Tisza River Valley: future prospects

István Nagy[1], Ferenc Ligetvári[2] and Ferenc Schweitzer[3]

Abstract

Hungary is among the countries in Europe most severely endangered by floods. Fourteen rivers entering Hungary from the mountainous area of the Carpathian Basin have high channel slope gradients which serve as a source of considerable flood hazard. The disastrous floods during the last decades in Hungary have been caused mainly by Tisza River and their tributaries situated on the eastern part of the Great Hungarian Plain (Alföld). These cases make necessary a thorough analysis of the extreme flood events to be carried out and the drawing of conclusions with recommendations to be made as for the immediate legal interventions. The present article outlines a river regulation program on the basis of a new concept. The purpose of this program beyond the increase of flood security is to improve the quality of life of the population concerned, extend water supply capacities, preserve natural resources and to provide flood risk management.

Keywords: flood hazard, river regulation, water management, Tisza River

Introduction

Tisza is the second largest river of Hungary. Its entire watershed (157,135 km^2) is to be found within the Carpathian Basin. Tisza rises from the Marmarosh Mountains (Ukrainian Carpathians) and flows after 1,260 km in the Danube at Titel (Serbia). From the point where the main branch of the Tisza reaches the Great Hungarian Plain 5–6 cm/km maximum gradients prevail. Along the lower stretches of the river they are reduced to 2–3 cm/km. Therefore, the river meanders lazily, forming sinuous loops, fens and oxbow lakes. The Tisza often changed course prior to its regulation, and frequent floods used at Szolnok, could be 63-fold (60 and 3,800 m^3/sec, respectively). This phenomenon is due to the 8 major tributaries of the river, namely Bodrog, Sajó, Bódva, Hernád, Szamos, Kraszna, Körös and Maros rivers *(Figure 1)*.

These tributaries entering Hungary have high channel slope gradients, which serves often as a source of regular flood hazards. The regime of rivers flowing into the plains

[1] KÖTI-KÖVIZIG Middle-Tisza District Environment and Water Directorate. H-5002 Szolnok, Ságvári krt. 4. E-mail: kotikovizig@ kotikovizig.hu

[2] Szent István University, H-2103 Gödöllő, Páter K. utca 1. E-mail: ligetvari.ferenc@mkk.szie.hu

[3] Geographical Research Institute HAS, H-1112 Budapest, Budaörsi út 45. E-mail: schweitf@mtafki.hu

Fig. 1. Catchment area of the Carpathian Basin (Kocsis, K. and Schweitzer, F. eds. 2009. after VITUKI)

shows extreme values. The upper reaches of tributaries are particularly wild, especially, dangerous are those of the Upper Tisza and of the Körös (the latter empties into the Lower Tisza) where the water level might rise 8–10 m within 20–30 hours following intense rainfall (Kocsis, K. and Schweitzer, F. eds. 2009).

To mitigate the extreme flood hazard, drainage regulation measures and the construction of flood control embankments started nearly 200 years ago and their alteration has been continuous ever since. With the regulation of the Tisza its section has shortened by more than 460 km on the present-day territory of Hungary. All these have resulted in increasing flood subsidence, especially on the Upper Tisza. However, it may also result in grave situations developing on the Lower Tisza, dependent on the coincidence of, or difference between high water stages of the tributaries.

A new concept for flood prevention

A detailed re-examination of the concept and regulation of the Hungarian flood prevention was carried out last time in the 1970s. In order to avoid the impending disasters the elaboration of a new strategy has become an urgent and imperative task by now *(Photo 1* and *2, Table 1).*

The catastrophic floods of the last decades in Hungary have been caused not only by the major rivers (Danube and Tisza), but by their tributaries as well. For instance, high water stages during the last 15 years in the catchment area of the Tisza River proved to be critical in 1998, 1999, 2000,

Photo 1. Siltation of 2–3 cm thickness following the flood of 2000

Table 1. Major flood waves on Tisza River since 1973 (after I. Nagy)

Year of occurrence	Actual peak stage at Szolnok (cm)	Under bed conditions of 2000		After the 30 years occurrence, if no intervention follows		
		Above the level of 1970 (909 cm)	Above design flood stage (961 cm)	Expected date of occurrence	Anticipated peak stage due to further deterioration	Above design flood stage (961 cm)
1977	880	940	–	2007	954	–
1979	904	**975**	**14**	2009	**993**	**32**
1980	873	930	–	2010	950	–
1981	885	940	–	2011	**962**	**1**
1998	897	903	–	2028	959	–
1999	974	**977**	**16**	2030*	**1,101**	140
2000	1,041	**1,041**	**80**	2050**	**1,151**	190
Occasion	*7*	*6*	*3*	*7*	*4*	*4*

* After 31 years, ** After 50 years

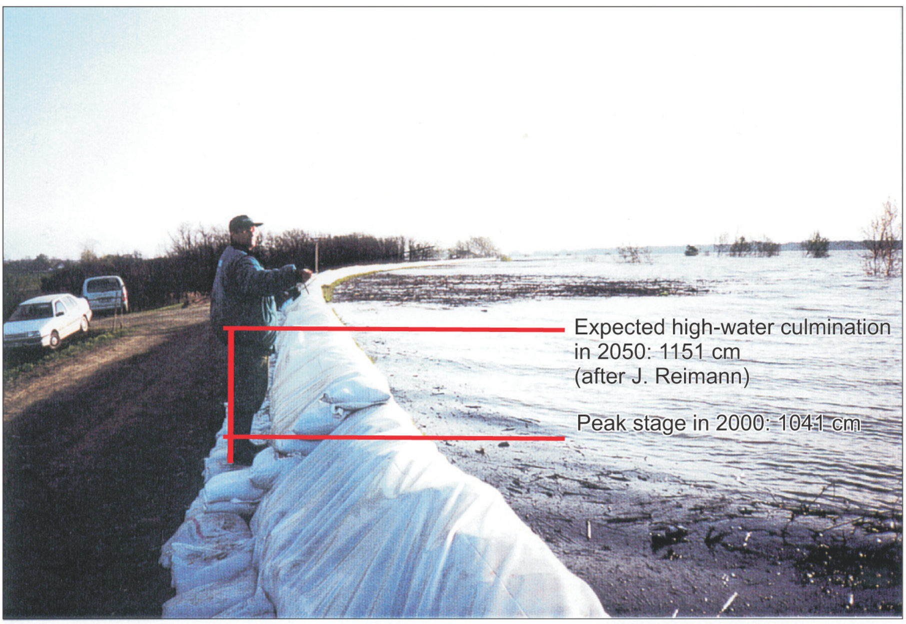

Photo 2. Change in peak stages of floods between 2000 (actual) and 2050 (anticipated)

2001, 2006 and 2010. All these cases make necessary a thorough analysis of the extreme flood events to be carried out and the drawing of conclusions with recommendations to be made as for the immediate legal interventions.

At present there is no flood security regulation, and probably this could be the cause of the absence of the systematic control and evaluation. The regulation on the design flood stages of the rivers (MÁSZ) published in 1976 can be regarded only as planning prescription. The assessments and statistics on the flood situations on the rivers do not deal with the flood security.

(Note: According to the public knowledge, in 1976 this prescription was constructed for a probability of the occurrence of the highest floods once every 100 years. It was not valid for every river even then, but nowadays it is almost impossible to find a river segment where it could be adopted. The build-up of the top level of the embankments was mostly based on the regulations for 1934 and the period before 1956. The situation, however, has changed significantly since then resulting in false concepts. According to the rules valid in the Netherlands, the embankments of rivers with high risk of flooding must be constructed for a probability of the occurrence of the highest floods once in 1,250 years.)

Before 1976 the measure of flood security was based on the difference between the height of embankments and the highest level of former floods. Since 1976 this kind of records on the rivers has not been made, only on some short segments. The recommended difference between the height of embankment and the former highest high water stage was gradually increased by 70 cm up to 100–150 cm between 1852 and 1934, and the minimum size of the embankment section was also determined *(figures 2 and 3).* In 1956 the average value was 100–120 cm along the Tisza River, but it reached +70 cm almost everywhere. At present this value is generally less than 40 cm and it does not even reach +20 cm along the river at a length of several hundred kilometers. (As a result during the flood in 2000 a temporary dike had to be built and the embankments had to be raised along a 155 km segment of Middle Tisza.)

During the last 100 years the difference between the embankment height and the highest level of floods along the Tisza River has never been as low as in the present (Schweitzer, F. 2009).

In Hungary great care was taken to the maintenance of the conditions of the high-water (flood) bed and the free throughflow of the rivers until the 1960s. In 1960 the afforestation of the floodplains, the building of inner, summer dikes and cottages, the leaving of the pastures and ploughlands, the

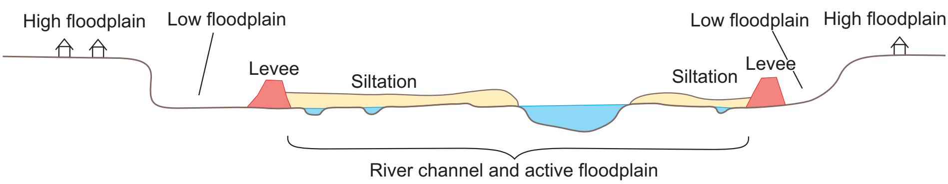

Fig. 2. Rising of the flood control embankments since river regulation (after Schweitzer, F. 2001)

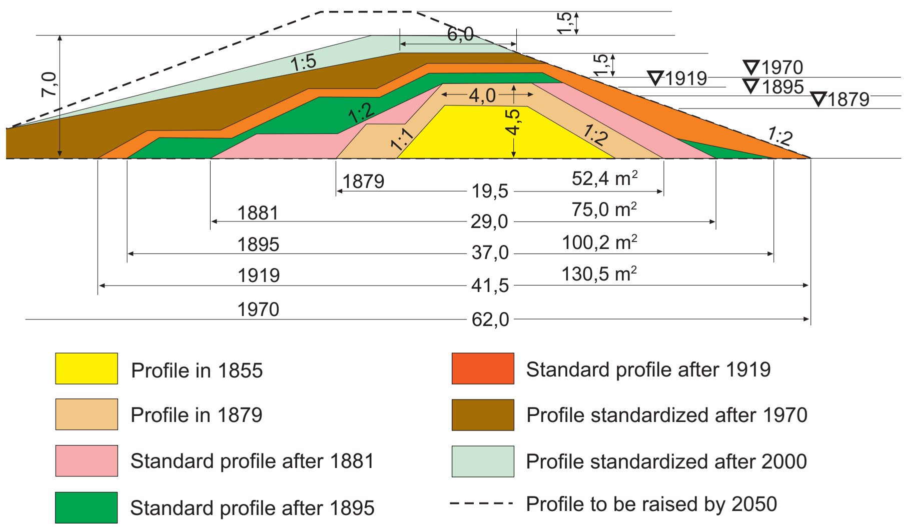

Fig. 3. Rise of the embankments (after Vágás, I. 1982)

spreading of the invasive species (e.g. *acacia*) began, which have largely contributed to the fast rise of high-water levels and the increased accumulation of the transported sediments. It can be stated that Hungary has given up the maintenance of the transmissivity of the active floodplain, only the construction of the embankments was emphasized. Flood retention reservoirs were constructed only on the smaller streams. Hungary did not deal appropriately with the causes of the frequency, discharge, height and duration of the floods and with the probable consequences. The siltation of the river channels makes the rising of the embankments necessary, but it could be done only at some places. New storage capacities should be created, sometimes by means of sacrifying populated areas. Technical solutions are just partly able to provide remedy for the problems. A novel examination of regional development, landscape management and landscape rehabilitation are the issues to be addressed. A new land use system on cultivated areas is to promote the establishment of wetland habitats which requires the participation of local people. To avoid disasters the involvement of public-minded politicians might be instrumental. This common responsibility makes necessary to prepare the acts for legitimization, which is a national security issue *(Figure 4, Photo 3).*

The flood security of an area is determined by the state of the weakest points of the embankments. During the last two decades the number of construction objects and traverses to be renovated or replaced has been on rise due to the increased water load caused by the aging of the embankments and the rising flood levels. Owing to damages, the flood-defence scheme and its future prospects must be revaluated. Remarkable flood level rise can be

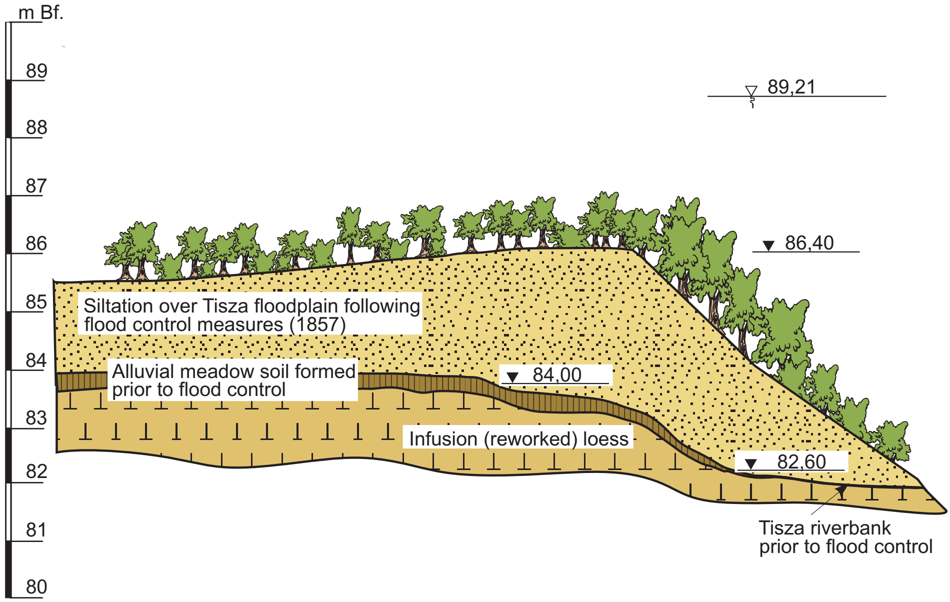

Fig. 4. Siltation over Tisza floodplain at Alcsisziget, Szolnok (after Nagy, L., Schweitzer, F. and Alföldi, L. 2002)

Photo 3. Floodplain sediments of Tisza River near Szolnok

expected in inland catchment areas because of natural processes and economic shifts and other human interferences having taken place in the active floodplain. The conveyance capacity of the flood bed decreased by 3 cm per year along the Middle Tisza section between 1970 and 2010 (Schweitzer, F., Nagy, L. and Alföldi, L. 2002). It means that in the case of the occurrence of a flood similar to the one of 2000 the embankments could not prevent the river from overflowing even if the excess water were led into the flood-control reservoir at Tiszaroff. *(Figure 5)*

There would be a similar situation at Tiszabecs if the 2001 flood happened again. Such and similar areas are still found in great number between Khust and Titel. An immediate moratory must be declared on building up these territories which are suitable for the establishment of retention reservoirs.

The narrowing of the river channel jeopardizes vast tracts, among others within densely populated areas. This is primarily not a technical problem, but specifically an administrative and political issue. Changes in the catchments beyond the state border are also unfavourable. In Hungary little emphasis have been put on monitoring of the role and operation of foreign reservoirs. Information derived from the daily data traffic is scanty either.

The raising of the embankments in Subcarpathia, the flood-control reservoirs constructed at the meeting point of Tisza and Batár rivers as well as the restricted river bed of Tisza at the Serbian–Hungarian state border resulted in new conditions which have not been dealt with at all. During the 2006 Tisza valley flood the operation of foreign reservoirs was not reckoned with, analyzed and evaluated.

In view of the above facts it may be claimed that over the past 100 years the effectiveness of flood prevention has never been so low along the Tisza River as it is nowadays.

Similar problems can be observed in other catchment areas, too. During the last 15 years extreme flood events have become more frequent which may bring about an increase in the number of damages and even fatal accidents might occur owing to further disasters.

The Amended Vásárhelyi Plan (VTT) approved for the Tisza Valley in 2003 aimed to improve the situation of the most critical valley segments of Tisza outlining the preparation of a forthcoming program. Unfortunately, a new concept or a program garanteeing a long-term flood prevention have not been prepared yet.

(Note: several documentations under the aegis of the concept have been prepared, but none of them have informed the audience about the present and future flood prevention.

They do not refer to the level of security which can be achieved by utilizing the proposed development fund.)

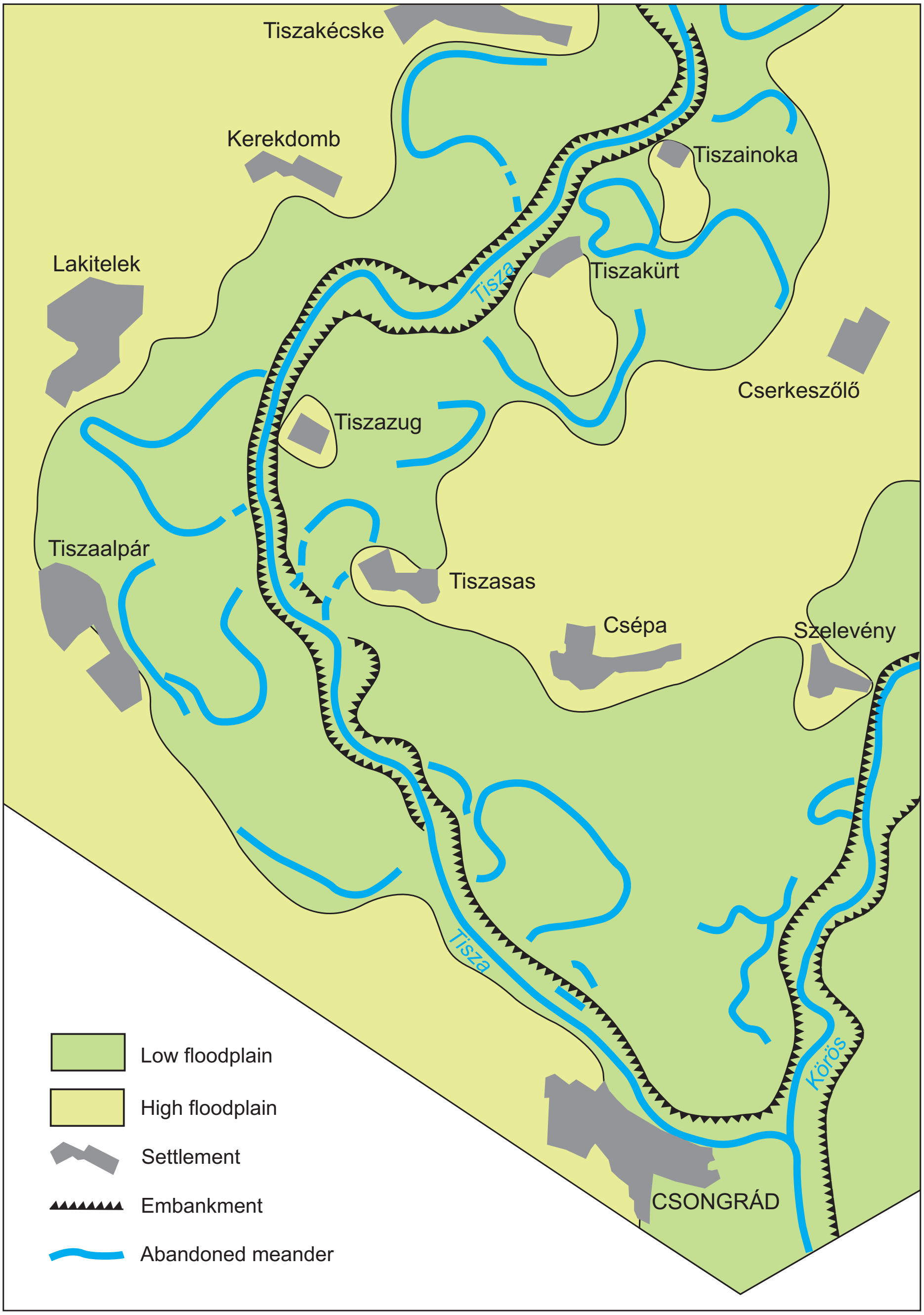

Fig 5. Tiszazug, a low-lying area, a key location for the establishment of a retention reservoir (after Schweitzer, F. 2001)

Conclusions

The future objective of the Hungarian flood prevention must be the creation of flood security as by law enacted. The protection of the Tisza Valley and catchment areas of other rivers is a national strategic priority.

The reform of the Hungarian flood prevention, the development of the new flood prevention concept and doctrine are crucial technical and above all political questions.

Taking into consideration the new concept, the elaboration of a program under realistic assumptions is needed to ensure a long-term flood security of protected flood areas along Tisza and other rivers to be able to inform decision makers, stakeholders as well as the inhabitants concerned and to utilise the available sources. The purpose of the new program beyond the increase of flood security is to improve the quality of life of the population concerned, extend water supply capacities, preserve natural resources and provide flood risk management.

Hungary is to undertake a similar task she did during the 1830–40s. Strategic decision for the next 100–150 years should be made for the sake of the population of our river valleys and protected flood areas.

These proposals have been made on the basis of the activity of professionals who work on the comprehensive reformation of the Hungarian flood prevention and set themselves a target of creating a new structure for the sake of river basin development and management under the EU regulations.

References

Kocsis, K. and Schweitzer, F. eds. 2009. *Hungary in Maps.* Budapest, Geographical Research Institute of HAS, 175 p.

Nagy, L., Schweitzer, F. and Alföldi, L. 2002. Jelenkori övzátony (parti gát) képződés és hullámtéri lerakódás a Közép-Tisza térségében (Relationship between the formation of point bars and natural levees and flood bed sedimentation along the middle stretches of Tisza River). *Földrajzi Értesítő* 51 (3–4): 257–278.

Schweitzer, F. 2001. A magyarországi folyószabályozások geomorfológiai vonatkozásai. (Geomorphological aspects of river regulation in Hungary). *Földrajzi Értesítő* 50 (1–4): 63–72.

Schweitzer, F. 2009. Strategy or disaster: flood prevention related issues and actions in the Tisza River Basin. *Hungarian Geographical Bulletin* 58 (1): 3–17.

Vágás, I. 1982. *A Tisza árvizei* (Floods of the Tisza River). VÍZDOK, Budapest, 283 p.