluvial forests and that shall be flooded during high floods to reduce the maximum debits.
- The increase of the transport capacity of riverbeds on medium and lower sectors of waterways where the natural slope is small, by eliminating certain hindrances created

by Man, the encouraging of correctly using lands, the creation of bypass channels and by increasing the drainage capacity in the sections of the polders.

The estimation of the risk and the graphical representation

The risk chart for floods is a cartographic representation of the high flood features and damages caused by it for various occurrence probabilities, and it underpins the estimation and the determination of using lands, the testing of the flooding regime of constructions, the information and readiness in case of floods.

The most significant representations of charts presenting the zoning of floods are the following:

- The indicative chart of floods is a representation of floods caused by high floods with various occurrence probabilities.
- The danger chart of floods includes historic events, as well as future events with various probabilities, illustrating the intensity and magnitude of the disaster, such as the estimated depth, duration and dynamic effects of the flood. From the combination of these elements results the intensity and frequency of the disasters and thus it is possible to specify the areas subject to disasters (zoning chart of the floods).
- The chart of flood risks combines the above-shown information with the economic characteristics and such of resistance to flood from using lands within the affected areas, the density of the population and other relevant information in order to define the risk level in the major riverbed.

As an example, table 4 presents the marking manner of the lands on the maps of the chart for flood risk, a procedure that is to be implemented in Romania within the following 3-4 years.

Area	Flood risk	Manner of using the land
Red	High risk degree	New constructions are interdicted
Blue	Medium risk degree	Constructions are allowed, but with restrictions
Yellow	Low risk degree	Restrictions only for significant objectives (e.g. hospitals)
White-yellow	Remanent risk	Warning of potential disasters (emergency plan)
White	Without flood risk	Without restrictions

The infrastructure for the defense against floods in Romania is composed of:

- 1,300 storage dams with an attenuation volume of 3.7 billion m^3
- 7,000 km of dykes for the defense of localities
- 4,983 km river regularizations
- 1,140 km bank defenses
- 157 derivation channels with a total length of over 1,100 km
- 178 other hydro-technical works

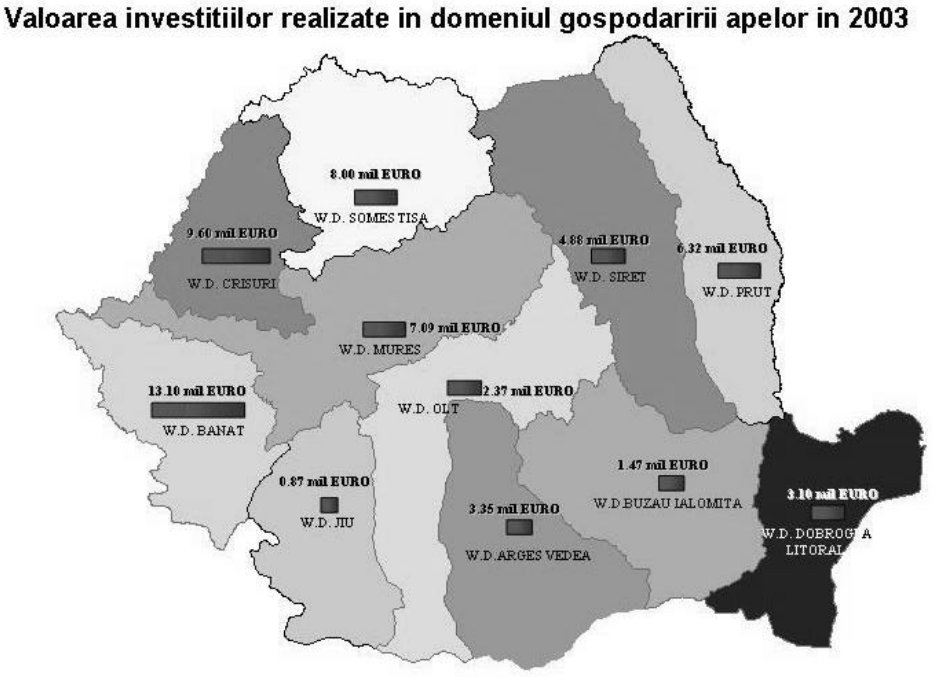
Structural measures shall be limited within the defense concept to the absolutely necessary ones, i.e.:

- The building of strategic storage dams of complex uses within the areas with occurrence of high flood.

- The creation of polders with controlled flooding in order to reduce the maximum debits of high floods.
- The creation of embanking on short river sectors and only to defend localities and very significant economic and social objectives against floods.

The accomplishment stage of the works for the defense against floods and the investments in defense works at the level of the year 2003 are presented below:

No.	Water direction	Tanks with reduction volumes of high floods (pieces)	Reduction volumes (billion m^3)	Regularizations and embanking (km)	Investments in 2003 (million EURO)
1	Somes Tisa	67	114	1,680	8
2	The Cris Rivers	130	226	1,780	9.6
3	Mures	31	194	1,495	7.09
4	Banat	54	242	2,095	13.1
5	Jiu	50	177	890	0.87
6	Olt	191	113	1,666	2.37
7	Arges Vedea	224	104	384	3.35
8	Buzau-Ialomita	77	29	715	1.47
9	Dobrogea Seaside	36	35	138	3.10
10	Siret	129	415	1,738	4.88
11	Prut	308	2,067	798	6.32



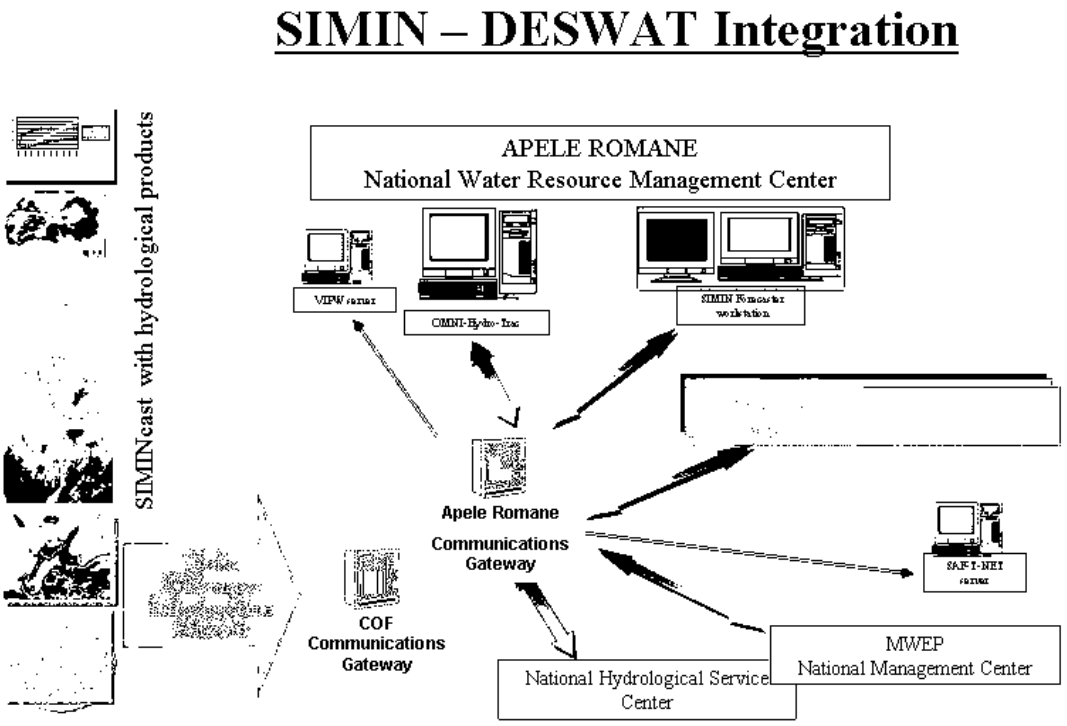
The value of the investments accomplished in the domain of water management in 2003

Starting with the year 2000, three significant investment programs were promoted in Romania for the construction of hydro-technical works with a defense role, financed both from funds of the State Budget and from external credits from the European Investment Bank (Euro 130 million), the Development Bank of the European Community (Euro 46 million), the World Bank (USD 120 million).

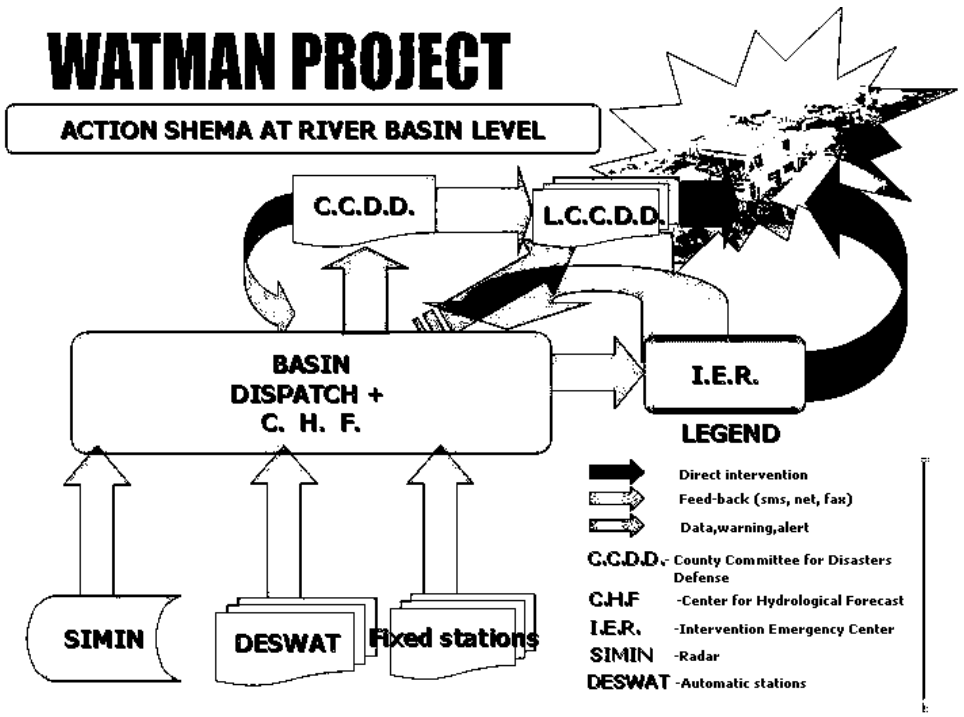
Non-structural measures

In the effort to enhance the management of emergency cases in the domain of defense against floods, the following 3 projects in the total amount of USD 180 million were initiated at national level, starting in the year 2000:

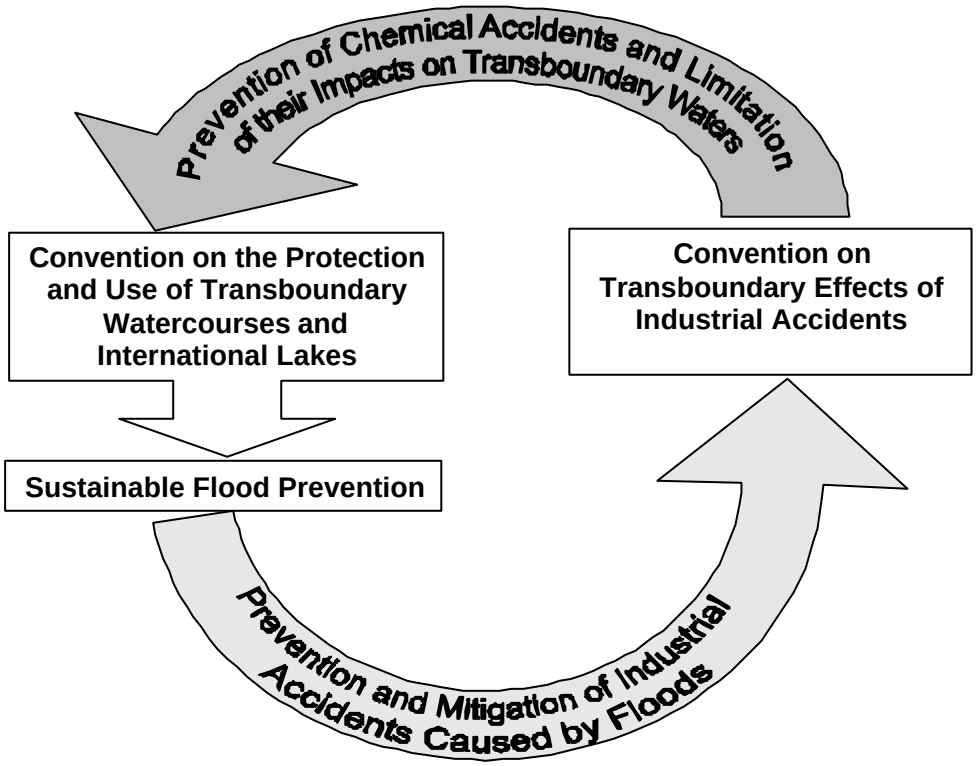
The SIMIN (Meteorological Integrated National System) Project, in the value of USD 56 million promoted in the year 2001 that shall be finalized in the summer of the year 2004, a project that aimed at modernizing the national meteorological system and weather forecasts.
The DESWAT (Hydrological System for Warning and Forecasting) in the value of USD 46 million that shall be carried out within the period 2004 – 2007, a project that aims at modernizing the national hydrological system by creating a station network for the automatic measurement of water levels and quality at national level and the enhancement of hydrological forecasts.



The WATMAN (Water Management Integrated System) in the value of USD 80 million that shall be carried out within the period 2006 – 2000, a project that aims at strengthening the reaction capacity for flood defense of the responsible institution and local administration, implementing of the decisional support systems and built of the emergency centers, associated with modernization of the hydraulic structures monitoring systems.



1. Approach of the Project and links to the UN ECE Conventions



The prevention of, preparedness for and response to industrial accidents capable of causing transboundary effects are subject of the Convention on the Transboundary Effects of Industrial Accidents. Several subjects are covered by related implementation activities like accident notification, exchange of information on safety technology and management and civil liability. The joint expert group works on the prevention and mitigation of industrial accidents that may cause pollution of transboundary waters.

The prevention, control and reduction of pollution of transboundary waters are subject of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes. One related important subject is the sustainable prevention of floods. On the basis of the UNECE Guidelines on Sustainable Flood Prevention from 2000 elaborated the EU Commission recommendations on the Best Practice of Flood Prevention in 2003.
The UBA research project addresses the prevention and mitigation of industrial accidents, caused by natural impacts especially floods. The subject of accidents caused by natural disasters is within the scope of the Convention on Industrial Accidents according to its Art.2, but has to base on and is related to the flood prevention activities.
Therefore the findings of the project may help to link the subjects of both conventions in the other way than by the main approach of the joint expert group.

2. Links to the Activities of the Joint Expert Group

Of course the joint expert gave recommendations on subjects of the project as well and other results of the expert group are quite useful.
The long-term work program of the joint expert group addresses already the requirement to ensure that containers and parts of installation with substances hazardous to water are protected against buoyancy, avulsion and damage from floating material (item No. 8) and the consideration of flood risk in siting of hazardous installations (item no. 9).
The inventory of existing safety guidelines and best practices for the prevention of accidental transboundary water pollution includes already the recommendations for the prevention of industrial accidents and safety of installations of the International River Commissions. Especially the recommendations of the International Commission for the Protection of the Elbe include already detailed technical requirements for the prevention of releases of hazardous substances in case of floods due to buoyancy, avulsion and damage from floating material.

3. Links to the Recommendation on Sustainable Flood Prevention and related Best Practices

The guidelines on sustainable flood prevention give already some quite helpful advice for the identification of hazards to installation by floods and required safety measures:

- Flash floods and riverine floods can thread installations.
- The kind and degree of these threats can change due to natural developments or human activities.
- Legislation like building codes or spatial planning should require that installations including hazardous substances are not sited in flood-prone areas.
- This requires clear flood maps and easily accessible information about restrictions on construction in flood prone areas.
- If nevertheless the siting there cannot be avoided or these installations exist in these areas they should be made flood-compatible.
- The existence of forecasting and early warning systems is essential to allow the required emergency response at these installations.

4. Subjects of the Research Project

The scope of the project is limited to

a) establishments and installations, which are subject of the German Hazardous Incidents Ordinance, which implements the EU Seveso-II-Directive, and

b) other installations for the handling of substances hazardous to water

on the one hand.

On the other hand the scope is limited to the prevention and mitigation of accidents caused by floods for both types of establishments or installations and caused by storm, earthquakes and subsidence by mining for type a) establishments and installations.

It has to be regarded that the scope of the project covers other kinds of consequences of accidents than the pollution of water.

Contractor of the project is Warm-Engineering in cooperation with Dr. Kröppke (engineering consultants), Krätzig and partners (civil engineers) and the institute for water management of the Karlsruhe University.

The specification of the project is structured in six main tasks:

Task one is the evaluation of hazards by floods. This task started with the identification of relevant, threatened establishments and installations for further fact-finding on site. The UBA has to thank the Länder North Rhine-Westphalia, Saxony and Saxony-Anhalt, which support the project and supported especially this identification and fact-finding on site. At the same time the contractors evaluated in cooperation with the competent authorities the kind and degree of past and actual flood risks for the sections of the Elbe and Rhine catchments area where these establishments and installations are located. Subject of ongoing evaluation is to what extent areas at risk due to failure of dikes are considered in flood risk maps and the existence of hazardous installations is considered in flood risk prevention and mitigation policies. Additionally the contractors have to compile the legal requirements, technical standards and recommendations on control of flood risks and control of risks of releases due to floods. Finally the contractors made surveys on site at establishments and installations threatened by flash floods in Saxony, threatened by riverine floods in North Rhine-Westphalia and Saxony-Anhalt and one establishment threatened by earthquakes and storm in North Rhine-Westphalia. These surveys shall give information on problems with the implementation of legislation, standards, recommendations and other practical problems.

Task two is the evaluation of hazards by storm, earthquakes and subsidence caused by mining. The contractors shall evaluate how far kinds and degrees of effects by theses hazards are considered in legal requirements and standards on one hand and in safety reports and licences on the other hand.

Task three is the evaluation to which extend hazards by floods, earthquakes and subsidence by mining are covered by the emergency planning of the operators of the relevant installations and the related risks by installations are considered in the contingency plans of the competent authorities.

Task four is the compilation of information on the state of the art in and options for retrofitting for the control of risks of releases of hazardous substances due to floods. This compilation shall cover measures to protect sites against flooding by siting, stationary or mobile technical equipment as well as measures to prevent or limit releases in case of flooding of the site. Because in the scope of the project are complex industrial installations this has to include the flood-compatibility of auxiliary safety relevant equipment like process control devices, energy supply, cooling water supply etc. The compilation shall include measures for emergency management in case of releases as well.

Task five is the evaluation of information on the state of the art in prevention of major accidents due to storm, earthquakes and subsidence by mining at establishments and installations that are subject of the German Hazardous Incident Ordinance. This evaluation shall cover adapted engineering and design practices as well as specialised construction technology. Additionally the contractor shall make suggestions on the improvement of related regulations and standards.

Task six is the set up of modules for the case of floods for emergency plans of operators of establishments and for contingency plans of authorities. This modules shall help to improve the coordination of both types of plans, the access of operators to forecasts and early warning

systems, an appropriate choice of an emergency management strategy of the operators and an integration of the needs of operators of hazardous establishments in contingency plans of authorities.

The final report of the project shall be presented by the end of 2005.

5. First Draft Findings:

At the moment the contractors are working on task one to three of the project specification. Some of the draft findings are:

a) In case of floods the amount of hazards should not increase by releases of hazardous substances. In case of floods the possibilities to mitigate the impacts of these releases into water or air to man or the environment are less than in normal situation. Therefore risks and safety requirements of hazardous establishments and installations should be considered in flood prevention policies.
b) The legal requirements, standards and recommendations concerning the prevention and mitigation of releases by floods should be harmonised. At the moment the policy approaches and requirements differ and make it difficult for operators to identify their obligations. Harmonisation of the approaches and recommendations especially those of the International River Commissions may help to harmonise legal requirements and technical standards.
c) If the siting of hazardous installations in flood prone areas cannot be avoided it requires an evaluation of flood risks and requirements of flood protection and/or flood compatible design. These evaluations should be updated on a regular basis because the floods risks may change over time.
d) The maps on flood plains and flood prone areas should be easily accessible for operators and authorities in charge for licensing or inspection of hazardous installations.
e) The forecast and early warning systems should consider hazardous installations in flood plains and flood prone areas and provide specific information to the operators of these installations.
f) The flood protection policies and the contingency planning of authorities for floods are focused on the protection of residential areas. The cooperation and communication between operators of hazardous installations and the authorities competent for flood prevention should be improved to identify and consider the specific risks and needs of these installations.
g) Activities for flood risk identification for and control at hazardous installations should be included in flood control action plans and definition of risk reduction aims.