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Application of a multi-criteria decision making process to facilitate the Improvement of the Vásárhelyi Plan

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Abstract

In recent years floods have caused enormous damage and to prevent this the Government has launched a comprehensive programme called the Improvement of the Vásárhelyi Plan (IVP). In step with the original plan, new objectives have emerged, contributing to a solution for the Tisza Region's problems in water management and regional and rural development. In tandem with the planning stage, a strategic environmental assessment has also been conducted. The assessment's objective was to develop a multi-criteria system to help choose from a variety of feasible development plans, the ultimate goal being sustainability associated with social, economic, and environmental objectives. In its related decree, the Government recognised the results of the applied multi-criteria decision-making process.

Key words

Improvement of the Vásárhelyi Plan, sustainability, multi-criteria decision-making process, strategic environmental assessment

The processing and development for planning the IVP

Between 1998 and 2002, after a relatively dry decade, there were several unusual floods in the Tisza Valley, which increased the top water levels as never seen before. In March 2001, when the dyke on the right river bank between Tarpa and Tivadar broke, people living in communities in the Bereg flood basin had to be evacuated. After high floodtides occurred in the Tisza Region, there were inundations from excess water and a series of streamlet floods. Moreover, these extremely high water levels occurred despite the presence of comparatively favourable hydro-meteorological factors. The assessments indicated that even a slightly unfavourable change in meteorological conditions may have unusual consequences in the Upper Tisza region (*Vágás, 2001; Szlávik, 2005*).

150 years ago Count István Széchenyi's water management programme first began to modify the Tisza Valley's natural environment. The programme, which was called the Vásárhelyi Plan, satisfied the need for more land by initiating flood and excess water control and through the installation of irrigation systems which ensured water supplies. Water control primarily meant making most meanders shorter and restricting the river in narrow flood plains bordered by dykes. The length of the Tisza river was reduced by about 450 kms, (40%) and making the river-bed shorter created 136 kms. of new bed. Those Tisza Valley areas spared from flooding (about 1.4 million hectares) are three times greater than in the Po Valley, and the length of the dykes two times longer (2,940 kms in the Tisza Valley). This project, then unique by European standards, attained its goal and the Great Plain became a civilised, habitable place suitable for extensive farming and crops. Over the last hundred years, this has basically transformed the area's water balance conditions. Water control fundamentally altered the region and sparked development, but back then people did not realise the impact water control would have on the area's water balance (Szlávik, 2001; Süli-Zakar, 2001).

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The increase in flood water levels and related extreme water balance problems are linked to several overlapping and accumulating causes stemming from both human and natural factors:

- Initially, during floods they expected that an increase in water levels between the dykes would be compensated for by a deepening effect on the watercourse running in the beds that were made shorter, but this didn't happen. *(Ángyán et al, 2003)*.
- Because of the point bars rise caused by the floods' alluvial deposit, floodplain drainage starts later. Over the last one hundred years, hydraulically speaking, negative changes have occurred. Areas overrun with trees, numerous improperly constructed smaller summer dykes and other landforms have worsened hydraulic conditions, frequently preventing floodplain drainage *(AKII- KRF, 2005)*.
- In the last few years climate change factors have also been detected. (*Szlávik, 2001*), and resulting from this drought areas could increase as well as extreme weather conditions (e.g., torrential rains, snowfalls) which could cause serious flood damage (*VAHAVA, 2006*).
- Because of farming practices which didn't lend themselves to controlled flood and excess water drainage and to new ecological conditions, there was an increase in the excess water level and more drought (Szlávik, 2001).

Today the river's flow is restricted by dykes, and the river endangers an area of 2.1 million hectares rather than the previous 1.6 hectares. But despite the failure of the dyke system, flooding only occurs in the floodplains *(Ángyán et al., 2003)*. Therefore, unless concerted action is taken to stop or at least counteract these processes at the catchment area, there will more often be large-scale damage from floods, excess water, and drought.

The Tisza region constitutes at least one quarter of the country's area, and is inhabited by 17% of the population and their living conditions are basically determined by the above mentioned water balance conditions. Farming's decreasing economic role impacts heavily on this region because the population's livelihood and self-sufficiency is linked to agriculture. Only one third of the fields are suitable for cultivation, the remainder rendered unusable by a growing shortage of water. The area is economically depressed, with GDP per capita only two thirds the national average, and the employment rate only 31% compared to 36% nationally. This low level of activity constitutes the area's greatest weakness, not to mention the moderate decline in population when compared to the national average over the last ten years. All of this results in low per capita income *(VÁTI, 2004)*.

To prevent punishing floods around the Tisza, the Directorate of Water initiated a development programme, and the technical concept, which included comprehensive notions about flood safety, was in fact completed (*VIZITERV, 2001*). During planning, objectives were set containing planned measures to help resolve the Tisza's regions complex problems, stipulating that the budget include landscape management and regional nature protection conditions.

The Government in its March 2003 decree passed (see below)[3], decided on concepts to improve flood safety in the Tisza Valley, referred to as the Improvement of the Vásárhelyi Plan. The Decree declared that the technical investments should allow water to be sent to various locations, and that this water should be used for rural and regional development purposes and for the preservation and improvement of Tisza Valley natural habitats.

[3] Governmental Decree No. 1022 of 2003 (III.27.) on the re-examined development tasks of the flood safety constructions of the Danube and Tisza rivers and about the concepts concerning the increase of flood safety in the Tisza Valley (the Improvement of the Vásárhelyi-Plan).

The significance of Strategic Environmental Assessment in the planning

Besides technical planning, the Directorate of Water, during implementation of Phase I of the Improvement of the Vásárhelyi Plan, started to integrate rural and regional development into its planning, and ordered a Strategic Environmental Assessment (SEA) to help assess environmental concerns. The SEA's function is to gauge the environmental impact of certain plans, programmes, and proposed documents. Assessment of applicable methods may vary widely. Back then the advent of the SEA was considered innovative Although its birth followed the relevant EU directive, it nonetheless preceded the corresponding Hungarian law[4] (*ÖKO, 2003a*).

The IVP's research phase meant the planning levels' practical aspects harmonised with the general strategic level (the selection and analysis of those constructions implemented in Phase I). The SEA's major goal was to decrease flood risks and this determined the measures it took towards regulating the river bed and the construction of drainage reservoirs, but its mandate did not entail less detailed options and their assessments.

From the outset the SEA's basic task was to ensure that the planned drainage system had the potential to improve environmental and natural conditions both inside and outside the water reservoir areas. But further tasks included environmentally assessing the flood regulation plan and optimising flood protection and rural development. Another task was creating a new landscape management system toward a positive environmental and social impact.

Given the above factors, the assessment process focused on feedback derived from various viewpoints and interests, but these excluded implementation of environmental objectives and the examination of possible unfavourable environmental processes. This was meant to come up with the most suitable and **acceptable** plan to meet social, economic, and environmental needs. One of the SEA's main advantages is that it actually emerged in tandem with the plan, and thus it can spotlight various views and interests which harmonise environmental aspects with other viewpoints and interests, allowing it to create common ground among various interest groups. SEA objectives not only entail an assessment capable of revealing environmental effects, but also an assessment which results in decision making (*Szilvácsku, 2003*).

The priority and criteria system designed to ensure sustainability

In environmental protection it is imperative that sectoral policies blend together, a principle corroborated in several EU documents (*Mozsgai, 2004*). The assessment was also based on the principle that to be successful the IVP had to be "at the centre" of varying interests. Therefore, a solution was needed that was geared toward sustainability objectives. For this there are many different types of definitions, but today almost all relevant strategies call for a well-balanced approach dealing with three key dimensions: society, economy and environment (*Bulla et al, 2006*).

The IVP must meet several criteria, and these criteria fall under the umbrella of the three dimensions. Among these criteria are blunting local effects of extreme weather conditions, rural development, achieving popular acceptance, and protecting nature and the landscape. To be successful plans need to satisfy all these criteria. Consequently, the SEA's mandate extended to values regarding ecological protection but also sustainability which embraced the entire scope of development plans. The following figure details the process for the applied priority and criteria system designed to ensure sustainability within the SEA.

4 Governmental Decree No. 2 of 2005. (I. 11.) on the environment assessment of certain plans and programme

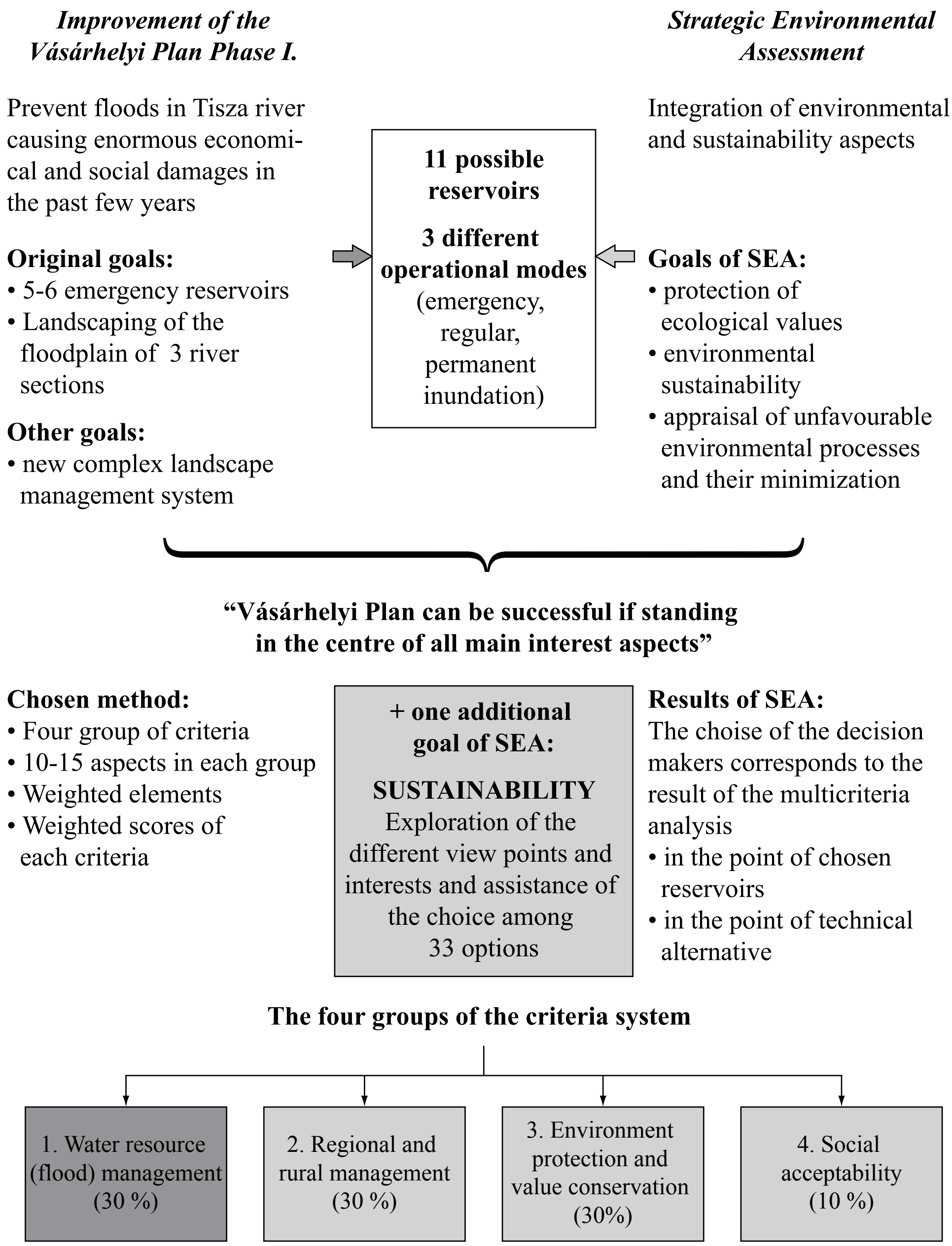

Figure 1: Application of multi-criteria decision making process to facilitate the Improvement of the Vásárhelyi Plan

Source: Authors' own construction

The assessed versions

The pertinent Decree regarding water management entailed numerous technical objectives. These objectives included enhanced flood safety, an increase in the drainage capacity of the main watercourse, and building water reservoirs and other drainage facilities to combat rare but damaging floods. Although rare, such floods potentially exceed acceptable water levels, and can cause dyke breakage and inundation. During planning, it was concluded that 1.5 billion m^3 of water can cause a projected one metre drop in flood levels along the entire length of the Tisza River. About 30 potential water storage sites were observed, 10 to 14 with the potential to accommodate the above mentioned capacity *(VIZITERV, 2001)*.

In the concept 31 water reservoirs were assessed and there were 8 possible reservoirs contained in Phase I. However, later three new reservoirs were added in Tiszakarád, Dél-Borsod and at Nagykörű. This was done to satisfy the economic interests of the inhabitants living in the affected areas. The decision makers decided to begin construction where the project was popular on condition that the reservoirs conformed with the original objectives. Within the framework of the strategic environmental assessment, 11 reservoirs were assessed. The locations were: Szamosköz, Szamos-Kraszna-köz, Cigánd, Tiszakarád, Dél-Borsod, Tiszanána, Hany-Jászság, Hany-Tiszasüly, Nagykunság, Tiszaroff and Nagykörű. *(VIZITERV-VÁTI, 2003)*.

Between 2004 and 2007 Phase I allowed for the building of 5 or 6 water reservoirs and complete floodplain regulation of three river reaches. Phase I objectives also entailed construction of effective flood control reservoirs. However, these reservoirs needed to have broad popular support and be immune to environmental, nature and heritage protection factors. Building reservoirs and floodplain construction according to these criteria meant a potential 60% decrease in flood levels at the most critical sections of the Tisza River, and entailed about 35% of the entire cost.

There are three possible ways to divert enough excess water from the Tisza to floodplain reservoirs in the course of drainage. These three options are possible for all the reservoirs, and thus the assessment had to extend to these operational modes (VIZITERV-VÁTI, 2003;Bokartisz, 2003):

- **emergency (flood) reservoirs**: Normally this type of reservoir is not in use and its drainage capacity is only used during heavy flooding when flood levels are above normal. The reservoir is used to prevent catastrophes and dykes from being breached. Building the system enhances emergency flood water storage, and allows the area to be inundated. In the given area there is also traditional dry land farming, and the system is also capable of meeting the farms' water needs. Inundation is primarily used for flood safety.
- **regular reservoirs**: Here the system regulates water flow to ensure planned inundations and irrigation for landscape management. Every year the area in question is inundated but the land is also used for emergency water storage, but this practice doesn't reduce its effectiveness. In the area there is floodplain landscape management. Sufficient and regular inundation meeting ecological and agricultural water needs must be guaranteed. Constructing such a system cost 10 to 15% more than in the other two cases. The area affected by inundation (for additional water supply) can exceed the area used for water storage.
- **permanent reservoirs**: these are reservoirs where the water level must at least in some places be constant. These reservoirs are shallower or the surface smaller than with emergency water storage, and thus these reservoirs have significantly lower flood prevention effectiveness.

When defining reservoirs it was important to consider three possible technical options for each reservoir. The three options differ in their operational modes, and their design is geared toward different priorities. Thus, their social, economic and environmental effects are also different, meaning the assessment encompassed the three different operational modes regarding eleven reservoirs, equalling a total of thirty-three options.

Achieving water storage in certain sections of the Tisza was a further IVP concept condition, meaning when choosing the reservoirs additional criteria had to be met:

- there had to be at least one reservoir (from among the Szamosközi, Szamos-Krasznaközi reservoirs) on the Upper Tisza,
- at least one in Bodrogköz (from among the Cigándi, Tiszakarádi reservoirs),
- and at least two or three reservoirs in the Middle Tisza (from among Dél-Borsodi, Tiszanánai, Hanyi-Jászsági, Hanyi-Tiszasülyi, Nagykörűi, Nagykunsági, Tiszaroffi reservoirs) had to be constructed.

The main elements of the multi-criteria decision-making method which were applied when evaluating reservoirs

Based on the above principles, the objective was to develop a criteria system to further the assessment of the building projects. The assessment had to be consistent and allow comparison of the various conditions in a way that could be easily processed by the decision makers.

A multi-criteria decision making method proved adequate for the assessment. This method is easily applicable in cases where a project or a decision must satisfy often controversial objectives. The method is viable because it means that assessment is done using various measures and information isn't lost when one assigns homogeneous values – financial values – to every single criterion. A multi-criteria decision retains the diversity of the original dimensions *(Marjainé, 2005).*

According to *Omann (2000)* multi-criteria decision analysis consists of the following steps:

1. definition and structuring of the problem,
2. creation of options,
3. defining a set of evaluation criteria,
4. a choice between discrete and continuous methods,
5. preparation of the decision (supply of data)
6. identifying the preference system by the decision maker and those who will be eventually affected
7. choice of an aggregation procedure, carrying out of the procedure; using feedback loops with the people affected by the decision.

We established four criteria groups and chose the weighted scoring method as the basis for the assessment. Our basic assumption was that the first three criteria groups appearing as immediate objectives (water management, socio-economical and environmental conditions) must be granted the same stature in the interest of sustainability, so these must be afforded the same weight when they are evaluated. The fourth criterion group is popular acceptance and here a dual approach must be applied. If the construction of a reservoir is rejected by local residents, the reservoir cannot be considered feasible. However, popular acceptance tends to be subjective and volatile so one must remain open to change. Consequently, smaller weight was assigned to this criterion system; but when it was established its exclusive criteria were also determined.

Within the individual criteria groups, several criteria were identified, and we assigned different scoring scales to criteria according to their weight. A small portion of the criteria have an exclusive nature, and thus the construction of a given reservoir is slotted until that given criterion is met. A problem such as a current lack of popular acceptance or when a protected nature conservation area is affected and there is no agreement with those managing that area. Only one such criterion is enough to cancel the construction of a Phase I reservoir. Most criteria are designed to evaluate which reservoirs have advantages or disadvantages based on the individual criteria.

For exclusive criteria, the assessed option is ruled out by the application of a naught (0) multiplier. To determine the favourable or unfavourable tendencies, the scale can extend to both positive and negative directions if it is justified. The scoring system uses negative numbers if there are unfavourable effects from the aspect of the given criterion. The general case where one can expect both positive and negative effects can be assessed on a scale extending from –10 to +10, where the zero means a neutral state. Higher scores can be assigned to key questions where the maximum figures can be between –20 or +20. There were criteria where the scale is not asymmetric. After we summed up the scores for the individual criterion groups, and calculated the mean for those scores, we multiplied them with the weight assigned to the given group. We assessed the orders set up on the basis of these scores both together and separately in the individual groups. If the result was negative, it meant that the solution assessed by the given criteria system is problematic, and the given reservoir alternative cannot be supported in its present form. We divided the interval between zero and the maximum score into three parts. If the score was in the uppermost third of the scale, we rated the alternative as "good" If the score was in the middle third, we rated it as "adequate", and if it was in the lowest third, but was assigned at least a score of 15, we rated it "acceptable." Options scoring below 15 were rated as "low" usability options, which are inadequate solutions in their present form.

In order to determine the concrete figures of the criteria, we used the results and conclusions of studies which were prepared for this assessment by professional experts. (see *Bibliography*.) The applied method is located in the next chapter within the Cigánd reservoir example.

The criteria necessary to select the reservoirs and their operational mode and the major results of the applied method

The objective of the **water management criteria** is to select the possible methods and places to improve water reservoirs, flood safety, and the water balance in the Tisza River's catchment area. This criteria system consists of such water management aspects which can, in a complex way, assess potential for reducing flood damage, excess water, and drought regarding natural conditions and technical parameters. The identified water management criteria can be found in Annex 1.

The total scores above zero were asymmetric. The reason for this is that the water reservoir system is primarily designed for water management purposes, meaning the relevant positive characteristics are naturally higher. Of the 10 criteria, 8 were determinable in this phase of the planning. (Criteria 1.3 and 1.5 were not assessed.)

The data and information needed for the assessment were from background studies by the experts involved in the research (*VITUKI, 2003; VIZITERV Consult-VÁTI, 2003*). Mainly the regular reservoirs were able to satisfy the complex water management criteria. Within the criteria group, almost all the 11 regular reservoirs were among those ranked as good or adequate. The reservoirs in Nagykunság and Tiszaroff could also regarded as permanent reservoirs.

The results regarding water management in terms of the number of reservoir necessary in certain sections of the Tisza:

Upper Tisza: In terms of water management all the reservoirs at Szamosköz and Szamos-Kraszna-köz were rated as good, so selection will be determined by the other criteria. From a hydraulic point of view, the Szamosköz reservoir rates best.

Bodrogköz: The reservoir at Cigánd received a high rating in all aspects of water management, and ranks first.

Middle-Tisza: All the regular reservoirs in Nagykunság, at Tiszaroff, Hany-Tiszasüly, Nagykörű, Hany-Jászság achieved virtually the same good rating, but the reservoir in Nagykunság came second best among all rated reservoirs. For water management, the emergency reservoirs in Dél-Borsod and at Tiszanána were the least adequate solutions.

The **regional and rural development criteria group** sets objectives corresponding with the preservation of natural values, and which further sustainable forms of agriculture and help preserve population numbers in the region. Regarding construction of the reservoirs, this system examines the extent to which traditional forms of agriculture in use near the reservoirs harmonise with nature and the landscape and how they can be given priority in the context of flood safety objectives. The chosen regional and rural development objectives can be found in Annex 2.

Here the assessment system is also asymmetric in the positive direction, but the reason for this is located in the criteria established for the plans; a plan is deemed acceptable if it aids the affected inhabitants. The required data and assessment information were from background studies conducted by the experts involved in the examination *(VÁTI, 2003a,b; Bokartisz, 2003; BKÁE, 2003).*

The assessment has shown that at the regional development and landscape management level, regular water storage is by far the most effective. In Phase I all the reservoirs are ready for potential landscape management. The assessment indicates that the emergency reservoirs offer little financial benefit to the people affected. Naturally, the permanent reservoirs are less amenable to landscape management; however, none of these reservoirs is completely deleterious (a large negative figure) if one considers tourism, or fishing potential, etc. But abandoning present farming practices would have devastating financial and social consequences.

Results regarding rural development in view of the necessary number of reservoirs needed in certain sections of the Tisza:

Upper Tisza: The reservoir in Szamosköz is rated better than the one in Szamos-Krasznaköz (especially regarding aspects 3., 4. and 6.).

Bodrogköz: The reservoirs in Cigánd and in Tiszakarád have are the mostly highly rated and have almost the same scores.

Middle-Tisza: The Nagykunság reservoir also is awarded the highest scores, whereas the other regular reservoir options receive similar, adequate ratings with little variation from the pattern.

The **elements of the system of aspects pertaining to environmental and value protection** can primarily be interpreted according to the natural, cultural, and landscape values found in the reservoirs and their impact areas. Another important aspect is developing the area's natural resources in a sustainable manner. The value protection pertaining to certain operational modes (e.g., permanent) is doubtful, and thus in these cases exclusive criteria were formed. The assessed elements of the criteria system are can be found in Annex 3.

The data and information used by the assessment are provided by the background studies *(ÖKO, 2003b; VÁTI, 2003c; MTA TAKI, 2003; Env-in-Cent, 2003).*

With respect to the environment and value protection criteria group, we found a reason preventing (excluding) completion of the Szamosköz reservoir, and this reason involves all three operational mode options. In fact, the reason was that some protected areas were affected, but the National Park Directorate did not expressly reject this solution. With the other reservoirs no significant environmental problems are apparent, but careful planning and construction are necessary in order to reduce risks. From an environmental aspect regarding the other reservoirs, the regular operational mode offers more advantages for every reservoir, and were thus rated as adequate.

The environmental and value protection point of view regarding the necessary number of reservoirs needed in certain Tisza sections:

Upper-Tisza: The only adequate alternative is the construction of the (regular) reservoir in Szamos-Kraszna-köz. The Szamosköz reservoir would affect protected areas and this is considered to be an excluding factor.

Bodrogköz: The regular reservoirs at Cigánd and Tiszakarád have similarly favourable ratings regarding environment protection.

Middle-Tisza: The Middle-Tisza section regular reservoirs are not significantly different However, regarding the Nagykörű and Tiszanána reservoirs, both the emergency and permanent operational options are unfavourable in terms of environment protection. The emergency reservoirs at Dél-Borsod, at Hany-Tiszasüly and at Tiszaroff border on being unacceptable.

One of the basic requirements concerning planning is that the area's citizens should be involved in decision making to the greatest possible extent. The **criteria group for popular acceptance and acceptability** assesses on the one hand the options and possibilities to improve local living conditions, and on the other finding options which are best suited to local interests. If local inhabitants strongly oppose it, the assessment excludes construction of a reservoir in Phase I. The assessed elements of the criterion system can be found in Annex 4.

Among these criteria the greatest weight was assigned to the aspect of popular acceptance (1.). Besides this, we also assessed the expected psychological impact linked to, among other things, the proximity of large quantities of water in the reservoirs at flood events. This criterion has a special role in the long-term operation of the reservoir.

The data and information needed for the assessment were from background studies conducted by the experts involved in the examination *(Bokartisz, 2003; VÁTI, 2003b).* The results showed that in most places the popular acceptance of reservoirs with a regular operational mode is high, or at least neutral (positive scores), except for the reservoir in Szamosköz, which in its given form can be considered rejected.

The results in terms of popular acceptance regarding the necessary number of reservoirs needed for certain Tisza sections:

Upper-Tisza: At present popular acceptance is restricted to the regular reservoir in Szamos-Krasznaköz, making it the sole solution (the construction of other operational modes enjoy no popular acceptance). Popular acceptance for the reservoir in Szamosköz is highly limited, making it unviable.

Bodrogköz: The regular reservoir at Cigánd rates highest of all reservoirs, but popular acceptance of the regular reservoir at Tiszakarádi is also high.

Middle-Tisza: The regular reservoir at Nagykörű has the highest acceptance rate in the Middle Tisza section. Regarding the reservoir at Hany-Tiszasüly, all three options have gained popular acceptance. Among the regular reservoirs in Dél-Borsod and Nagykunság, the Tiszanána reservoir having the permanent operational mode would be highly popular.

In the aggregate assessment the highest possible scores are around 100, but this was somewhat modified due to unanswered questions. For the aggregate assessment, not only were the allotted scores significant, but also the really good options did not receive negative scores for any of the criteria.

At least for Phase I, we chose not to propose the construction of the Szamosköz reservoir. Most of the problems concerning this reservoir are of an environmental nature (protected areas are affected), and popular acceptance of the reservoir is rather unlikely.

With the exception of the one in Szamosköz, all the reservoir options proved to be at least adequate, and the Cigánd reservoir received the highest rating (good). Regarding **water storage, all the reservoirs fall into the acceptable category; therefore, for these options selection remains basically open** As for emergency storage**, t**he reservoirs in Nagykunság, at Hany-Tiszasüly and at Tiszaroff are among the strong candidates concerning acceptability. Of the reservoirs having emergency operational mode, two (at Nagykörű and Tiszanána) have total scores which render them unsuitable. Moreover the permanent operational mode options were given the worst qualifications; all receiving negative scores in at least one respect (see Annex 5).

The summary of the results regarding the necessary number of reservoirs needed by certain sections of the Tisza:

Upper-Tisza: the **regular reservoir in Szamos-Tisza köz**.

Bodrogköz: The reservoir at **Cigánd rates** best among all reservoirs.

Middle-Tisza: **The reservoirs in Nagykunság, at Tiszaroff and at Hany-Tiszasüly** having the regular operational mode were deemed adequate, and with emergency operational mode were rated acceptable given that they did not have negative scores in any of the criterion groups. The reservoir at **Nagykörű,** regarding the regular operational mode, had favourable ratings while for other operational modes it had negative scores in more than one criteria group.

Results: their use and usability

The set of reservoirs that are to be built in Phase I were recorded in a Governmental Decree passed in November, 2003[5]. The decision makers accepted the importance of regular water storage, and that the projected reservoirs be completed and combined with the technical facilities serving water flow regulation and the further conveyance of water. Regarding the chosen reservoirs, the decision makers agreed with the Phase I conclusions arrived at using the multi-criteria decision-making system, which stipulated the construction of six regular reservoirs out of the eleven, and which entailed combining two reservoirs (Cigánd-Tiszakarád, Szamos-Krasznaköz, Nagykunság, Hany-Tiszasüly, Tiszaroff, and Nagykörű I. Phase).

Initially, planning for the reservoirs at Cigánd and Tiszaroff was started, and then a law was passed to facilitate the planning and licensing processes (Law No. LXVII. of 2004). Even though the licensing procedures and land expropriation took longer than expected *(Bognár, 2007)*, the considerable delay in project completion was mainly due to a lack of domestic financial resources. The reservoirs in Szamos-Krasznaköz, Nagykunság and at Hany-Tiszasüly are reliant on EU financial help which became available from 2007 onward. Planning for this started last year, but completion is only anticipated between 2008-2009. Regarding the reservoir at Nagykörű, probably only landscape management programme elements will ever be completed.

Other than the completion of Phase I for the Improvement of the Vásárhelyi Plan, several other sectoral infrastructural development projects will occur in Hungary, and they will be co-financed by Hungary and the EU. From a Hungarian standpoint, an essential objective is that these projects should encompass social, economic and environmental aspects to ensure that they will not be deleterious in either the short or long run, something which can only be countered through costly investment. The method presented above bolsters the creation of a basis for sustainability concious decisions.

The strategic environmental assessment potentially provides an important framework toward integrating environmental issues with sectoral policy decisions. Moreover, both the pertinent EU Directive and the Hungarian laws offer a wide scope concerning the contents of strategic environmental assessments. As in other EU member states, it would be necessary to publish a summary of those methods applied in successful Hungarian assessments, and this collection could serve as a model and contribute toward unifying strategic environmental assessment methodology and enhance the accuracy of future research.

Acknowledgements

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[5] Governmental decree No. 1107 of 2003 (XI.5.) on the programme for the improvement of flood safety in the Tisza-Valley and the regional and rural development of the affected area (the Improvement of the Vásárhelyi-Plan).

Annex 1

I. Water management criteria group

Criteria (Weight: 30 %)	Score		Cigánd regular
	Min.	Max.	
1. The planned solution should assume a role as big as possible in the fulfilment of the basic objectives of the IVP: "The level of ice-free flood passing 1.0 m higher than the design flood level must be reduced by a minimum of 1.0 m along the Tisza. That is, water levels exceeding the design flood level should not be allowed to occur on the Tisza." (60 cm is to be achieved in the first phase)	0	20	17
2. The reduction of flood risks should be carried out in a way that the reverse extreme weather conditions occurring in the same area – dryness and damages caused by droughts – should be moderated to the greatest possible extent.	0	20	18
3. The area's suitability for various storage purposes based on the connections of the geographic structure of the relief, its declines and levels, and the water levels of the Tisza.	-10	10	10
4. Flood storage should be solved by causing the least possible damage, and, at the same time, the advantages originating from the construction of the system should also be exploited.	-10	10	10
5. The flood risk or dangerously high water level to other territories should not be exported.	-10	0	0
6. The water flow regulation possibilities formed by natural conditions and by existing and planned technical constructions should be flexible.	0	15	15
7. The satisfaction of the ecological water demand on the outskirts of reservoirs should be ensured as much as possible.	0	10	7
8. The effects of the developments should not worsen the problems caused by excess waters at areas which are to be protected from excess waters.	-10	5	5
9. In the respect of areas bordering on reservoirs, the smaller the number of those impact bearers sensitive to excess waters, the bigger the advantage is. However, at the determination of the areas of the reservoirs, the territories exposed to the danger of excess waters, and low floodplains are at an advantage.	-10	10	10
10. The technical solutions needed to utilise the storaged water on the area of the planned reservoir and on the bordering areas should be already on hand after the completion of Phase I. (e.g., the possibilities of water flow regulation).	0	10	8
Total	**-50**	**110**	**100**
Weighted total	**-15**	**33**	**30**

Source: ÖKO, 2003a

Annex 2

II. Regional and rural development criteria group

Criteria (Weight: 30 %)	Score		Cigánd regular
	Min.	Max.	
1. In terms of property and value protection, fewer inhabitants should be exposed to the danger of this kind.	-10	0	-1
2. The change of land use is justified by the aspects of the cost of living, it is desirable if it is helped by the inhabitants' professional qualifications and, in the meantime, the population supporting ability of the area is also improved.	-10	20	20
3. The large proportion of areas which, in a morphological sense, capable of floodplain cultivation (floodplain orchards and ancient type of ecological farming using flood openings "fok" management etc.) and the preservation of the traditions of these areas are considered an advantage both in the reservoir and at areas surrounding it.	0	10	8
4. The characteristics which can ensure the possibility of forming areas that are capable of fisheries mean advantages.	0	10	7
5. The possibility of escaping should be ensured as easily as possible for the game stock.	0	5	4
6. To what extent sustainable soil usage adapted to the conditions of the area can be provided for after inundation	-10	10	5
7. The constructions should contribute to the prevention of possible, unfavourable climactic changes.	0	5	4
8. The changes in the values of nature's capital should be as positive as possible.	0	10	8
9. The landscape potential should increase and the land use should be more reasonable.	-10	10	5
Total	**-40**	**80**	**60**
Weighted total	**-13,3**	**26,7**	**20**

Source: ÖKO, 2003a

Annex 3

III. Environment and value protection criteria group

Criteria (Weight: 30 %)	Score		Cigánd regular
	Min.	Max.	
Natural assets			
1. Nature protected values cannot be in areas affected by inundations	multiplier 0 if there is		1
2. The development should support the functioning of the Tisza as a continuous ecological corridor.	-10	20	15
3. The chances for the survival of valuable wet land and aquatic habitats should be increased as well as their preservation conditions and the possibilities of their restoration.	-10	10	9
4. In the case where valuable habitats are flooded, the water level and the interval of the inundation should not endanger the survival of the habitat.	-10	10	8
5. The developments are at an advantage where they can help to form valuable water types.	0	10	10
6. The characteristics and the technical possibilities on hand should provide good conditions to avoid the damage in fish stock and to assist their reproduction.	-10	10	-4
7. The cultivation in the area of the reservoirs should promote to restore the traditional landscape types (habitats) on flood plains.	-10	10	7
Cultural heritage			
8. No territories that are parts of World Heritage can be in the area of the reservoirs or in their impact area.	multiplier 0 if there is		1
9. No reservoirs can be constructed where there are highly or strongly protected archaeological sites, historical earthworks or protected values.	multiplier 0 if there is		1
10. The number of registered archaeological sites should be the lowest possible.	-10	10	-4
11. The number of cultural values: architectural, etnographical and others should be the lowest possible.	-10	10	-3
Protection of landscape and settlements			
12. The water reservoir and its operation should not have an unfavourable effect on other areas (important holiday resorts, historical wine regions, protected areas of water supplies, other regional and settlement values) which are valuable from other than nature preservation aspects.	-10	10	-2
13. In the impact area, safe waste water treatment and waste disposal should be solved as extensively as possible.	-10	0	-5
14. Natural features should be used as great extent as possible at the construction of reservoirs.	-10	20	10

Criteria (Weight: 30 %)	**Score**		**Cigánd regular**
	Min.	**Max.**	
Sustainable usage of natural resources			
15. The regional and integrated assessment of the soil conditions.	-20	20	10
16. From a physical and chemical point of view, the quality of the stored water should fall into the category of Class II (good water quality) determined by the EU Water Framework Directive.	-10	10	10
17. The composition and abundance of the aquatic communities evolved in the reservoir during water storage should reflect the Class II (good) ecological status determined by the EU Water Framework **Directive**	-10	10	10
18. The impacts of the developments (e.g., the quality of the water fed back to the Tisza) cannot impair the Tisza's current water quality according to water quality classification.	-10	10	10
19. In the area of the reservoir, there cannot be any point or diffuse source which spoils the quality of the stored water including the excessive accumulation of nutrients. (e.g. intensive use of fertilisers.)	multiplier 0 if there is		1
	-10	0	-3
Total	**-160**	**170**	**79**
Weighted total	**-30**	**31,9**	**14,8**

Source: ÖKO, 2003a

Annex 4

IV. Social acceptance criteria group

<table>
<tr><th rowspan="2">Criteria (Weight: 10 %)</th><th colspan="2">Score</th><th rowspan="2">Cigánd regular</th></tr>
<tr><th>Min.</th><th>Max.</th></tr>
<tr><td rowspan="2">1. The social acceptance of the constructions should be as high as possible.</td><td colspan="2">Total reject: multiplier 0</td><td>1</td></tr>
<tr><td>-10</td><td>20</td><td>20</td></tr>
<tr><td>2. The possibilities to choose between the alternatives of farming should be increased by the developments.</td><td>-10</td><td>10</td><td>10</td></tr>
<tr><td>3. The existence of institutional conditions (emergency, regular, permanent storage) of the planned land use is an advantage.</td><td>0</td><td>10</td><td>10</td></tr>
<tr><td>4. The planned solutions should improve the cooperation of common interests between the affected settlements and regions.</td><td>-10</td><td>10</td><td>6</td></tr>
<tr><td>5. The developments and facilities which are to be built should have as little impact as possible on settlements and habitable environment. (Psychological burden.)</td><td>-10</td><td>0</td><td>-2</td></tr>
<tr><td>Total</td><td>-40</td><td>50</td><td>44</td></tr>
<tr><td>Weighted total</td><td>-8</td><td>10</td><td>8,8</td></tr>
</table>

Source: ÖKO, 2003a

Annex 5

Final ranking based on reservoirs' location and operational modes

Location of Reservoirs	Operational Modes	Scores	Qualifications
Cigánd	***Regular***	***73,6***	***Good***
Tiszakarád	**Regular**	**63,7**	**Adequate**
Nagykunság	**Regular**	**61,7**	
Nagykörű	**Regular**	**60,8**	
Tiszaroff	**Regular**	**59,1**	
Szamos-Krasznaköz	**Regular**	**57,2**	
Hany Tiszasüly	**Regular**	**54,5**	
Hany-Jászság	**Regular**	**52,8**	
Dél-Borsod	**Regular**	**51,9**	
Tiszanána	**Regular**	**50,6**	
Tiszaroff	*Emergency*	*24,6*	*Acceptable*
Tiszanána	*Permanent*	*24,4*	
Nagykunság	*Emergency*	*23,2*	
Tiszaroff	*Permanent*	*22,8*	
Cigánd	*Emergency*	*21,1*	
Nagykunság	*Permanent*	*20,4*	
Szamos-Krasznaköz	*Emergency*	*20,4*	
Cigánd	*Permanent*	*20,3*	
Hany Tiszasüly	*Emergency*	*19,1*	
Hany-Jászság	*Emergency*	*18,7*	
Hanyi Tiszasüly	*Permanent*	*18,7*	
Dél-Borsod	*Emergency*	*15,5*	
Tiszakarád	*Emergency*	*15*	
Nagykörű	Emergency	14,8	Low Usability
Hany-Jászság	*Permanent*	14,3	
Nagykörű	*Permanent*	14,1	
Tiszakarád	*Permanent*	10,9	
Dél-Borsod	*Permanent*	10,4	
Tiszanána	Emergency	7,9	
Szamos-Krasznaköz	*Permanent*	3,8	
Not supported in Phase I:			
Szamosköz	Emergency	0	Excluded
Szamosköz	Regular	0	
Szamosköz	*Permanent*	0	

Source: (ÖKO, 2003a)

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