WMO/GWP Associated Programme on Flood Management

STUDY OF HISTORICAL FLOODS IN CENTRAL AND EASTERN EUROPE FROM AN INTEGRATED FLOOD MANAGEMENT VIEWPOINT

Summary Report

Bratislava, July 2005

CONTENTS

LIST OF ACRONYMS

APFM	Associated Programme on Flood Management
CEE	Central and Eastern Europe
EACD	Executive Agency of Civil Defence
GIS	Geographical Information Systems
GMT	Greenwich Mean Time
GWP	Global Water Partnership
GWPCEE	Global Water Partnership Central and Eastern Europe
IFM	Integrated Flood Management
IWRM	Integrated Water Resources Management
NFIP	National Flood Insurance Program
TSU	Technical Support Unit
WMO	World Meteorological Organisation

1 BACKGROUND

Floods are among the most frequent and costly natural disasters in terms of economic loss and losses of lives. Most communities in the Central and Eastern Europe Region (CEE Region) can experience some kind of flooding from river floods, ice dam floods, urban area floods and flash flood. Mainly flash floods, which are defined as flood events where the rising water occurs during a few hours after the associated rainfall, are the real issue in the flood management sector of the region. The urgency for proper flood management is growing for a number of reasons. Population growth increases the number of citizens at risk, and increasing urbanization alters the hydrological and mesoscale meteorological setting. Greater recreational use of the mountainous regions and urban expansion is creating pressure to develop housing and commercial use in the flood-prone areas. All these aspects are resulting in the loss of lives and a growing economic loss associated with flash floods.

Therefore, the Global Water Partnership's Regional Chapter in Central and Eastern Europe (GWP CEE) decided to take part in a pilot project of the Associated Programme on Flood Management (APFM) under the umbrella of the World Meteorological Organization (WMO) and the Global Water Partnership (GWP). The Project was divided into two phases. The title of the first phase is "Study of Historical Floods in Central and Eastern Europe from an Integrated Flood Management Viewpoint" and the second phase will focus on the flood warnings and titled as "Forward Integration of Flood Warning in Areas prone to Flash Floods". The basis for starting such a project in the CEE Region has been a great source of experience and knowledge with flood management in the CEE Region. This knowledge is based on scientific results, practical experience and the high skill of the associated flood and crisis managers.

Seven countries from the CEE Region agreed to take part actively on the APFM project in the first phase, namely:

- Bulgaria
- Czech Republic
- Lithuania
- Poland
- Romania
- Slovak Republic
- Slovenia

Experts from the above-mentioned countries compiled National Reports about significant flash flood (or flood) events. The National Reports were reviewed by the Technical Support Unit (TSU) of the APFM and Council Members of the GWPCEE and after that used to prepare this Summary Report of the CEE Region.

The Summary Report is structured in such way that readers may understand the state of the flash flood issue in the CEE Region, the gaps in management practice and to indicate and describe problems related to flash floods.

2 PURPOSE AND OBJECTIVES

Sustainable development through Integrated Water Resources Management (IWRM), as it is stated according to the GWP, is a process that promotes the co-coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. As a subset of IWRM, Integrated Flood Management (IFM) has been defined as an approach to flood management with the aim towards maximizing the net benefits from floodplains and minimizing loss of lives from flooding. To fulfil such an aim, there is a great attempt around the societies to improve the flood risk mitigation by using such integrated approach as defined by IFM.

The main objectives of the APFM project in CEE Region of the first phase were as follows:

- to make a review of the recent floods in the CEE Region with special emphasis on flash floods from all relevant aspects,
- to select the Pilot river basin for testing IFM,
- to identify the most appropriate measures and tools for integration of flood warning in areas prone to flash floods.

The following immediate objectives were envisaged:

- to prepare a list of relevant recent floods in the CEE Region based on the review elaborated by participating countries (1 – 2 cases by each partner),
- to prepare the selection criteria for Pilot river basins for applying IFM approach based on the lessons learnt from recent floods review,
- to select pilot river basins (2-3) in the CEE Region for applying IFM principles.

This Summary Report focuses on those objectives dealing with recent floods in the CEE Region as they have been described and assessed by the experts from seven countries.

3 METHODS USED

Flash flood events involve several attributes, which can have an effect on the magnitude and scale of the flooding. These are for example, meteorological and hydrological conditions, soil permeability, terrain gradients, urban areas and so on. Therefore, study teams in the CEE countries decided to approach the flash floods as a complex process (including the socio-economical aspects), for both better understanding of the causes and effects of the flash floods that have occurred in the selected river basins and for achieving their integrated management. Following aspects were studied and evaluated during the first phase on the national level:

- Identification and selection of the main flooding that occurred in the past (2-3 events per country in the CEE Region).
- Collection of meta information on impacts of flooding in the river basins.
- Analysis of the characteristics of flooding and their social, economic and environmental

The following characteristics and impacts were described and analyzed in more detail:

a) Characteristics of the catchment
River basin characteristics, land use patterns, soils and vegetation, population, flood control measures (including flood risk) and other relevant information was used.

b) Hydrometeorological aspects of the flood
Both hydrological and climatological situations were described, together with direct causal factors of the relevant floods.

c) Warning and rescue system
Description of the flood forecasting and warning system (if any) and rescue system were provided for the floods in question.

d) Interaction of the natural resources
Land use aspects, groundwater and water quality problems (including drinking water) were evaluated in this part.

e) Flood control measures
Existing flood protection and control measures were described and if relevant the use of the flood control measures prior to and during floods (movable levees, sand bags, etc.) was mentioned, as well.

f) Population behaviour
Capability of the population living the flooded areas to cope with the floods, behaviour of the people and their respect to the flood management authorities (evacuation, etc.) were evaluated.

g) Flood losses
Impact on the human health, losses of life and economic losses were provided for the relevant flood events.

h) The removal of flood damages
Interventions to minimize the negative impacts of the floods on the society in the catchment area were described. Both technical and financial aspects were taken into account.

i) Flood protection measures adopted (post flood)
Based on the experience and knowledge from the previous flash flood, necessary mitigation and prevention measures that were taken up are described (post flood activities).

Results and findings from the all seven National Reports were used in the process of preparing this Summary Report. The information and data from the National Reports has been used to provide a synopsis of the flash flood management in the CEE Region and to contribute to the overall understanding of the flood management under the umbrella of APFM.

The following flash floods (or floods) were selected in seven CEE countries:

Country	**Floods in**
Bulgaria	Arda and Yantra Rivers
The Czech Republic	Svratka and Svitava Rivers
Lithuania	Nemunas River
Poland	Vistula River (city Gdansk) and Klodzko River
Romania	Slanic, Visen and Crisul Alb River
The Slovak Republic	Svinka and Strbsky Creeks
Slovenia	Savinja river (2 different floods)

4 LESSONS LEARNED

4.1 Understanding flood phenomena in Central and Eastern Europe

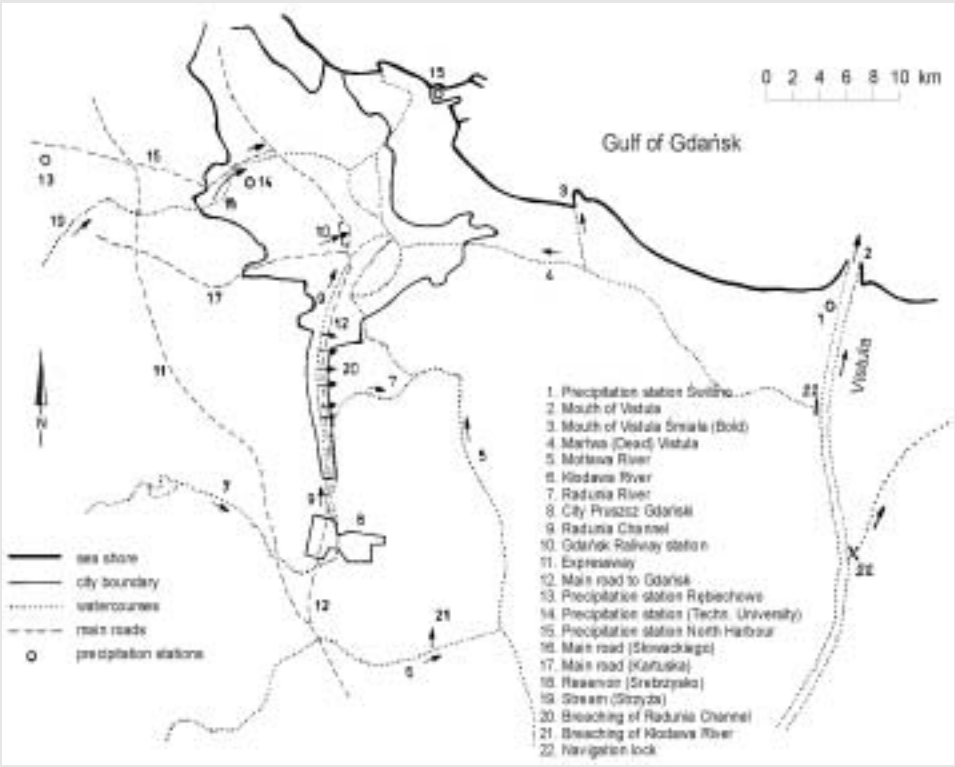
Based on the case studies it was found that similar to other parts of the world in the CEE Region, there are many different types of the floods, and some of them are listed below.

River flood
Flooding along the river is a natural event that can occur regularly. Some of them may occur seasonally when winter snowmelt is coupled with spring rains and the river will overflow its bank. Frequently, the land around the river will be covered by water for a long distance.

Urban flood
As land is changed from fields or forests to roads and parking areas, it loses its ability to store rainfall. Generally, urbanization can increase the runoff a few times over what would occur on the natural terrain. Urban flooding has a high potential to cause substantial economic losses and due to floodwaters in the direct living environment of the population pose a substantial threat to human live. This particularly applies for getting trapped in flooded basements or cars, electrocutions and the contact with contaminated floodwaters.

Fig. 1: The area of Gdansk subject to flood

Losses of people property and in the city infrastructure caused by flood were very high and estimated at about 50 million USD. More than 300 families were affected by the flood (damaged houses, loss of property). It was necessary to rescue people and their property from complete damage and destruction. Basements of numerous houses were flooded and required draining and drying. About 5000 people received special calamity status, which affords social assistance.



National Report (Poland,2004)

Ice jam flood

Floating ice may accumulate at a natural or man-made obstruction and stop the flow of water, creating the water reservoir.

Rapid snowmelt was initiated in the basin. Runoff accelerated, in the tributaries in particular and river began filling up within short time. See hydrographs (Fig.2) showing water level rise due to ice jams at hydrological stations downstream the River Nemunas.

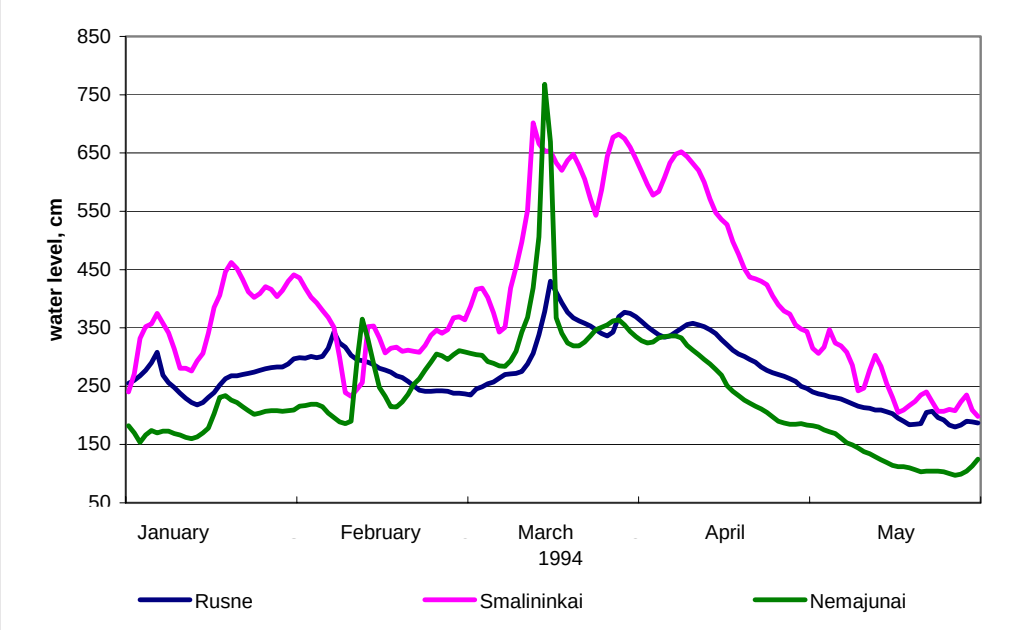


Fig.2

Water level rise due to ice jams recorded by stations located downstream the River Nemunas. Ice jam phenomenon is known as a powerful driving force during a flood period. Temperature regime of rivers in Lithuania is determined by cold air masses from Arctic or warm air masses from Atlantic. Those factors are not constant in space and time, and river's regime strongly depends on their fluctuations, especially in winter.

National Report (Lithuania, 2004)

Flash flood

A flash flood is the fastest moving type of flood. It occurs, when heavy rain rapidly accumulates in a stream, changing the normally quiet river corridor area into an instant rushing current. This very quick change is a reason, making the flash flood very dangerous. Flash floods are a specific type of floods moving quickly across the country and with little warning lead-time. Flash floods are distinguished from other types of flooding by the short timescales over which flood producing rainfall occurs and the small spatial scales (generally several square km) of drainage basins in which flooding occurs.

However, in some countries in the CEE Region other typology of the floods, as mentioned above, was used. Flood events are categorized on such criteria as size, frequency and duration and territorial coverage of the spread.

The Executive Agency of Civil Defense (EACD) in Bulgaria has introduced the following categories of floods, depending on their size, frequency and duration:

I. Small floods
They are characterized by low intensity and frequent recurrence – once in 10-20 years. These are floods bearing the lowest grade of risk (danger). They do not cause damage and do not leave long-lasting traces in the memory of the local population.

II. Dangerous floods
Their characteristics are average intensity and probability of emergence once in 20-40 years. They cause damage to the immediately adjacent to the river agricultural land, buildings and facilities. They pose danger for the people and animals not only in the river valley proper, but also on the flooded river terraces.

III. Very dangerous floods
Their characteristics are high intensity and probability of emergence once in 40-80 years. They cause damages to bridges, water catchments, and embankments along river corrections, adjacent land, buildings and engineering structures. They pose great danger for people and animals along the banks of the river.

IV. Devastating floods
Their characteristics include high intensity and probability of emergence once in 80-150 years. They cause great changes in the river course with grave pitting, meander breaking, destruction of banks, retaining walls, heavy damages and destruction of bridges, hydro-engineering facilities, sites situated near the river etc. They cause huge material damages and the peril of people and animals.

V. Calamitous floods
Their characteristics are very high intensity and probability of emergence once in 150-200 years. They cause sharp changes in the riverbed – pitting and destruction of old meanders. In the mountain sections the river course carries huge stone blocks of up to and above 2-3 m in size. At the point of exit of the river out of the mountain and into the flat land large, several meters thick torrential cones might emerge, made up of block piles, gravel and sand or sludge. In the flat land end the river valleys got covered with a thick layer of slime. Hydro-engineering and building facilities and sites, situated along the riverbanks, such as reservoirs, bridges, roads, barrages, buildings etc. get entirely demolished or gravely damaged. Devastation and catastrophic material damages are inflicted and there are great losses of human life and animals.

In terms of territorial coverage of the spread, the EACD, Bulgaria distinguishes the following types of floods:

a) ***Local floods.*** They emerge on individual rivers or river sections

b) ***Medium-range floods*** (medium-scale, mezo-scale). They emerge in a given area on several rivers.

c) **Large coverage** (large-scale) **floods**. They extend over large areas with many rivers or the course of a big river, such as the Danube River and the adjacent flooded terrace of the territory of the country.

National Report (Bulgaria, 2004)

4.2 Flash floods in CEE Region

Since the purpose of the study was focused on the flash floods, this type will be described more in detail.

4.2.1 Flash flood causes

Many factors contribute to the creation of flash floods. In general, they are the results of heavy rain concentrated over an area and specific morphologies of the drainage basin. Specifically, factors that contribute to the flash floods in CEE Region were identified as climate variability, low permeability of saturated soils, impervious ground surfaces and steep slopes. Phenomena such as debris dams, created through a landslide into a river, contribute to the fatalities and damages associated with flash floods.

Flash flood frequency and occurrence

The national reports did not concentrate on the overall statistical study of the flash flood frequency and occurrence in the time period. However, it was recognized that the most frequent time period for flash floods occurrence, both spring – summer high flows and summer – autumn low flows, might be considered.

Between 3 and 7 March 2001 the torrential rainfalls, which in quantity exceeded 150 l/m^2 and also because of the rise of the temperature up to 10°C, which caused a rapid melt of the snow cover, the maximum discharge exceeded the flooding level. The snow cover on 2 March 2001 had a height of about 29 cm and on 6 March 2001 the snow had completely melted. Also, the rise was strong because the soil was frozen into depth and so the runoff coefficients were augmented. The flood has a rapid and highly culminating discharge that caused devastating socio-economic effect al local level.

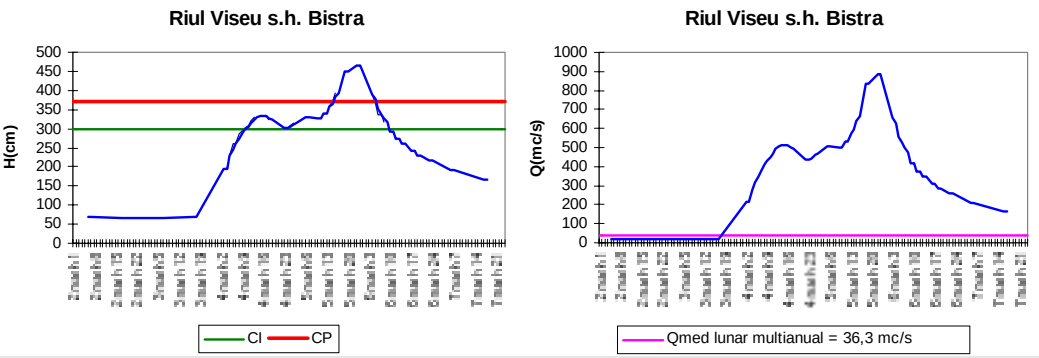


Fig. 3 Flood on the interval 3-7 March 2001 on Viseu river, Bistra gauging station (Cl-flooding level, CP-danger level)

National Report (Romania, 2004)

Before the flood event, water levels of streams in this area were low, flows from 10th July 2002 on the upper Svratka River in the water gauging station Borovnice were on the level of 250- to 335-daily discharges. In the water gauging station Bílovice on the Svitava River, the flows from 10th July 2002 were at the level of 240- to 330-daily discharges. Water levels up to the 13th July were stable; on the 14th July a slight increase of the water levels occurred.

On 15th July 2002, after torrential rainfalls between 17:30 and 19:00 hours a flood wave was created, which receded approximately at midnight. Most affected were left hand tributaries of the Hodonínka Rivulet: Veselský Creek and Crhovský Creek. Approximately at 19:30 hours, the Mayor of Hodonín u Kunštátu broadcast on the local radio, that a torrential flood wave is approaching Hodonín from Olešnice. In the course of twenty minutes, water level reached 2.5 m in a place where the normal stage is 10 cm. This situation lasted for about 4 hours. According to local inhabitants, the Hodonínka Rivulet was 40 to 50 m wide in a place where the normal width is 2 m.

National Report (The Czech Republic, 2004)

In July 2004, the intensive continuous precipitation occurred in form of torrential rains, connected with thunderstorm activity. High precipitation totals were the reason of a flood situation in Poprad and Dunajec river catchments. On 24 July 2001 in the afternoon, a flash flood occurred on Štrbský Creek, which significantly hit Štrba village. The flood reconstruction was made after terrain investigation on August 14, 2001 (21 days after the flood).

The High Tatras Mountain was hit by abundant precipitation in July 24, 2001. The upper cyclone with centre above East-Slovakian lowland caused the northern-eastern movement of wet unstable air mass across the High Tatras ridge. In the mountain ridge area there was continuous precipitation. In the unstable air created the cloud of Cumulonimbus type from 11 to 12 GMT. Later, after 13,30 GMT on the leeward side of mean Tatras mountain ridge one isolated Cumulonimbus occurred suddenly, which was growing and moved in southwestern direction. This cloud hit the Štrba village region with its precipitation activity.

National Report (The Slovak Republic, 2004)

The flash floods reported in the national reports have occurred in the time scale of a few hours with a little or no warning and inundated areas with several meters of water within minutes. Furthermore, flash floods occurred in majority in the afternoon and late evening time, where citizens were not expecting such a hit of the floodwater.

4.2.2 Forecasting and warning systems

Due to the fact, that flash flooding can occur spread over the national territory of some of the countries, and in the range of several hours of the rain event, it is expected to produce short-term forecasts (hours). For this purpose integrated hydrometeorological approaches should be suitable to be used by forecasters and hazard managers. Therefore, prediction of flooding events require the interactive use of both meteorological and hydrological models, that introduce the new weather radar data and feedbacks from the soil - water – atmosphere system. However, this integrated approach was not reported in the national reports to be in use. Nowadays, in some of the CEE countries there is a great effort to develop the flood forecast and warning system, where one part of the system is flash flood warning. On Figure 4 below, the scheme of the Local Early Warning System in the Slovak Republic is presented as an example. The system as such has following components:

- rainfall and runoff information system
- data communication system
- predictive models
- warning dissemination system
- action plan for flood management authorities on local level

In present time only the first two components are put into practice in the Slovak Republic.

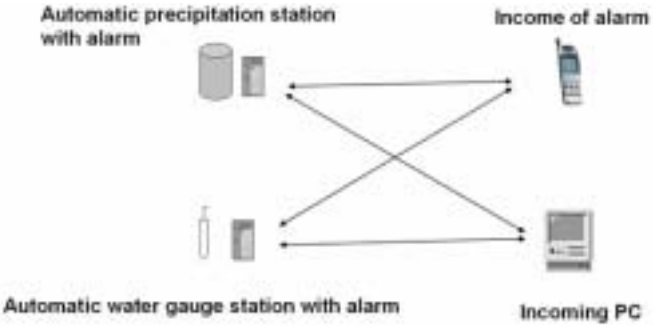


Figure 4: Scheme Local Early Warning System in the Slovak Republic

4.2.3 Flood mitigation measures

In CEE Region the floods and storms are the most common natural disasters. Experiences and knowledge, which were gained from the individual flood events, are used by the flood management authorities and competent institutions for flood prevention and protection measures. For instance, in the Slovak Republic, the flash flood in July 1998 led to the development of the strategic document "Programme of Flood Protection till 2010".

Generally, flood mitigation measures consist of the activities having the prevention and protection effects. These measures are distributed in the time span before, during and after flood event.

Before the floods

National Reports presented mainly the prevention and protection measures of structural character (dikes, wears, polders reservoirs, etc.). There were little or no flood protection objects situated in the river basin areas. Flash flood warning system as a prerequisite to cope with the flooding was not developed and used in any countries included in the APFM project.

Similarly, training activities of the citizens and their preparedness to live with the floods were not in the agenda of the flood management authorities of the CEE Region. None of the national reports consists of the information on the existence of the flood management plan and emergency instructions. These aspects had a crucial impact on the situation during flooding in reported case studies.

During the floods

As has been mentioned, the flash floods in the studied areas occurred during the afternoon and late evening. Little or no warning system and missing training of the people on how to behave and to cope with flooding were a basis for huge damages on the properties and even losses of lives as it was reported in the National Reports.

The rescue system and the behaviour of the citizens play an important role during the flood. All participating countries reported very good practice and co-operation of the rescue teams (fire brigades and river basin authorities or municipalities) with citizens during the flooding. This co-operation and overall preparedness of the rescue authorities created a good basis for elimination of the impacts during and immediately after floods. However, co-operation of the municipalities affected by the flooding was presented as not sufficient in majority of the National Reports. This shortcoming might be caused by the damages on the communication network or missing ability of the individual officials.

Behaviour of the population during the flood was reported from "fully organized" to "chaotic", depending on the situation and people preparedness. If necessary, evacuation was done smoothly and rapidly.

Sudden occurrence of the flash flood in such a magnitude has found the people unprepared, just returning home from the work.

The citizens behaved in different ways from the organized self-protection to panic. Confusion and panic have occurred mainly by the young Roma population, where majority of the causalities were registered. The older family members of the Roma community were not in their houses, which were located in the inundation area. The children had to cope with the situation alone with no experience and knowledge how to behave. It is necessary to be mentioned that neither the older generation was trained by authorities to cope with such a situation nor children. However, the older generation was better prepared and organized, having certain knowledge and experience with extreme flood events from the past.

In spite of occurrence of the flash flood in the afternoon hours, its consequences continued till the late night causing great difficulties to rescue teams. Communication and co-operation between rescue teams and population in the affected area was very good and smooth.

FLOOD DAMAGES

All together during this flash flood more than 3 600 people were evacuated. As a great success 56 people were rescued, whose lives were under great danger. Unfortunately, despite the enormous effort of the rescue teams 47 people died, majority of them in Jarovnice village. Published costs on rescue activities exceeded 116 millions SKK (19,6 million SKK were used to reconstruct banks, to clean the main channels and inundation areas from detritus and sediments, etc.).
The overall damages were estimated to the value 850 million SKK. Structure of the damages was as follows:

- State properties – 273,4 million SKK
- Municipal properties – 110,4 million SKK
- Legal entities – 336 million SKK
- Individual citizens – 130,2 million SKK

National Report (The Slovak Republic, 2004)

After the floods

After each flood event, information on damages and flood consequences are recorded and assessed. An evaluation of the operational status of the crisis management (such as evacuation plan, etc.) and the damages caused by a disaster should be done in order to set up the financing for repairs.

The flooding of the populated zones and the installation of the drinking water reservoirs can have an impact on the public health, socio-economic and psychological conditions. Due to the fact that drinking water resources were deteriorated, the movement of the human and animal populations was a consequence. Activities on sanitation and water purification were done. Delivery of the drinking water to the citizens was the first step to be done by crisis management. Depending on the local conditions crisis management made other necessary actions to prevent the epidemics in flooded areas (like decontamination, vaccination, resettlement of populations and other health warning and information services).

Based on the national reports of the participating countries, several action programmes were introduced in the CEE Region. Experts reported great level of post flood co-operation between neighbours and municipalities. Huge degree of solidarity was recognized in the society. Both crisis management authorities and volunteers contributed significantly to mitigate the impacts on the health and properties. Delivery of drinking water to the affected citizens was done by crisis management.

5 SOCIO-ECONOMIC ASPECTS OF FLOODING

5.1 Floodplain utilization

Recreational activities and economic development continue to place pressures on floodplain utilization. As a result, the number of flood-prone communities increases and therefore there is a need for more timely and accurate warnings continues to increase. Although structural measures of protection such as flood control reservoirs, polders and others, can provide some protection from flooding from larger streams with longer flood lead times, it is too costly to use flood control structures on the large number of small streams flowing via the populated areas. Moreover, it is costly and difficult to construct and then monitor the safety of all structures that could mitigate flash floods. Therefore it is crucial to reduce the population living in the floodplain. For this purpose, land use planning can be used as a tool for decision-making process in close connection with risk mapping and quantification of the vulnerability and sensitivity. In some of the CEE countries, flood managers use these tools. For example, in Bulgaria a map of the threatened areas in the country was developed. This map is used by the flood forecasting service to produce a better prediction of floods, and by the administration to reduce the damages.

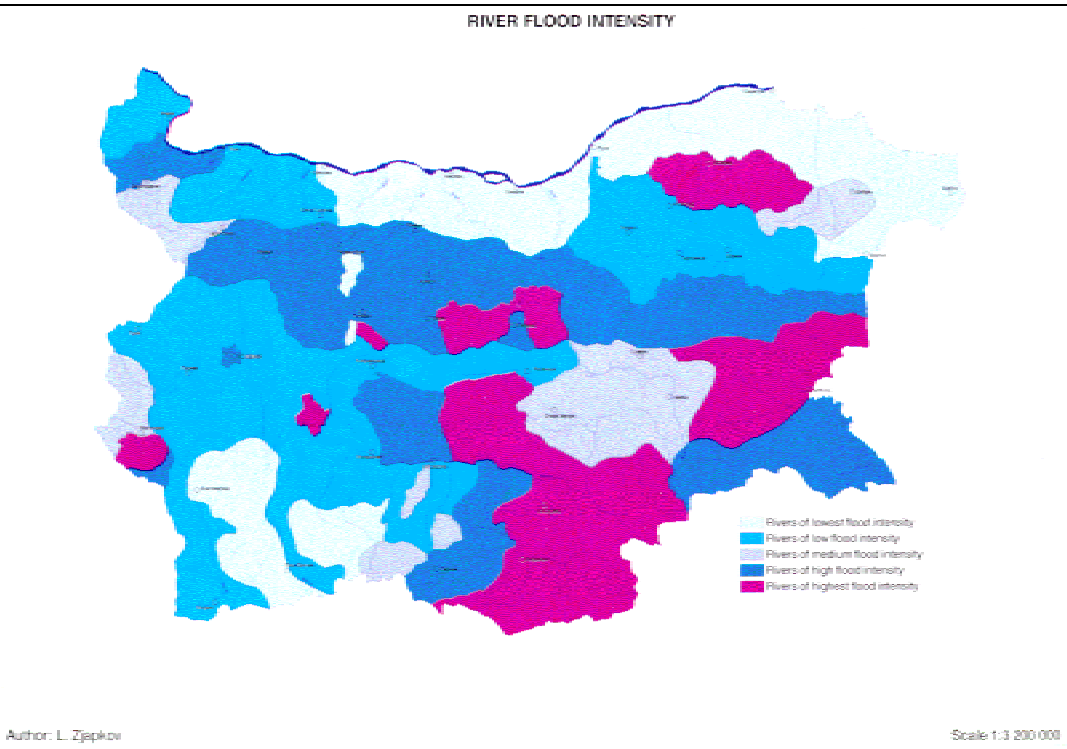


Fig. 5 Map of threatened by the flash floods areas in Bulgaria.

National Report (Bulgaria, 2004)

Similarly, a map of the flash floods vulnerable areas was developed in the Slovak Republic. This map is used by the Hydrometeorological Service for more precise flood prediction and by Regional Government for land use planning activities.

The Civil Protection Board of the Fire and Rescue Department in Lithuania tested a system that is capable of generating and displaying maps of potentially inundated areas. This inundation mapping system integrates real-time or forecasted data provided by the Hydrometeorological Service.

5.2 Flood insurance programme

In spite of the attempt of the society to reduce the population living in floodplain zones. It is unlikely and in many cases socially and economically undesirable to generally evacuate flood prone areas. Therefore some non-structural measures have to be implemented for those to stay in these localities. Insurance programmes are one of the measures to be applied to help to sustain development in the flood-prone areas. Such programme can help to mobilize the financial resources for the reconstruction. Insurance companies are using for the flood insurance programme tools such as mapping of hazards and quantification of risks from flooding. Due to fact that some of the structures as buildings and houses are located in the localities with a very high degree of exposure to flooding, there is a problem to get insurance. This was also described in the National Reports of the APFM project, where only a few cases were insured.

6 PUBLIC PREPAREDNESS AND SELF-HELP PROGRAMME

6.1 Dissemination of the flood warnings

Essential part of the warning system of flash flood is among others the dissemination system. National Hydrometeorological Services are using the advanced technologies for making flood forecasts and their distribution to the flood management and general public. Dissemination of flood warnings has improved in recent years as well, largely in response to the enhanced coverage and attention of the local media (such as TV, radio, newspapers), which could have a direct communication with the Hydrometeorological Service.

However, this information on the dissemination of the flood warnings in the CEE countries is not reported in the National Reports. This situation can be caused by fact that such a system is completely missing or experts did not take into account such a system. This topic would be a core element of the second phase of the APFM project in the CEE Region.

6.2 Public preparedness

Proactive preparedness programmes remain indispensable for loss of life and flood damage reduction. Flood management and crisis management should take actions to educate the general public regarding the occurrence and destructive force of the flash floods. These activities are essential to live with floods, due to facts that floods have been, are, and will occur. Flood management plans, including flood hazard maps, should be developed with direct involvement of the public.

6.3 Training activities

Both flood management and crisis management should organize training courses and activities for different target groups. These courses should be done on the regular basis for both professionals and general public to cope with the flash floods when occurred. Target groups must include the groups with the highest exposure to, or vulnerability to the negative consequences of floods.

Besides the importance of this part for the flood protection, in the National Reports of the CEE countries no training activities of the flood management were reported. However, from the literature related to this topic, there are some training activities concentrated on the professionals in the individual CEE countries (rescue system and evacuation).

7 CONCLUSIONS AND RECOMMENDATIONS

Seven countries from the CEE Region have taken part on the WMO-GWP APFM Project "Study of historical floods from an integrated flood management viewpoint". Experts from the countries evaluated two or three flood events with main effort on the flash floods in the region. From the submitted national reports following can be concluded:

- several types of the floods occur in the CEE Region (river flood, flash flood, urban area flood, ice dam flood),
- flash floods are a great issue in the CEE Region causing huge damage on the properties and losses of lives,
- both periods spring – summer high flows and summer – autumn low flows are the most frequent time span for occurrence of flash floods in the CEE Region,
- the most frequently, flash floods occurred during the afternoon and late evening,
- no flash flood warning and forecasting methodologies were developed in the CEE countries,
- local warning systems of flash floods were developed in three countries (Czech Republic, Slovak Republic, Poland) and put into practice. However, essential components of the warning system such as warning dissemination and action plan of local civil authorities are still under development,
- both structural and non-structural measures were taken to prevent and protect the population living in the flood-prove areas,
  - structural – dikes, reservoirs, polder weirs, etc.
  - non-structural
- insurance programmes are not well developed in the CEE Region, in spite of the population living in flood plain areas,
- after flooding some interference with the environment was reported such as drinking water resources contamination, changing ecosystems biodiversity, land slides, etc.
- rescue systems are well developed for during and after flood activities (evacuation, contamination, vaccination, population removal (both human and animals),
- there were no regular training courses and activities reported for both professionals and general public to cope with floods,
- some of the countries have created maps of flash flood hazards and quantification of vulnerability of people to floods.
- communication with media as tools for dissemination of the warnings is not sufficiently used by the flood management authorities in the CEE Region.

Based on the analysis of the national reports following recommendations are suggested to fulfil the objectives of the Integrated Flood Management and fill the gaps of existing flood management in CEE countries regarding flash floods:

- Intensify effort in the field of preparedness to flash floods in the CEE region because of approved findings that they are a great issue in the CEE Region, causing huge damage on the properties and losses of lives.
- Communicate to public the fact about probability incidence of flash floods to be better prepared to take the most efficient emergency service against them.

- Develop methodologies for flash flood forecasts and warnings in CEE countries.
- Complete sub-components of the warning systems already developed for local flash floods warning systems in some CEE countries (Czech Republic, Slovak Republic and Poland), such as efficient warning dissemination and local authority's action plans.
- Create GIS maps on the national level of flash flood risks and quantification of flood effects on the local population.
- Facilitate preparation of appropriate insurance schemes for the population living in flood prone areas.
- Support regular trainings on how to cope with floods for both flood management professionals and general public.
- Promote the use of communication with media as an effective tool for dissemination of early warnings, understandable for local authorities and public, by flood management authorities in countries of CEE region.
- Use the existing political will and initiative to apply the Integrated Flood Management and fill the gaps of existing flood management in CEE countries regarding flash floods.

Participating countries acknowledged the support of the WMO and GWP to solve the issue of the flash floods in the CEE Region and express the sincere desire to continue in the existing APFM project by the second phase.