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THE ASSOCIATED PROGRAMME ON FLOOD MANAGEMENT

INTEGRATED FLOOD MANAGEMENT

CASE STUDY

UKRAINE: *FLOOD MANAGEMENT Within the Tisza River Basin*

Edited by

TECHNICAL SUPPORT UNIT

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1. Location

1.1 Physiographic and Climate Characteristics

The Tisza River is the greatest left tributary of the Danube River. Its length is 967 km and the catchment area is 157 000 km^2. The upper reaches of the Tisza River begin in Ukraine, in the Carpathian Mountains at the confluence of the Czorna Tisza and Biela Tisza rivers. The Tisza river basin within the territory of Ukraine is 12 760 km^2. The length from the spring (the spring of the Czorna Tisza which is considered as the source of the Tisza because it has a large catchment than the Biela Tisza) to the border with Hungary is 220.4 km. In three parts, the Tisza River forms a state border – twice with Hungary and once with Romania. The total length of the river within the territory of Ukraine is 155.4 km, and 107 km of the river forms state borders. The average elevation of the Tisza river basin is 964 m. The catchment is 75% in the mountains and 25% in the lowlands.

The Tisza river basin is asymmetrical – the catchment portion related to the left bank tributaries is smaller than the catchment portion related to the right bank tributaries. The slopes, in the upper part (in mountains) are 2.385 ***prom***, and in the lower part are 0,087 ***prom***.

The Tisza River basin within Zakarpatskya oblast (administrative district) of Ukraine is characterized by moderate-continental climate. The influence of the Carpathians that protect Zakarpatskya oblast against intrusion of cold arctic mass of air from north-east and east results in soft and warm winters, moderate warm summer and autumn in the Tisza river basin.

Normal annual air temperature is ranging from +3.0 to 9.0 ˚ C depending on the area elevation. On the plain part of Zakarpatskya oblast with altitude up to 300 m above sea-level, annual average temperature is ranging from 9.9 to 8.2 ˚ C. At foothills on the altitude from 300 to 500 m it reaches + 8.0…+6.6˚ C, and in mountains at the altitude of 500-700 and 700-900 m correspondingly it is ranging from +6.3…+5.5 ˚ C. to 5.4…4.4˚ C.

Absolute minimum of air temperature is observed usually in February, and in the plain part, it reaches 32-33 ˚ C below zero and in the mountain part of the Carpathians, it exceeds 36˚ C below zero.

Maximum temperatures are observed in July and August. In the plain part of the basin, the temperature reaches 40-41˚ C, and in the mountain areas, up to 36 ˚ C.

Normal annual precipitation per year at upper reaches of Tisza and its tributaries Teresva, Tereblya and Rika is 1200-1400 mm. In the middle part of rivers the norm of precipitation is 1100 – 1300 mm. At foothills the precipitation decreases to 800 – 1000 mm, and in the plain area, 530 – 700 mm.

In summer, the maximum annual precipitation is observed – 60 – 80%. Intensive precipitation during this season is caused by atmospheric fronts from northwest, west and southwest cyclones that are formed under the influence of orography and results in undulatory intensifying of precipitation. During this season, maximum precipitation is observed in the central part of mountains, on peaks of mountain systems, Chornohora, Gorgany, at the headwaters of the following rivers such as Black and White Tisza, Teresva, Tereblya and Rika.

In autumn, maximum precipitation (300mm and more) that results from the upcoming south cyclones is observed on the south- west slopes of the mountain.
In the Ukrainian Carpathians, daily precipitation of 200 and more mm were observed during last decade.

Snow cover in the mountains appears in the middle of November and melts in the first part of April. On the plain snow cover appears a month later than in mountains, and melts a month earlier. Number of days with snow covers ranges from 50 to 110 in the plain and more in mountains. The maximum observed depth of snow cover ranges from 35 on plain to 110 in mountains.

The hydrographic characteristics of rivers of the Tisza River Basin within Ukraine are presented in the Table1.

Table 1. The hydrographic characteristics of rivers of the Tisza River Basin within Ukraine

River name	Distance from the mouth of the main river, km	River length, km	Catchment area. sq. km
Tisza	1218	252	12760
Black Tisza	913.5	53.3	563
White Tisza	913.5	35.4	485
Kosivska	876.6	43.1	157
Shopurka	871.9	41.4	286
Teresva	835.4	90.8	1220
Tereblya	818.1	97.0	755
Rika	793.0	94.1	1145
Borzhava	729.3	115.5	1450
Latoritsya	90	156	4418
Uzh	0	112.8	1582

The mean annual flow volume/km^2 in the Tisza River basin decreases by 1/3- 1/4 from the north east to south that ranges from 39.2 1/s/km^2 to 12.41/s/km^2
Here alimentation of rivers is combined by the snow, rain, and base flow, with various share of each in the total flow. Up to 40% of annual flow occurs in March-April during spring flood that is usually formed through snow melting-rain floods. Rain floods on the rivers are observed at any season, and there may be some combined floods during thaws in winter.

The distribution of flow in summer-autumn period and in winter period differs in the eastern and western parts of the basin. Thus, annual flow reaches 40-45% in the eastern part of the Tisza river basin during summer-autumn and in winter, reaches 15-20%. In the west, in summer-autumn annual flow is 25-40% and in winter 25-35%. The share of winter flow increases to the direction of the mouth of rivers. In case of decrease of annual effective precipitation, the share of spring flow decreases, and the share of winter flow increases.

1.2 Land use

The general land-use distribution, which has an influence on run-off, infiltration and flood retention and indirectly affecting most of the hydrological and meteorological parameters is as follows (in % of total land area):

- farm land/arable land – 38%;
- forests and forest covered areas – 56%;
- developed lands (with buildings) – 3%;
- open lands without vegetation cover or with minor vegetation cover / open swamped lands – about 1%;
- waters – about 2%.

The distribution of forests in the watershed and the dynamics of deforestation are problems that have attracted public attention after the recent hazardous floods. The wood working industry is an important component of the economy in the Zakarpatskya oblast. Changes in land use and urban development in recent decades have definitely accelerated the runoff and decreased the natural retention. However the exact impacts of various land-use changes can be elucidated only by using simulation models with physical parameters.

2. Description of floods

The vast majority of floods (app. 94%) in the Tisza river basin are caused by macro – or micro scaled cyclone systems (perhaps coinciding with snow melting), while only 7% is primarily caused by rapid snow melting due to zonal warm advection.

The catchment area of the Tisza River is located in the south or southwest of the mountain ridge. Consequently route of warm, wet air is nearly perpendicular to the mountain range. Therefore, the amount of precipitation is the highest in the northeastern part of the Carpathian Mountains, in the area where the springs of the river Tisza are located. The amount of precipitation during the period of the flood formation (2-3 days) can be 250-280 mm and more.

High flood waves can form in nearly any month of the year. The frequency of peak stages is the highest in March (17-22%), the second highest is in April (13-16%). In August and September it is exceptional to have peak water, however in November and December the frequency exceeds 10% again. Summarizing the results it can be concluded that during the cold period of November – April, when the flood waves form as a joint result of snow melting and rains, 77 – 80 % of the annual peak water stages occurs during this period.

At mountain regions, flood peaks are formed within hours following the end of precipitation. Accumulation time is short, the flood peaks form in 24 – 28 hour after the beginning of the rain. The intensity of water level rise can be as high as 20-40 cm/hour. During the flood, the rise of the water stage can reach 10-11 meter per 20-40 hours on flatland river sections. Big and fierce floods took place in November 1998 and March 2001, which was accompanied by several dike breaches.
Long-term observations of the level regime and maximum flow discharge shows that extraordinarily high floods occurred in the Tisza basin in 1913, 1927, 1933, 1941, 1948, 1955, 1957, 1968, 1970, 1980, 1992, 1993, 1995, 1998 and 2001, and it should be noted that floods of 1947, 1957, 1968, 1970, 1992, 1998 and 2001 are particularly significant due to their character and catastrophic consequences.
For instance, during the flood in March 2001, the huge quantity of rain pouring down breached the protective dikes at dozens of places; jeopardized human lives; washed away railways, roads; destroyed houses; spoiled cultivated areas; and caused extensive damage to the natural fauna and flora. It drifted, washed away soil, and stoned, uprooted vegetation, parts of buildings and debris.

The flood deposited silt on lower sections; as a result the river changed its course at several places and forms small islands, which obstructed the smooth flow of water in the river.

The dike breaches in the mountains caused the flooding of smaller areas for a short period, but the rapidly flowing water washed away everything in its way. Over the higher sections of the flatland dikes, several million cub. M of water flooded Ukrainian territories near Korolevo, Bolovoe, Chetovo and Tarpa, thousands of acres of fields remained underwater for a long time. Under such extraordinary circumstances, the flow at Vilok exceeded 3,000 m^3/s and the total mass of water in ten days reached as much as 1.3 km^3.

3. Strategy of the flood management

3.1 Non structural measures

3.1.1 Brief characterization of legislation

The following legal acts regulate activities in the field of flood management and protection in Ukraine:

- the Constitution of Ukraine;
- the Water Code of Ukraine;
- the Law on legal procedures of emergency;
- the Law on zone of ecological emergency;
- the Law on civil defense of Ukraine;
- the Law on defense of population and territories against emergency situation of man-caused and natural character;
- the Law on emergency and rescue services;
- *the Resolutions of Cabinet of Ministers of Ukraine:*
- on land use regulation in high-risk zones;
- on unified state system of emergency preparedness and response of man-caused and natural character;
- on procedure of emergency classification;
- on approval of statement of state monitoring system of environment;
- on approval of statement of warning system in emergency;
- on overall program of flood prevention measures for 1994-2000;
- on program of flood prevention measurers in the Tran Carpathian region for 1999-2000;
- on program of complex flood protection in the Tisza river basin in Zakarpatskya oblast for 2002-2006 and forecast to 2015".

3.1.2 Institutional background

Investigation of the allocation of public tasks concerning flood management, the role and responsibility of Ukrainian governmental bodies gives the following results.

The Tran Carpathian (Zakarpatsky) Branch of the State Committee of Ukraine on Water Management (ZBWM) is responsible for flood management and response in the Tisza river basin, maintenance of flood protection, construction and development of new flood protection measures, maintenance of polders, channels and other engineering structures of water management.

The State Hydro meteorological Service manages National Meteorological and Hydrological Networks, and operates via its structural units that are responsible for:

- the operational processing of monitoring the data, operational forecasting, official dissemination of monitored data and forecasts to the governmental institutions and mass-media - Ukrainian Hydro meteorological Center, Kyiv and regional Tran Carpathian Center on Hydrometeorology in Uzhgorod;
- the storage and long-term processing of hydrometeorological data, data archiving, methodological guidance of monitoring network - Central Geophysical Observatory, Kyiv;
- Research and Development in the field of hydrological and meteorological forecasting - Ukrainian Research Hydrometeorological Institute, Kyiv.

The Transcarpatian regional branch of the Ministry of Emergencies and Affair of Population Protection, as a consequence of Chernobyl Catastrophe, is responsible for flood emergency response in the Tisza river basin. It provides operational actions in emergency for population protection and also takes part in the maintenance of flood protection constructions during periods of emergency as well as the reparation of constructions destroyed during the floods.

Problems and needs
This distribution of responsibilities among the different national agencies dealing with flood forecasting and flood management is the result of long-term experience and traditions. Since the technology and tool have changed in hydrology and meteorology, there is now a demand for flexible reflections also in organization schemes.

The connections and interactions within the main structure of State Hydrometeorological Service should be organized in a more efficient way to complement the data processing technology.

The Regional Flood Centre (focusing on forecasting and management) of the Tisza river basin should be set up as a basis for joint execution of the AIVS –Tisza -2 system by the Zakarpatsky Branch of State Committee on Water Management and the Zakarpatsky Centre of Hydrometeorology.

There is a strong need to upgrade the knowledge of experts through specialized training and sustainable education effort in hydrological engineering in the Carpathian region. It is needed to start preparatory work to establish the relevant courses at Uzhgorod University.

3.1.3 River flood forecasting and warning system of the State Hydrometeorological Service

Existing hydrometeorological measuring and observation network
The primary factors which influence the accuracy and lead time of hydrological forecasts are the accuracy, speed and reliability with which the real-time values of hydrological and meteorological variables are collected, for this purpose extensive monitoring of hydrological and meteorological data is carried out.

The present hydrological and meteorological monitoring network system and hydrological forecast service of Ukraine have been inherited from the former Soviet Union.

In the Tisza river basin there are thirty-eight operational hydrological stations: Tisza river – 6, Czorna Tisza – 1, Biela Tisza – 1, Kosivska – 1, Teresva – 2, Mokranka – 1, Tereblya – 1, Rika – 1, Golyatinka – 1, Repinka – 1, Pilipez – 1, Studenyi – 1, Borzhava – 2, Irshava – 1, Latoritsa – 4, Vecha – 1, Pinie – 1,Stara – 1, Uzh -4, Lyuta – 1, Turya – 2.

Ten meteorological stations are operated in the Tisza river basin: Khust, Rakhiv, Mizhgirya, Nizhnyi Studenyi, Pozhezhenska, Nizhni Vorota, Beregove, Vilikyi Bereznyi, Play, Uzhgorod.

Twelve hydrological stations within the Tisza river basin were closed during the period from 1980 up to 1990.

Problems and needs
Unfortunately, the absence of number of automatic and long distance hydrometeorological information systems is a critical deficiency of existing observation network.

The density of the ground network for meteorological observation is comparatively low; its distribution is unfavorable. Measuring places are mostly located in areas below an altitude of 500m. In winter snow thickness and snow water content are measured from the first snowfall till the end of December every ten days, after this, every five days until the end of the melting period. Besides this, meteorological stations do daily snow observation.

During flood-free spells, 2 water stage data per day while during floods 6 data per day (every four hours) are available from the hydrological measuring network. Unfortunately, the numbers of discharge measuring stations are low. Concerning discharge measuring places, data is partly available for the geometry of cross sections. These include data of low and medium water level of river, however, they do not have data for the flood plain.

The basic instrumentations used in the State Hydrometeorological Service were produced in the 1960s and 1980s. There are only 3 automatic stations for precipitation measurements. The water level is measured automatically at only one station. Old kinds of propeller current meters are used for discharge measurements. The profiles of the cross-sections for discharge measurements are rarely updated due to lack of ultrasound profilers. Such old technology gives results with low measurement accuracy for high water discharges and discharge rate curves. Systematic analyses have not been provided of channel riverbed deformations, caused due shortage of field measurements.

The instruments used in the hydrological monitoring network have not been equipped with data loggers. All data transmissions are provided manually.

The Ukrainian modern automatic hydrometeorological station has been elaborated in Ukraine. But the absence of budget don’t allow to put them in them operation.

At present there is no meteorological radar in operation in the Ukrainian part of the Tisza river basin, but the digitalized precipitation intensity images produced by the Hungarian meteorological radar every 15 minutes are obtainable for flood defense purposes in Ukraine. Water stage, precipitation and air temperature data from Hungary on-line network containing 14 operating remote sensing stations are shown on the computer screen of the Tran Carpathians Center on Hydrometeorology 24 hours a day.

The first Ukrainian (Soviet) plan for automation of measurements was prepared between 1986 and ´90 in the framework of a Hungarian - Soviet technical – scientific co-operation. Based on this plan the Ukrainian automation development plan was prepared, and then depending on financial sources the implementation began in the middle of 1990s.

The central building of the system was constructed in Uzhgorod in 1999. In the framework of a Hungarian -Ukrainian collaboration, establishment of an automatic data transfer system for flood forecasting commenced, which was financed by Hungarian government grant. Accomplished major Hungarian-Ukrainian developments are:

- installing structured computer network in the central building of the Zacarpatsky BWM;
- creating hydrological remote data measuring network containing one center and 2 station;
- constructing the backbone of a UHF network capable of voice – and data transfer, covering the whole Trans-Carpathian region.

During 2002- 2003 twelve new automatic hydrometeorological stations will be constructed in catchment sectors in Ukraine with Hungarian government aid.

Twelve automatic station should be constructed in the frame of other international technical assistance programs.

In order to create international connections, a unified system approach for the entire catchment area is crucial when designing the automatic monitoring system. Besides this special requirements of each country have to be taken into consideration. The required minimum level of unify has to be defined in a way that the usage of various type models is possible in the system (instruments, data collection, operating software etc.). The hardware operated in the system has to meet national and international standards, compatibility and as long as possible, most of the elements should show some similarity. However, differences cannot be excluded. This means, that existing or planned system elements (e.g. primer instruments, communication equipments) of all Tisza river basin countries can be included into the new automatic system, provided they are up-to-date, operating safely and are suitable for the strategies.

Flood warning and forecasting

Flood warning and forecasting are special form of flood prevention, in fact the most efficient ways if expenses and gains considered. They provide decision-making bodies with information to enable them to produce the most efficient flood management strategy.

A flood warning normally includes a written general description of the expected flood-wave. Specific hydrological parameters are usually not included, at most, the expected magnitude is given. A forecast includes the most important numerical parameters of the flood-wave. Obviously, producing forecasts require more accuracy than producing warnings. The quantity and quality improvement of existing hydrometeorological data allows earlier issue of forecasts, thus it increases the lead-time.

In Ukraine, flood warning and forecasting activities are carried out by organizations of the Sate Hydrometeorological Service.

Flood protection management is not the responsibility of the Hydrometeorological Service. It is the duty of the local governments, the Trans-Carpathian Branch of the State Committee on Water Management

In Ukraine the flood forecasting system was set up decades ago when social conditions, governance and technology were quite different. Small corrections to the system have been done, however, present conditions (driven by technological changes) would justify reconsideration of the whole system.
The flood forecasting system is still more centralized in Ukraine than in other Tisza river basin countries. Regional centers have more flexibility and freedom in Hungary and especially in Slovakia.

In case of preserving the present organization, real or deemed competition must not be developed among the participants in non-profit activities with a multi-participant system. The goals should be served by each organization efficiently and equally.

Special attention must be paid to the establishment of high standard technical and personal facilities of communication among the organizations. It is especially true in case of institutions doing the same or similar activities under various government offices.

Flood forecasting methods
Flood forecasts can be grouped into the two categories as below:

Peak forecasts. In this case only the peak water stage and/or discharge values are forecasted, together with the expected time of the peak. Stochastic and graphic methods, based on water stages, are used. There is no information about the flood hydrograph in the peak forecast.

Continuous forecasts. In this case certain parameters of the total flood hydrograph (mainly water stage and/or discharge) are forecasted in discrete time intervals. The time interval is usually determined by the measurement interval of available hydrometeorological data.

As reliable quantitative precipitation forecasts are not available, rainfall-runoff models are used for middle and lower sections of rivers only, because of the fast accumulation processes. The methods used are based on the method of water balance and the actual calculation algorithm varies depending on the nature of the runoff (snow melting, rain, or the two combined).

The presently used models were elaborated mainly by the Ukrainian Hydrometeorological Research Institute located in Kyiv.

Dissemination activities
Current hydrometeorological information focusing on the natural weather conditions and on the hydraulic structures has been disseminated mainly in paper form – in text format, in map format, and also in the form of a hydrological bulletin/report. Text warnings are distributed concerning possible consequences of rises in levels, in particular inundations zones. Storm warnings are disseminated by telephon**e**, by fax and only to the level of regional, municipal, and partially, district authorities. Dissemination also takes place via the mass media.

3.1.4 Methodology used for the determination of the floodplain

The extension of flood prone areas is determined at most cases simply by horizontal projection of the peak stages recorded so far, to the terrain. This method is the so-called *static projection method*, which gives the possible largest extension of area at risk – *area under flood level*, but is unable to identify the real extension and contours of the floodplain.

Series of maps contain the result of a research to identify the river floodplain of different probability of inundations. The maps contain floodplain contours of 1, 2, 5 and 10% probability. The calculated river flood levels of different probability are projected horizontally to the terrain as if there were no levees along the rivers.

3.1.5 International Co-operation

Bilateral Transboundary water agreements

These agreements refer to the disposals of the UNEEC Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992) and the Convention for the Protection and Sustainable Use of the Danube River (Sofia, 1994). Agreements cover all aspects of water related activities of the bordering countries. The proper implementation of agreements is supervised by Government Commissioners that are authorized to solve any Trans boundary problem including flood control.

Each agreement contains provisions on flood control, including preparatory and emergency activities, details of which are set in special regulations. The preparatory activities include the joint assessment of planned interventions that may affect the regime or quality of waters in the frontier section, joint assessment of flood control structures and measures affecting the river sections of common interest, while the emergency activities include the system and order of information exchange and mutual assistance.

The existence of bilateral intergovernmental agreements on Transboundary watercourses between Ukraine, Hungary, Slovak Republic and Romania favours the successful solution of regional flood control problems.

Multilateral co-operation in the Tisza river basin

Until May 2001 interaction of the Tisza river basin countries on flood management issues was exercised exclusively on bilateral principles. But extraordinary high flash floods of 1998 and 2001 evidently proved that the problem couldn’t be solved critically in this framework only. Pooling of technical, scientific, material and financial resources of all the catchment-sharing countries is needed.

For the purpose of co-coordinating flood control activities the Ministers responsible for water management of the five riparian countries have met on the initiative of Hungary, in Budapest, on May 2001, and signed the Agreement called Budapest Declaration, and established the Tisza River Basin Forum, as the executive organization of the Agreement.

The Forum stressed that neighbouring countries shall establish and implement joint programmes for monitoring the conditions of Transboundary waters, including flood control. They shall provide for the widest exchange of information, as early as possible, about any critical situation that may have Transboundary impact. Furthermore, they will set up, where appropriate, and operate coordinated operation or joint communication and warning systems with the aim of obtaining and transmitting information. These systems should provide the speediest possible transmission of emergency data and forecasts about any impending threat and permit early undertaking of corrective and protective measures in the areas likely to be affected.

The implementation of both structural and non-structural measures will ensure sustainable socio-economic development in adjoining regions of Hungary, Slovak Republic, Romania and Ukraine, sharing transboundary watercourses and using them of different purposes. It also will contribute to reducing the magnitude of damages caused by recurrent flash floods in the region.

Participant countries have elaborated the Tisza River Basin Flood Control Concept and the national coordinators have adopted it on 19 December 2001. The Concept is focusing on key tasks, which are organized into working groups as follows:

WG	Title	Co-ordinator
1.	Natural characteristics of the Tisza river basin	Serbia and Monte Negro
2.	Evaluation of present flood control situation	Romania
3.	Increasing the lead time available for preparation	Hungary
4.	Determination of the design floods	Slovak Republic
5.	Determination of the potential flood control improvement measures	Ukraine
6.	Environmental Impact Assessment	Slovak Republic
7.	International co-operation, legal framework	Hungary

3.1.6 Non-structural flood loss mitigation measures

Limitations and restrictions in land use are regulated in Resolution of Cabinet of Ministers of Ukraine *on land use regulation in high-risk zones.* Danger of flood among other factors is identified in the regulation.

The regulation prescribes limitations and restrictions in lot formation and construction on territories in high-risk zones. Rules of identification of these zones and the organs responsible for the identification are defined. It must be mentioned that breaking of these rules was frequent in the lack of strict countermeasures against the rule breakers.

Floodplain zoning that categorizes territories under risk with different probabilities and prescribes different land use types having adequate sensitivity to the risk identified on the given territory do not exist.

3.1.7 Organization of flood defense issues

The basis of emergency management strategies and prevention are the Ukrainian, Romanian, Hungarian and Slovak State Security Principles. The laws on emergency situation defense, and civil protection differ in the countries concerned and there are also different directories for their execution.

To the main principles include:

- prevention, intervention and reconstruction;
- execution of national and international requirements in this field and when possible taking part in international help;
- emergency management is a system built on the local authority system which is implemented on the basis of joint state activity and its law system;
- the mandatory and volunteer participation of citizens;
- the basic concept of protection is the analysis of all the emergency situation, the preparation for the management of emergency situation, integration of all the participants of defense works;
- information and preparation of the citizens to the rules of behavior in emergency situation, e.g. self protection.

The Ukrainian Government determines the aims and requirements of the strategy which guarantee the necessary financing. The prevention, emergency response and reconstruction are firstly belong to the local responsibilities. The authorities of emergency management coordinate the activities of local defense committees and of mayors with the attraction of competent organizations.

3.1.8 Basic principles of the system and levels of flood alerts

The system of flood alerts is based on the combination of forecasts of the possible progress of dangerous hydrometeorological situation, the readings on designated stream gauges and the conditions of elements of flood alleviation system.

Taking into account the very rapid response of the mountainous catchment, the reliable storm warning is essential on the upper part of the river basin, since in the narrow valleys of the rivers and its tributaries there is no lead time available for the introduction of protective measures.

The alert system is a "three plus one" system, and consists of Level I, II and III disaster control. The definition of the levels is as follows (levels are fixed to readings on corresponding stream gauges).

- *Level I* – water level in rivers and canals reaching bank levels;
- *Level II* – at river overflow of booms, partial inundation of arable lands;
- *Level III* – river level is as close to the crest mark of flood protection dike as 70 cm.

A 24 hours running dispatcher service is established and operated in the Transcarpathian department of State committee on water management. Tasks and responsibilities of this service are duly regulated in detail, also with respect to the mutual warning tasks set up in the respective bilateral transboundary water management agreements with the countries involved (Slovakia, Hungary, Romania).

3.1.9 Characterization of public awareness

In Ukraine the goal of the public awareness survey was to understand public approach to the flood risk problems. In the beginning of the year 2002 a public survey was conducted to investigate public opinion on flood risk management policy issues. The purpose of the survey was to learn about the following:

- What are the main causes of increasing flood loses in Tran Carpathian region?
- What measures do you think would be most effective for reducing flood losses?

The survey extended to the whole Tran Carpathian region. Similar survey was made on the other side of the border, in Hungary early. The comparison of the two reports helps to understand the different basis of the flood mitigation problems.

Some of the most important and interesting answers are following.

Concerning the first question.

- The water management organizations have weakened – about 20% of Ukrainian and Hungarian answers.
- Due to global climate change – 68% of Ukrainian and 38% of Hungarian answers.
- Large forest areas were cleared in the catchment – 70% of Ukrainian and 62% of Hungarian answers.
- Authorities issued building permits for risk areas – 17% of Ukrainian and 33% of Hungarian answers.
- Levees have not been properly maintained – 57% of Ukrainian and 71% of Hungarian answers.
- River regulations have changed the water runoff – 16% of Ukrainian and 18% of Hungarian answers.
- Persons aren't taking sufficient measures to prevent losses – 10% of Ukrainian and 5% of Hungarian answers...
- Warning systems are not early enough – 24% of Ukrainian and 10% of Hungarian answers.
- Too many people have chosen live in flood-risk areas – 24% of Ukrainian and 8% of Hungarian answers.

Concerning second question.

- Reforestation – 72% of Ukrainian and 51% of Hungarian answers.
- Heightening and strengthening the dykes – 50% of Ukrainian and 63% of Hungarian answers.
- Prevention of construction on the floodplain – 48% of Ukrainian and 23% of Hungarian answers.

- Drainage systems – 10% of Ukrainian and 38% of Hungarian answers.
- Development of flood monitoring and forecast system – 10% of Ukrainian and 17% of Hungarian answers.
- Transferring people out – 6% of Ukrainian and 11% of Hungarian answers.
- Informing the public – 2% of Ukrainian and 9% of Hungarian answers.

3.1.10 Assessment of the financing of the development, maintenance and operation of defense structures

In the period of 1996 – 2000, only 13.7% of the standard maintenance needs, 19.2% of the standard operation needs and 27.1% of the standard restoration needs was covered by the state and regional budget.

In 2001 the allocated budget for the regular maintenance and operation made up only 3.4% of the standard need, but in fact, only 2.3% was available. For restoration the budget allocation was 4.9% of the standard need, the actual financed costs reached only 3.9%. The integrated budget was limited to 4.3% of the normative needs, while the available resources made up 3.3% of that only. The budgets for 2002 and 2003 allocate 7.3% of the standard needs for maintenance and 4% for restoration.

3.2 Structural related elements of flood management

Non-structural issues of flood management, which are related to the structural elements of flood mitigation schemes, will be considered below.

3.2.1 National standards and guidelines related to structural flood management

Design flood.

Determination of design flood is standardized in a standard issued in 1982, regulating the loads and influences on hydro technical structures. The calculated maximum discharge of the 1% probability Q1**%** is used as the design flood discharge. Calculation is made using Q1**% = f (A, q)** type concentrated parameter function. Recalculation of runoff coefficient and separation of methods to be used in different tributary catchment with different extension was made. A design flood level is determined using rating curves along rivers.

Unfortunately, number of discharge measuring sections is rather limited, and discharge measurements are rather rare.

The *freeboard* is determined according to an equation that takes into consideration the wave impacts on the dikes, unforeseen events and the professionally acceptable uncertainties of the calculations too. The prescribed freeboard in the TransCarpathian region equals 0.7 m.

Risk assessment.

No risk assessment and mapping is available.

Dimensioning of flood defense structural

Dimensioning of flood defense structures, including earthen dikes, is regulated by standards. MCrest width varies between 2-4 m according to the importance of the dike; slopes are determined depending on the soil type and the hydraulic head. Typically the slopes are steeper on the dry (protected) side than on wet side. It is explainable with the relative short duration of flood waves that does not allow the saturation of the dike body.

The prescribed cross section does not contain provisions on the accompanying protective belts of the dikes at the wet- and dry side toe. These belts should be formed in a width of 10 m, with a slight slope of 5% outwards, and should be free from bushes, shrubs, trees or constructions.

3.2.2 Structural elements of flood management

Assessment of existing flood defense structure data
The data concerning dikes erected along canal systems are follows.

The total length of flood dikes including those along drainage main canals: 646 km.
Regulated reaches of main rivers: 82 km.
Bank protection (revetments of rip rap, gabion, etc): 245 km.
Length of main canals: 1344 km.
Pumping station: 53, in total capacity 127 m^3/s.
(reservoirs and 59 ponds with a total capacity of 60.5 Mm^3, total water table: 1,560 ha, 4 of which with a capacity of 9.5 Mm^3 is designated as flood retention reservoir in the Latorytsa basin Tereblya-Rika HPS reservoir (21.8 Mm^3) has no significant influence on flood transformation.

Protection embankments were constructed different times, from the beginning of 1863, with the use of various technologies, for various probabilities, and now according to present norms they do not constitute a reliable flood protection complex.

A slope protection from erosion consists of grassing, in some sections prone to strong currents; revetments were built of rock paving and reinforced concrete slabs. The width of crest is ranging from 2 to 4 m; slopes are 1:2 to 1:2.5, steeper on the dry side. The surface of crests and slopes is often eroded by precipitation and transport facilities.

Crest levels, due to embankments consolidation and other reasons, do not reach the required elevation over estimated flood levels of 1% of probability.

Availability of development plans of the flood alleviation Scheme
The institute “Ukrwodproekt”, located in Kyiv, worked out the “Scheme of integrated flood protection in the Tisza river basin in Zakarpatskya oblast”, that was completed in 2001 and approved by relevant governmental commission on August 29, 2001.

In order to solve the questions regarding implementation and financing of measures to be recommended by the Scheme the institute “Ukrwodproekt” worked out the “Program of complex flood protection in the Tisza river basin in Zakarpatskya oblast for 2002-2006 and forecast to 2015” that was approved by the Decree of the Cabinet of Ministers of Ukraine on November 24, 2001. Program lists urgent flood protection measures for the nearest future, instruments of implementation and sources of financing.

The Scheme 2001 recommends a comprehensive approach to:

- control of flood runoff with the help of special flood retention reservoirs, polders;
- erection of regulating hydro technical constructions (weirs and semi-weirs);
- strengthening of system of flood protection dikes;
- forest protection, antierosive and mudflow protection measures in the mountainous areas;
- local versions of protection of certain settlements or the proposals for their setting out.

The Scheme 2001 estimates construction of 42 unregulated, flow-through type flood retention reservoirs and additional polders with regulated outflow in the flatland to reduce the flood discharge Q1% to Q10% (Table 2)

Additionally the Scheme provisions:

- reconstruction of the operating flood protection dikes to withstand the flood of 1% probability and the construction of some new dikes especially those related to the creation of polders and some ring dikes for the protection of communities, in a total length of 957 km (191 km by 2005; 478 km by 2010);
- bank protection in a total length of 55 km to be finished by 2010 (11 km by 2005);

- river training in a length of 155 km (32 km by 2005, 78 km by 2010).

Estimated total cost of project is $ 270 millions, completion is planned by 2015. The urgent measures to be implemented by 2005 sum up to $ 80 millions. The works phased to be ready by 2010 reach $ 150 millions.

Table 2. Distribution of the reservoirs and polders

River	Number of flood retention reservoirs			Capacity, million m^3		
	Total	Till 2005	Till 2010	Total	Till 2005	Till 2010
Uzh	5		3	50		29
Latorytsa	8		2	62		14
Borzhava	7	1	3	25	7	16
Rika	6	1	2	29	15	19
Tereblya	1	1	1	20	20	20
Teresva	4	1	3	37	19	32
Tisza	11	4	6	65	30	42
Total reservoirs	42	8	20	288	91	172
Polders						
Tisza	16	12		142	4	
Borzhava	6			92	6	92
Total polders	22			234		
Total retention	64			522		

Assessment of the effect of the Scheme

The relatively small individual capacity and the territorial distribution on the numerous flood retention reservoirs in the mountainous region contribute to significant and balanced reduction of flood peaks along the tributaries.

The exclusive flood retention purpose of the reservoirs and the principle of unregulated operation exclude accidental mistakes or faults in the operation.
There is no alternative solution for the protection in the populated valleys.

While flood peaks reduced, the flood volume, which is temporary retained at the unregulated flow through type reservoirs, remains unchanged, and as a consequence, flood propagation downstream slows down and the duration of flood waves will be increased.

Significant volume and regulated outflow of the flatland may contribute to control the downstream flood *propagation*.

The creation of the flood formation model is needed to fine tune operation – to avoid superposition of flood waves of significant tributaries at downstream.