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FLOOD PROTECTION IN HUNGARY

Discussion paper transmitted by the Government of Hungary */

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1. FLOOD CHARACTERISTICS OF HUNGARY

1.1. The geographic situation, climatic conditions of the catchment areas of Hungarian rivers

Hungary is situated in the river basin of the Danube within which in the deepest part of the hydrographically uniform Carpathian Basin. Her territory is 93 thousand km², which is 11,4% of the 817.000 km² catchment area of the Danube River.

The Carpathian Basin is confined from the west by the mountains of the Alps exceeding 2000-3000 m of height while from the east the Carpathians border the country having an altitude of 1000-2000 m above sea level. Whereas 70% of the country is lower than 200 m and hardly 1% of her rises up above a height of 500 m. The eastern part of the country is the deepest one, the height of the plain extending over here is altogether 80-100 m.

The rivers arrive to the territory of Hungary from mountainy catchment areas belonging to the neighbouring countries and they flow down predominantly through the Great Hungarian Plain. This means that the fall of the rivers passing onto the Hungarian plain from the high - headwater catchment - areas decreases in a great extent and the floods of certain rivers get accumulated in these areas.

Owing to the topographic conditions roundly 21.200 km², the 23% of the territory of the country is lower than the level of standard floods of the rivers (annex). This condition, by itself means such a flood protection problem which is unique in Europe. This topographic condition being extremely unfavourable concerning flood protectional aspects, is aggravated by Hungary's climate, which is influenced by three effects: the one coming from the Atlantic-ocean, the continental and the mediterranean effects, depending on the case that just which atmospheric motion gets prevailed. The continental currents arriving from Eastern-Europe might cause durable heat and drought in summer while in winter they might result durable severe cold. The vaporous air currents arriving from the Atlantic-ocean from the west, or from the Medeterranean Sea might moderate the extreme values of temperature however they might bring abundant precipitation. These maritime air currents might engender extended rainfalls of great intensity in any part of the Danube River Basin at any time of the year which might cause violent and durable floods on the rivers of the Danube water system.

A significant amount of winter precipitation falls down to the catchment areas of rivers in the form of snow. The spring, early summer snow melting, especially in the case of a rapid warming up, accompanied by rain, can also be the causer of violent flood waves. The flood waves deriving from the spring snow melting are the characteristic and frequent phenomena of the Danube and Tisza regime.

Difficulties are increased by the fact, that owing to the asserting of extreme continental effects all rivers of the country might get frozen during winter. The thickness of the emerging ice cover might reach 25-50 cm too. It is a dangerous phenomenon if in such a case the warming up comes from the west and by its effect the flood waves arriving to the territory of the country on the Danube and its tributaries till find standing ice cover, which they burst when passing downstream and they might cause extremely grave floods with blocking ice.

On the basis of mathematical - statistical assessments carried out on the floods of Hungarian rivers we have to reckon with the appearance of medium floods in two-three years, in five-six years with significant and in 10-12 years with great floods.

The durability of more significant flood waves on the upper sections might extend to 5-10 days while on the middle and lower sections to 50-120 days.

1.2. The characterization of the areas endangered by floods

The problems of Hungarian flood protection beside the unfavourable topographic and climatic conditions are increased by the fact that the areas endangered by floods are the most precious densely populated ones of the country.

The flood plain of 21.200 km² is divided into 151 sub-catchments of inundation areas. These sub-catchments are such territorial units from which the water can not get into the neighbouring sub-catchment even in the case of inundation. The borders of the different sub-catchments are composed by the natural relief, the protecting works and - the artificial linear establishments (roads, railway - embankments, etc).

From the 21.200 km² of flood plains of the country, nowadays 97% of them are already protected - by flood protectional dikes constructed mainly along the rivers. The rest 3% ones are flood plains lying in narrow valleys along minor rivers, the flood protection of which is not economic within a reasonable time. Here only the ring dike protection of settlements located on the flood plain or of those extending over is solved respectively could be solved.

The defense of the flood protectional areas is served by 4.180 km long first-class flood protection dikes (the majority of them is earth dike, in the inner districts of towns stone-concrete flood preventive walls).

60% of the flood protectional dikes - apart from some exceptions - are built for the protections against ice free floods which occur once in 100 years, the rest in an average of once in 60-80 years. Budapest, the capital and Szeged and Győr towns are exceptions, where the protective works are built to protect against floods occurring once in 1000 year in average - considering the great number of inhabitants and the high economic values.

2. THE PROTECTION AGAINST FLOODS, HISTORIC RETROSPECTION

2.1. The development of the flood protection system

The flood protection is a continuous activity which gets adjusted to the social-economic development. The extent of flood protectional safety is determined by the social demands and economic conditions. The growing population, the increasing national wealth require an always more important safety however the feasible safety depends also on the bearing capacity of the country.

According to the evidence of the remaining data records the first works of flood prevention had been carried out in the 13th century.

These and the subsequent works of flood prevention had been only of local importance which had been restricted mainly to the protectional activities of certain settlements, towns, fortresses or the border areas of those.

The more significant works of flood protection which have been started at the beginning of the 19th century are already in close relationship with the development of the economy mainly with agriculture.

As a consequence of the flood protection having mainly an agricultural purpose, the economic development which became more and more lively on the areas of flood protection, reclaimed a major safety since the economy was vulnerably affected by the damages of floods causing the frequent ruination in the elementary works of flood protection.

As a result of the briefly presented obliging conditions the flood protective works - in the sense of today - started in 1846, with the regulation of Tisza River, opening by this a new era in the history of flood protection in the country.

During the works of flood protection for the regulation of rivers of the so called middle section character having a small descent - those principles were applied which had been established by the turn of the 18th - 19th century - which became classical since then. In the sense of these principles first the run - off conditions of rivers got improved by the cutting of over-developed bends, since the amelioration of descent condition - the acceleration of the transit time of floods - was a precondition of a resultful flood protection. Simultaneously with the above works, respectively straight subsequently the flood protection dikes were built along the rivers which impeded the spreading of floods.

A special requirement of the regulation principle, was that the flood waves of the tributaries should precede those of the main river recipients if possible, to enable the flood protection of downstream section being safer by the decreasing of the danger of the accumulating flood waves on each other. The reasonable establishment of alluvial plains was an important aspect, which had been made to lead down floods sediment and ice with an average width of 550-1900 meters of flood plain.

On the basis of the demonstrated principles the flood protection works were continuously carried out extending to all the major rivers. As a result of this activity by the end of the thirties those dikes of flood protection were prepared which before the flood protection had protected the majority of areas covered by flood, in an average of 3-4 years against those floods which were major ones than the medium, and which even now constitute the backbone of the flood protection system of the country.

Naturally flood protection has not been finished with this in Hungary. That is to say the economy was rapidly developing on the protected flood plains and thus it became more sensitive against damages caused by floods. However the extent of inundations decreased but the specific damage increased and has been increasing also nowadays. This reclaims the

increase of safety against floods. The result of it is that the improvement of the national flood protection system is still in process today.

2.2. International conditions

By the time of the First World War, in the field of the Carpathian Basin, in Hungary a more or less uniform flood and excess water control system was established, based on catchment areas. This uniform water management system was torn into pieces by the new boundaries of States stipulated in the Peace Treaty of Trianon in such a way that the upper parts of the catchment areas became annexed to the neighbouring countries while mainly the plain areas remained in the Hungarian territory.

Recognizing this situation which was „exposed” considering water management aspects during the peace-negotiations it was accepted on Hungarian proposal, that a controlling Committee should be established to survey all those water - and forest - related works to be implemented in future, which might affect the interest of other States.

On the basis of the article 293. of the Peace Treaty a Permanent Technical Committee of Water Management (in French: Commission Technique Permanente du Régime des Eaux du Danube, CRED) being competent in the Danube River Basin, and determined the concept of common interest in the article 294.

The CRED initiated the establishment of agreements between the concerned countries, and the frontier water co-operations based on bilateral inter-state and inter-governmental agreements have been set up which have been functioning since that time even today too. For the characterization of the importance of co-operations on frontier waters we have to mention some typical data:

- 96% of the surface water resources of Hungary derive from abroad, 120 billion m³ water streams through the country annually,
- the number of our water courses of mutual interest is 67, their length reaches 889 km. The total length of flood protection dikes of mutual interest is 2171 km, from which 1055 is on the Hungarian side while the length of dikes in foreign countries is 1116 km,
- the extension of the excess water systems divided by national boundaries thus having mutual concern is 16 thousand km². The number of boundary intersecting drainage canals is 109 from which 104 km constitute State boundaries and 440 km is the length of the boundary intersecting canal
of mutual interest, which transport entirely 147 m³/s of water towards our country.

The following derive, from the particular water management situation of the country which supports the necessity of international co-operation:

- the mountainy areas which are favourable concerning water retaining capacity and storing are located outside the country,

- the quantity and the quality of our surface and subsurface water resources are in close connection with the interventions implemented in the upper parts of the catchment area,
- the flood waves arriving from the neighbouring mountainous districts get accumulated over here, due to which of flood and excess water endangered situation is unique in Europe.

3. THE FLOOD PROTECTION SYSTEM OF HUNGARY

Owing to the geographic conditions of Hungary, from among the numerous effective methods of flood protection, the retention of flood on mountainous catchment areas in reservoirs or the run-off control by storage basins are excluded since the mountainous catchment areas which „produce” the floods are outlying of the country's boundaries.

The slope of rivers crossing areas of decisively lowland character is small therefore the flood water regulation of rivers that means the bend cuttings and the bilateral banking of rivers have been carried out.

By the midst of the thirties the system of flood protection works which have been operating even now too, was mainly established. The flood protection activities of open plains have been done in a small extent since then, the improvement of the existing protective works is running continuously in accordance with the flood event arising meanwhile further the social demands being influenced by the economic development and the increasing damage sensitivity.

The system of flood protection works are composed by the below establishments:

- the length of first-class flood protection works built along the rivers is 4.181 km, from which 3.980 km are earth dikes, 23 km wall of flood protection 178 km of high banks,
- on two minor rivers (Lajta, Répce) a flood channel was built to divide the flood discharge respectively to transfer the water to the other river valleys. The former is 13 km long, with a water transport of 50 m³/s, the latter with a length of 10 km with a capacity of 120 m³/s,
- plain area emergency reservoirs for the retention of the flood peak of rivers having a violent water regime and of a relatively low water discharge (altogether 10 pieces of 350 million m³),
- to impede the expanding of the eventually breaking floods or to drive them, localization lines were built respectively the terrain configurations being appropriate for it were marked out or establishments of other destiny (e.g. public roads and railway-embankments) were indicated,
- the retention of the flood at the site of their origin with mountainous and hilly-land (multipurpose) barrages could only be realized in the case of minor water courses due to the previously explained geographic characteristics.

4. THE FLOOD PROTECTION AS A PUBLIC TASK

4.1. The establishment of legal frames

Since the 11-17 centuries we can find laws referring to flood protection in the National Body of Laws.

The first uniform Hungarian Water Act, the Act XXIII. of the year 1885 on the water law which gives details of the rights and obligations deriving from the proprietary rights.

Concerning the flood protection it is essential that the Act declares: the concerned ones may establish associations for watershed management (channel control, bank protection, flood protection and the water drainage related to those).

Concerning the aspects of flood protection it is another significant stipulation of the Act, that the members of the association are not only the interested landowners but all those individuals corporate and legal entities who are directly concerned by the functioning of the association, that is to say, their valuables were protected or their activities were made even more profitable.

In this subject the Act finally declares, that the members of the association are obliged to cover the costs of the construction of flood protection works, their maintenance further the costs of defence during the flood time.

The Act regulated also that what kind of costs were undertaken by the State, in connection with flood protection, respectively, in case of necessity - for instance if material burdens were too high - what kind of subsidies might be granted by the State.

This was the Act which assured the legal frames for the realization of the Hungarian flood protection system and for its maintenance and operation for a long time.

The Act XXIII. of the year 1885 on water law was superseded by the Act IV. of the year 1964 on water.

The Act IV. of the year 1964 differs significantly in its concept from the previously valid one. This Act is based on the exclusive State ownership of waters, on the central planning, State intervention further on an organizational system of central subordination.

On the basis of the Act, the protection against floods - which on the one hand includes the necessary works to be done in order to prevent the damages caused by the floods, the construction, renewal, maintenance of the protective works further their improvement however on the other side the effective protection against the rising floods - is the task of the State. This on the main protective lines of flood protection - generally along major rivers and brooks - was performed by the State through the water management bodies.

On smaller brooks of local importance the law made both the preventive and the effective protection the task of the council bodies (nowadays of the self-governments) with the technical guidance of the water organizations.

The Act had the merit of enabling the realization of the defence organization which extends to the whole part of the country, which in case of necessity would be able to mobilize the population of the whole country and her economic forces - including the army too - to take part in the work of defense in the case of a disastrous flood case. The flood protection preserved its particular organizing force up to the present day. Unfortunately in the history of the floods in the country this has been needed, even recently too.

Following the changing of the regime of 1990, the new Water Act (the Act LVII. of year 1995 on Water Management) adjusting to the changed social and economic conditions, divides the tasks of flood protection - the building, improvement, maintenance, operation and the protection - between the State, the self - government, further between those who are concerned in the prevention or in the protection of damages.

4.2. The present organization of flood control

The present Water Act delegates these providing of the technical tasks of the flood control on the major State structures primarily as the task of the water bodies, the water service.

The water service includes the National Water Authority (OVF) and the district water authorities with the guidance of the Ministry of Transport Communication and Water Management (KHVM). There are twelve district water authorities functioning in the country - covering her entire territory - in such a territorial division that the operational areas of these authorities are composed of sub-water catchments being hydrographically uniform.

The theoretical guidance of the water service is the duty of the KHVM, the operative direction belongs to the OVF and the performance of regional activities is the task of the district water authorities.

During the period of flood the technical regional tasks of the defence are performed by the district water authorities. The national guidance is the KHVM Minister's tasks which he practices through the National Technical Directing Staff.

Beside the technical tasks of the protection it is also necessary to provide measures of public administration too. For instance the planning and ordering, implementing of the saving, evacuation, resettling, of the mobilisation and transport of public forces participating in the defensive work, for the sanitary and other supply, for the authority control of flooded areas, the arrangement of damages, etc. These tasks belong to the sphere of tasks of the self-governments which are performed by the using up of civil defence forces and their organozational help.

Naturally, the harmonization of the technical and public administrative tasks of flood protection, the guidance of the defence works, the concentration and mobilization of the forces being necessary for the protection - in the case of extreme preparedness - need the work of a well co-ordinated, continuously operating body. The director of this body is the minister of KHVM as the government commissioner.

The government commissioner disposes with the labour force (public force) of the population, with the installations, assets, material stocks, machines and vehicles of the managing organizations - according to the plans of the national concentration and co-operation of flood protection - in order to provide the tasks of protection entirely. If the labour force of the population it is not sufficient for overcoming the danger, the government commissioner is entitled to involve the national defence, respectively through the Minister of the Interior, the Hungarian Army, the civil defence and certain machines, tools and vehicles of the police units too.

In the case of an extremely great danger, when the country is already stricken by flood disaster, the national guidance is performed by the government committee. The members of the government committee are the ministers of those Departments which support the protection. The government committee practices the right of dispositions through the government commissioner.

The government commissioner is assisted in performing the tasks of public administration related to the defence works by the County Defense Committees which co-ordinates the activities of the local authorities, the leader of which is the president of the County General Assembly.

The technical guidance of the regional defence is the task of the district water authorities. The current director of the district water authority is the responsible for directing the regional defence. During the time of flood defence the entire personal staff, the machines, the assets, the installation could be delivered to the service of defence - on the basis of previously prepared plans.

The flood protection system of each district water authority consists of flood protection sections of mainly 30-50 km long, the local defence leaders of which are nominated by the director of the district water authority from the personal staff who pursues the directing of the defence with an individual responsibility in the leadership.

The presented organization of flood defence is operating on the basis of ready - made technical-, concentration-, mobilization-, alerting-, localization-, saving and evacuation plans. Those district water authorities which do not perform defence activities on their own territories give assistance to those being in defensive position by their own personal staff and installations.

The using of „third” forces could only be done when the own capacity of the water service got exhausted.

The supervision of the local water damage prevention is performed by the competent district water authorities.

5. THE TRENDS OF STEPPING FORWARD AND THE IMPROVEMENT

5.1. The supervision of the development plan for the flood protection of the country

The determination, supervision of the design flood

The basis of the qualification of flood protection establishments is the design flood which means that determined flood level and durability (altogether flood loading) against which is the given society safe protection is assured for those who live on the protected areas and for bearing which of the works of flood protection have to be dimensioned. The selection of its size depends on the safety demanded on given grade of social-economic development and on the economic charge bearing capacity of the country (or of the concerned ones) as a realistic possibility.

Formerly the greatest floods were considered design ones and the experts tried to build and strengthen the protective works accordingly. Therefore the fixed design flood parameters have not been comparable not only on different rivers, but even on the different sections of identic rivers because they have been lacking identic physical bases.

The mathematical - statistical assessments carried out concerning our rivers demonstrated that these were only of extent differences between the flood levels of 80-150 years average regression time, which did not exceed even the 5% of confidential interval characterising the reliability of calculated probabilities. Therefore, with the exception of areas demanding a special protection of high degree, uniformly the level of ice free flood of 1% probability was accepted as design one, regarding all the rivers of the country (1973).

The Danube section between Esztergom town and the southern national boundary make an exception where the greatest modified envelope curve of icy water-stage which has ever occurred is the critic one, further the protective works defending the towns of Budapest, Győr, Szeged further the territory of the oil-field of Algyő where the level of the ice free flood with a probability of 1% is the design one.

The declared critic durability is the duration of water levels exceeding the levels with a probability of 1% expressed in days.

The third criterion of the determination of the size of flood protection works is the prescribed height safety above the critic flood level. The value of it is generally 1,0 m, on the rivers constituting national boundaries or boundary interesting rivers is 1,2-1,5 m, in the area of Budapest, it is 1,33 m.

The determination of the design flood parameters according to the above was carried out in 1976 for the first time. In the past period, on certain rivers - by the effect of human interventions, causally - the typical water levels got changed. The changing of the run-off conditions motivated the supervision of the design floods, which occasion was used up at the same time for the perfecting the determination method. Its actualization was carried out in 1997, in the form of a legal regulation.

The taking into account the risks, the determination of the extent and sequence of improvement

The first complex plan of development was finished in 1981, the second in 1995. The third one is in process.

We have to take into consideration the results of cost-benefit assessment concerning the given development when the long-term plan of development is getting reshaped or when the developments are ranked and the risks as well.

The latter one is done partly with the determination of the damage sensitivity of flood plain basins, which includes also the parameters referring to the present protective capacity of the defence structures. On the other hand we have to take into consideration the number of inhabitants living on the given basin and the population density too.

The plan of development fixes as an objective the most efficient reduction of damages which might occur. Consequently in the first step the plan envisages the elimination of insufficiencies risking mostly the protectional safety of certain basins, enabling by this the effective interventions of protection. The building of the protectional establishments of designed safety for the certain basins could be carried out only in the second phase.

New flood protectional facilities are intended to get realized from the State resources only after the creation of the appropriate safety of the existing protectional works, in exceptional cases on the basis of individual consideration could only be done.

5.2. International co-operation

According to an assessment of 1988 from among the important rivers of the world on 155 rivers two countries, on 36 rivers three countries and on 23 rivers more than three countries are sharing.

While on the renewable freshwater resources of the Danube - in a unique way - 13 countries are sharing.

It is justified that such a master agreement should regulate the utilization and the use, which promotes the conclusion of bilateral and multilateral contracts between the 13 countries.

Owing to the geographic situation of Hungary it is an elementary interest of the national water management within which that of the flood protection, to be able to know in time the hydrological processes precisely occurring on the watersheds of foreign countries.

Similarly it is important to increase our knowledge about the run-off conditions of the catchment areas and the changes of those with a special regard to the antropogenic impacts.

All these could only be reached with the maintenance and improvement of our bi- and multilateral international co-operations.

The frames of these co-operations are well served by the boundary water agreements. However it is apparent that the increase of the problems of water management, the upgrading of the water as an evidently more and more strategic element, further the increasing sensitivity of the society for damages break open the frames of these co-operations.

Therefore new more complex common agreements which concern several countries are needed than those which have been before.

The basis of the new co-operation is determined by the Helsinki Convention signed on the 17th March, 1992 (on the protection and use of transboundary waters and international lakes) and the Danube Convention (concerning the preservation of the Danube and its sustainable use) signed in Sophia, on the 29th June 1994, which have been signed by all our neighbours.

The basic principle:

- the requirement of the sustainable use of waters
- the respecting of the „precautionary principle”
- the operation of monitoring system
- the building up of the warning system

There is a new international committee getting established for the implementation of all those contained by the convention. By this fact a significant improvement might take place in the water management of the region, to which we give all the assistance due to our peculiar water management situation.

5.3. The taking into consideration the aspects of nature conservation

Hungary is especially rich in natural values. Among which the habitats of natural state connected to the vicinity of water and the water bank have an important role.

Fortunately the wide alluvial plains (1-10 km) having been shaped after the river regulations of the last century preserved those potencialities which form and which might form the basis for the maintenance and the rehabilitation of aquatic habitats. In Hungary the natural values of the direct milieu of rivers have not fallen victims of the intense economic development as it has happened in the case of West-European rivers.

The Hungarian researches extend mainly to the dead branches and flood plains. One of the most important objectives of biologist to preserve the biodiversity.

It is clear nowadays that instead of the static vision of the protection of specis and regions the dynamic protection of habitats and specis comes to the limelight. The essence of the above is that it is able to follow the changes and to offer a specis protection of a broader circle, it is also able to reduce the conflicts between the human and natural settings.

The field and tool of realization of this dynamic concept of nature conservancy is the river valleys physically connected system, enmeshing the entire Carpathian Basin the so-called green corridor system.

The green corridor network enables the flowing between the gene stock by which we give the chance of survival to the different populations.

This is the programme to which we have to contribute with the appropriate shaping of the river valleys. The exploration of the relation of the two major systems the Danube and Tisza, to the national parks and protected areas has been finished in the case of Tisza.

Figures:

- Map of the water-balance (inflow - outflow).
- Flood map of Hungary

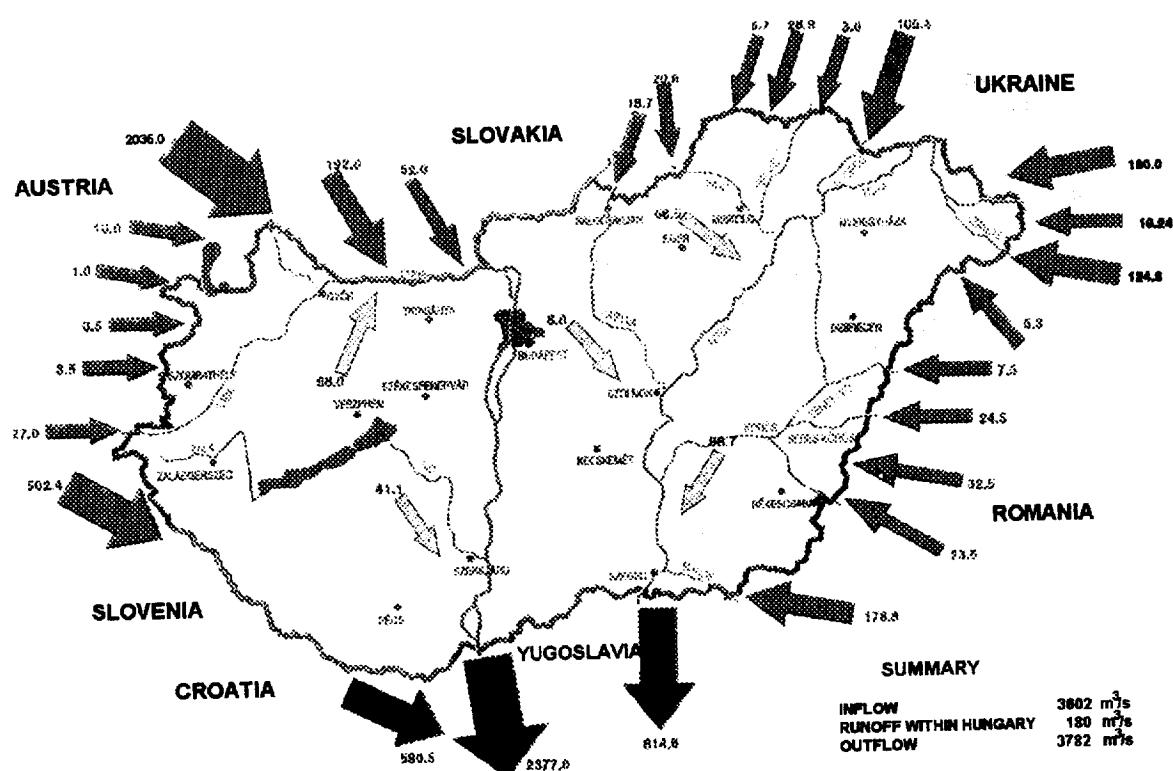


Fig. 1. Normal mean flow in the Hungarian rivers (m³/s)

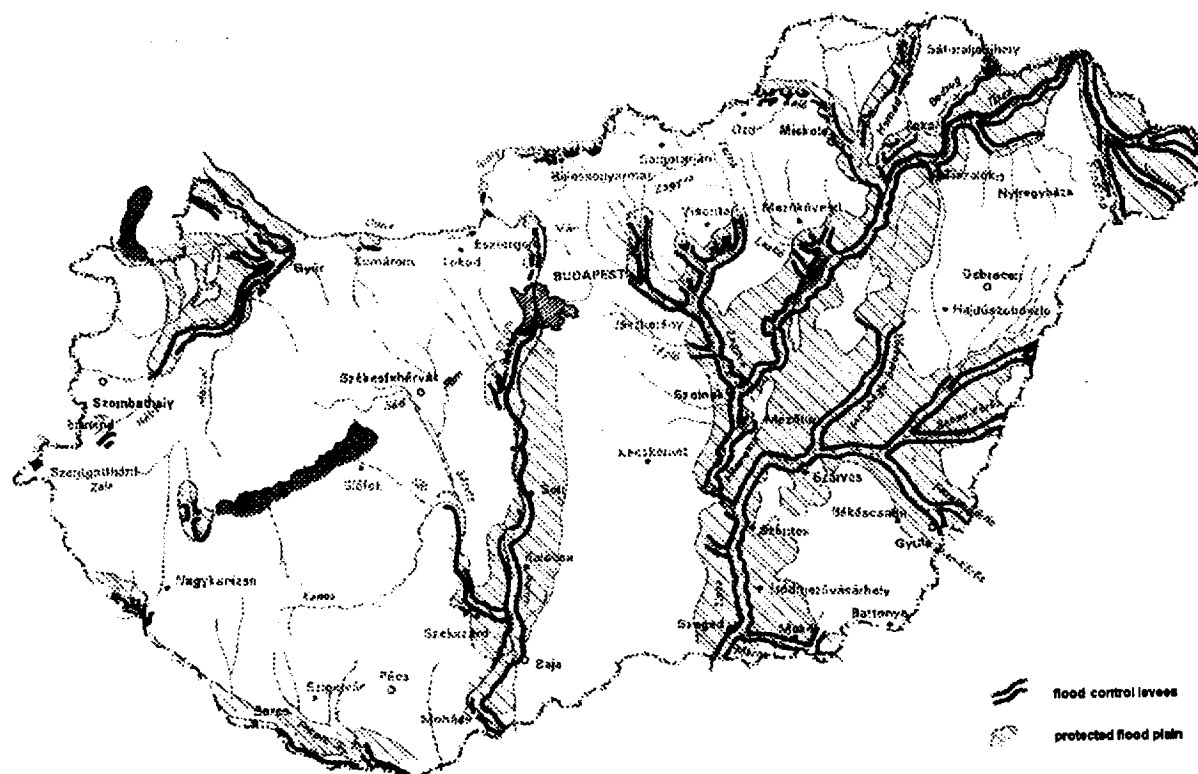


Fig 2. Flood map of Hungary