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Multi criteria assessment – tool for integrated water management in Bereg landscape, Upper Tisza

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Abstract: In interdisciplinary projects – such as the Bereg landscape revitalization, Hungary Upper Tisza - one of the main challenge how to incorporate the different fields of interests, aspects. In the methodology - to reflect sustainability, as qualitative criteria - different domains (i.e. the economy, society and the population) need to be considered. The results from discourse-derived narratives and extensive modelling can be incorporated in the project alternatives' evaluation, reflecting long term scenarios generated (Scenes Project, 2007). Multi criteria assessment (MCA) is a methodology incorporates the different opinion of the interested parties to support decision making. The method allows to take into account more diverse public opinions and supports a better, transparent documentation of opinions, norms. In the Bereg project the improvement of the MCA method to reflect the specific aspects of areas with high flood risk and natural, social vulnerability took place with intention to improve the data collection and decision making process at regional and national level. Results were fed into the Bereg Interreg project (HUSKUA/05/01/139), MCA results has been accepted and inserted into the feasibility study of the flood reservoir alternatives. It allowed a better incorporation of the opinions of local SH's. Development of main pillars of criteria of the proposed assessment, data collection procedure and its difficulties and finally decision making results are presented.

Keywords: multi criteria assessment; integrated resource management, sustainable landscape development, stakeholder involvement, valuation of flood retention alternatives, decision support at different levels, Upper Tisza, Bereg landscape.

1. INTRODUCTION

Over the past 130 years dramatic changes had an effect on the land management of the Tisza river basin, Hungary due to massive canalisation [Flachner, 2006; Sendzimir et al, 2007]. To improve large scale grain production and navigation the river has been strengthened and surrounding areas (secondary floodplains) drained (90% of wetlands were lost, river shortened to 1/3). Due to several environmental, socio-economic reasons the revitalisation of these areas has been initiated at many micro regions along the Tisza river in the 1990's and followed by a governmental program called New Vásárhelyi Program (further on VTT) in 2000's [VTT, 2004] to introduce measures to reduce flood risk (such as flood polders in micro regions) and improve livelihood in the region. Key issues and relevant process in the Tisza valley are summarized in Table 1.

The Bereg landscape is a unique environment from several perspectives – as a border area to Ukraine it was not developed in the lat 50 years, traditional agriculture could remain for much longer time period than in other parts of the country. Its nature value has been recognized quite early – up to 40 % the area is under national protection; marches, peatbogs, special meadows with *Crex crex* are targets of national and international nature management work. In 2001 the flood destroyed 50% of the area, 6 out of 19 communities have been rebuilt, culture values restored (wooden churches from 17th century can be found in large numbers).

The Bereg landscape represents the Tisza catchments problems very well. It is part of the Szatmár –Bereg landscape protection area, situated in the north east part of the country (see Figure 1., red colour represents the nature protection sites). The issues listed in Table 1. cannot be solved with singe measure-based linear approaches on sustainable manner.

Table 1. The main issues at the Tisza catchments [Flachner, 2006]

Main issues	Most relevant processes, problems
Natural:	- Ecological decline, loss of biodiversity, fragmentation - increase of risks: flood, draught, invasive species, pests - soil degradation (texture, productivity) - stagnating water at large parcels - groundwater decline, pollution of resources(local, transboundary) - landscapes under different threats fragmentation, aesthetic loss, etc.
Social:	- ageing and migration from the region - increasing minority issues (gypsies) - high unemployment rate (avg. 30%. but up to 70%) - low education and awareness, loss of traditional knowledge - high values cultural values (built environment, traditions, local knowledge) under threat
Economic:	- poverty, segregation - land fragmentation, unclear ownership due to uncompleted land consolidation (LC), need for land use (LU) change - lack of financial capital, high cost of loans - lack of high quality, optimal scale machinery and technologies - lack of management capacity and co-operation

To find integrated, sustainable solutions to reduce or mitigate flood risk, contribute to nature protection and provide livelihood to the communities several methods and procedures should be incorporated, and complex criteria-system has to be applied in decision-making process.

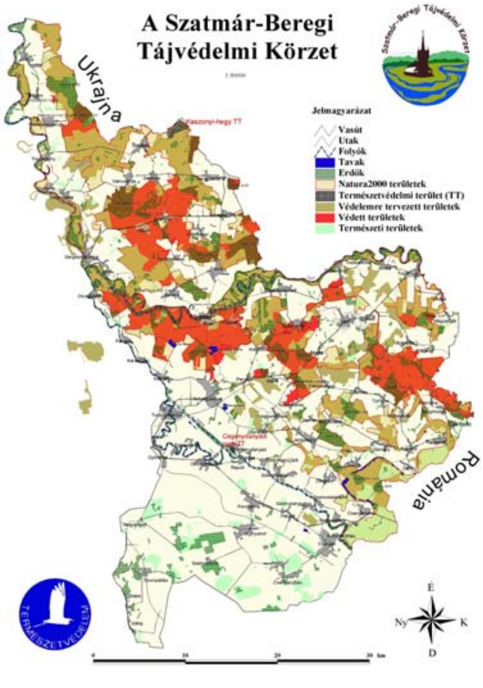


Figure 1. Nature protection in Bereg - Szatmár landscape, Upper Tisza catchments [HNPI]

In Bereg landscape a community based strategy development and action setting process provided an excellent framework to collect ideas to build up the criteria system and define the long term perspectives [Bereg Strategy, FAO TCP project; Flachner, 2008]. Further on a cross border initiation resulted in an Interreg project for complex flood protection and floodplain revitalization in collaboration with Ukraine, where the objective was to develop authorized plans for polder developments in the light of the flood risk reduction program (VTT) objectives. The process of linking these elements and integrating it into an effective and efficient decision-making is described in the followings.

2. DEVELOPMENT OF CRITERIA SYSTEM

2. 1 Development of the Bereg strategy

To develop long term strategies a criteria-system reflecting the needs for long term, integrated rural-regional development need to be defined. The Bereg landscape strategy has been formulated in a participatory strategy development and regional planning process. In three iterative cycles - involving different community groups, including minorities, policy makers and external advisors – the strategy and action plan have been developed in 1,5 years, but left opened for further improvement (so called ‘living document’ has been created). The strategy was incorporated into the LEADER (decentralized rural development under CAP) process and used as a background document for further discussion. Key elements of the strategy development process were:

- analysing the historic trends, processes (both quantitative and qualitative)
- understanding the casual links and select the important factors for common discussion for key stakeholder groups
- link the discussions to possible future scenarios (GEO4, IPCC) and derive key potential changes
- define principles and criteria and long term objectives
- select measures to implement in short term to gain benefits in short run.

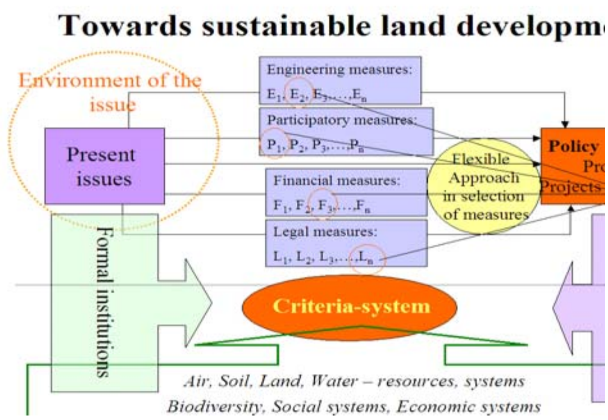
In the process the most important identified floodplain development targets were:

- Increase the water storage capacity in the landscape (habitats, soil, deeper aquifers as well), and support the soil, nature, landscape rehabilitation processes, flood risk reduction and production safety at different locations.
- Contribute to lower risks of (external) threats at landscape, floodplain and region level – climate extremities, vulnerability in water, raw material, energy, food supply. Increase adaptive capacity of the system (social, economic, environmental).
- Decreasing GHG emission, and increasing carbon sequestration by appropriate land management (landuse and technologies).
- Support the rehabilitation and management of natural habitats of floodplains (oxbows, peat bogs, marshes).
- Contribute to maintain, preserve genetic variability of special indigenous species.
- Decrease, fix pollution load from point and non point sources.
- Support socio-economic development: efficient and economic land utilisation and production, high quality eco-products; new technology based alternative energy production and utilisation; tourism and recreation. Support market development both internally and externally.
- Support landscape and its heritage protection, which create a basis of improved life quality and livelihood in the miro-region and in the Upper Tisza river basin.
- Increase the population retentive capacity of the area and reduce poverty and social segregation.

2.1. Key procedural lessons of criteria settings

Figure 1 presents the applied process where the defined criteria system supports the selection of measures and incorporates differnet aspects.

Figure 1. Framework of floodplain revitalization



The socio-economic systems have formal and informal structures which both have very high importance in the criteria setting in the Bereg landscape. Many communities had traditional roles, the flood defence and land management activities build up specific informal coalitions (eg. it worked very well during the evacuation in the 2001 flood, farmers were providing very efficient support to each other). Another very important informal criteria is the social acceptance of the proposed solutions by local society, which depends on e.g. the level of information provided concerning the VTT implementation; role and operation rules of the polders and expected benefits for the risk holders. Formal criteria is set by VTT law to designated flood-polder, where area utilisation restrictions are set. The criteria-system can be clustered in the light of the main systems, such as:

- **Environmental**: efficiency, sustainable resource utilisation, revitalisation processes.
- **Social**: cultural, normative acceptance, embeddedness into individual, community aims. Legal basis of the system (connected to the norm structures). Institutional capacities, frameworks and procedures.
- **Economic**: planning, execution and maintenance cost; contribution to GDP, increase the income level and value added. Technical capacities define the system and solution boundaries.
- In the Interreg Bereg project these criteria were specified and detailed to represent the Bereg strategy and communicate the local needs to water managers responsible for authorized planning of the polder. (Besides national experts were incorporating the national expectations as well – it is presented in a table with bold.)

Table 2. Main clusters of criteria and methods used for Bereg revitalization

Cluster	Criteria	Method of criteria-setting
Environmental	**Water retention capacity of landscape** (**in flood risk**, in normal operation) - S **Landscape-river connectivity, structures -S** Soil conditions and agricultural productivity - S **Ecological value of habitats** (Natura 2000) S-M, revitalisation capacity and water dependence (water stress-index) S-M Duration and depth of water cover –S	Environmental impact assessment Field work, monitoring GIS assessments 1D-2D modelling (ARES) for flood risk, climate change impacts, operation options Landscape development history assessment (from 18th century)
Social	**Reduce risk and system vulnerability** (maximise regional, community, individual/private protection) -S Empowered land utilisation tradition, value added (floodplain management knowledge)- S-M-L **Inhibit not sustainable development strategies S** Joined responsibility and ownership, improved regional network and lobby power (S) -M Equity, transparency of system benefits S-M-L	Social discussion, forums Survey on values, expectations, knowledge Elaboration of alternatives of models, data and information gained from assessments Networking
Economic	**Lower implementation cost of constructions M** Lower long term maintenance cost L **Lower stock at risk** (e.g. changing locations of buildings, farms, infrastructures) M Maximised landscape production (re-parcelling, land use change, new products, services) S – M- L Realised environmental service cost (subsidies, payments, support) S-M	CBA of technical measures Land use structure assessment, Land Consolidation and Land Development planning Product cycle assessment of present and alternative LU CBA for services of LU

(with bold the national criteria is presented; L-long term, M-mid term, S- short term).

2.3. Need for quantifications – MCA in the polder development for Bereg landscape

The Interreg project main aim was to define and plan common water infrastructures in both Ukraine and Hungary to support the flood risk reduction and floodplain revitalization by shallow flooding [Sendzimir et al., 2008]. The planning process was build on different landscape simulation modelling as well as other complex assessment researches (e.g. soil development and degradation assessment; level and risk of inland water stagnation; ecological corridor development, historic land use change, terrain model (detailed digital elevation) and habitat development).

Finally three alternatives were developed for potential flood polder (up to 90 million m^3 water retention capacity) with different locations and measures to which decision-making process had to be defined, input information formulated. In October, 2007 the first study provided by the lead partner (FETIKÖVIZIG – Upper Tisza Water Authority) considered mainly the costs and flood risk reduction benefits; and none of the ecological, social concerns reflected in the *Bereg strategy* were incorporated. Since the project had to be finalized by 2008 February very short time left to implement a more complex assessment – building mostly on available data, maps, statistical information gathered in the Interreg project and in the FAO TCP project.

Due to the above described reasons multi criteria assessment (MCA) in combination with CBA was selected to use in the following steps:

1. Potential criteria from Bereg strategy were extracted.
2. Stakeholder assessment implemented to understand the role in the decisions (level of impact, level of decision making power)
3. Criteria were discussed and defined with key stakeholder-groups (farmers in the target area; water, forest, nature managers; mayors in the area, outside the area; regional, national decision makers).
4. First calculations were implemented to gain the indicators supporting the criteria for each alternatives (for simplification process 2 alternatives are selected)
5. Presenting the indicators for each alternatives and ask SH to provide values.
6. Statistical aggregation of values for each alternative, for each groups and special factoring for specific interest groups: most effected ones, highest decision power; highest competence.
7. Presenting the calculation results and to verify it with key SHs in the Bereg landscape.
8. Finalize the MCA, combine it with CBA and report to decision making panel for decision (based on the methodology suggested by Sijtsma).[Sijtsma, 2006]

Utilizing the knowledge gained in the mentioned projects and implementing (*most of the*) following steps the MCA assessment was performed (see Table 3). The process and its link to decision making is detailed in Chapter 4.

Table 3. Selected parameters for MCA assessment

Selected parameters for MCA assessment		
A. Safety	***B Socio - economic aspects***	***C. Environment and nature conservation (resource management)***
1. Village safety	1. Landscape management potential Conditions for (extensive) grazing	1. Soil management (structure, productivity)
2. Other infrastructures (roads, trains, channels)	2. Transparency (decisions, data)	2. Water management (balance, quality)
3. Human life protection	3. Networks (socio-economic)	3. Protection of landscape heritage
4. Safety of production (arable land, orchards)	4. Tourist potential (including secondary potentials)	4. Biodiversity, genetic diversity
5. Risk reduction effects on downstream and upstream	5. Game management	5. Water demand for ecology /habitats
6. Water storage capacity	6. Biomass production	6. Climate change effects – carbon sequestration, adaptation and mitigation

3. QUANTIFICATION OF CRITERIAS

The implementation of the process was not ideal, but as a first complex polder development in the frame of the VTT project has remarkable values and lessons to be shared. Due to lack of time the iteration with SHs were not fully comprehensive, but since experts worked in the area already for longer time (almost 2 years), the team could rely on the knowledge gained in indicator development and in participatory process before [Flachner, Németh, 2005]. The criteria development is performed by the author; debates and definition improvement has been conducted by key groups of different experts, local team members.

In the process of calculations several indicators had to be replaced by expert judgements, since data were not accessible (eg. agricultural subsidies per ha) or would be with huge delay (eg. number of game in the territory) available. In the followings some key quantification procedures are detailed to present the complexity of the decision making process.

3.1 Quantification of flood risk and polder alternatives

Dynamic modelling supported the MCA criteria definition, where expected climate change impacts on the landscape and the water regime were considered as well. A hydrologic - 1D-2D hydrodynamic model has been applied, the so-called ARES model [Koncsos, 2006].

The model was incorporating the specific inputs from the actual soil survey (e.g. soil water retention capacity), land use survey took into account specific nature conservation needs and restrictions as well. The modelling process was performed in 3 iterations – first round the potential locations, storage capacity and its impacts on local, regional flood risk reduction was calculated, several alternatives described.

Water management experts and local key stakeholders reduced these alternatives. The remaining 3 alternatives were further specified (max.- min. water level, total storage capacity, flood risk reduction capacity, max. – min. water flow and speed, water retention time, option for drainage of the territory) and modelled for base line conditions and in light of potential changes in the region: introduction of other polders in Ukraine and in Hungary; climate change impacts; sedimentation of the riverbed. The final iteration was based on specific local demands, replacement of infrastructures, protection of important infrastructures.

The model calculations provided very important indicators for the MCA assessment, such as:

- Size of effected area (potential for sustainable landscape management area) /km2/
- Water supply to soil moisture and to groundwater recharge (in non-flooding case, in flood risk case) m3/m2
- Water purification /N removal potential/m2/
- Support for biomass growth at the secondary floodplain /m3 timber/km2/
- Nutrient supply for the agricultural fields
- Size of build area, infrastructures under threat in flood risk and in shallow flooding case. /m2/km2/
- Water storage capacity /m3/
- Risk reduction in the region /cm/cm flood level/

The calculation of parameters is transparent, for different sub-alternatives (variants) slight differences could be exactly derived. Maps and tables were generated and these information shared in public consultation.

3.2 Quantification of soft indicators

The Berge strategy has identified the landscape (aesthetics) as a very important cultural heritage and resource for future development, especially taking tourism and hunting income opportunities into account. The water management agents (regional authority and planners) had difficulties to incorporate these aspects into the plans, especially these issues were not considered as a selection criteria for polder’s water infrastructures. To tackle the issue landscape architects were involved to visualise locally and at landscape level the potential changes, difference between the alternatives. These alternatives were scored and valuated by local stakeholders and experts related to landscape management such as hunters, nature protection rangers, forest managers, tourist agencies. Different heights of dams of the polder and two different alternatives were assessed from the perspective of landscape to select the option, which has the least effects on the natural look of the Bereg.

The other important factor in the Bereg landscape is the high genetic variants of traditional fruit species and of course high biodiversity at protected sites. Since the habitats for these species are mainly water depended, 3 elevation categories were defined and the landscape classified based on the water- demand of habitats (including agricultural fields): from aquatic to drought resistant. These different plots were mapped, their potential water cover in each alternatives were analyzed, potential impacts assessed in the light of the water level and duration of water cover as well. These maps were turned into ranges of parameters and incorporated into the criteria system.

Water supply for marshes, wetlands, oxbows – contribution to nature protection and CC risk reduction and improvement of tourist potation of the landscape (fishing) has been based on previous surveys, and estimation of expected benefits preformed as expert judgement. Additionally survey on the ecosystem service assessment following the methodology proposed in the Millennium Assessment has started to quantify the services provided by the present system, the proposed system and a more intensified system, in the light of expected climate change as well [ADAM project report, 2008]. These results are not complete yet, but it will have a link to the LU modelling and water balance modelling work performed in the catchments and will be supported with further public debate processes.

4. DECISION MAKING PROCESS IN BEREG INTERREG PROJECT

The alternatives developed for final decision making process are the followings:

a) Polder development on specified territory with embankments height of 2,5 meter minimum, up to 60-90 m3 water storage capacity. In case of no flood risk the areas water steering system is supported by a semi natural channel supporting water charge from the Tisza river to the further areas in the Bereg landscape.
b) Polder development on specified territory with embankments height of 2,5 meter minimum, up to 60-90 m3 water storage capacity with a permanent lake inside the polder for other tourist utilization possibility. . In case of no flood risk the areas water steering system is supported by a semi natural channel supporting water charge from the Tisza river to the further areas in the Bereg landscape.
c) Polder development with dynamic territory, following the natural elevation options, with embankments height of 1,2 meter minimum, up to 60 m3 water storage capacity with specific local dams (circular dams) around key build areas (villages, infrastructures, specific individual farms) including min 1,5 time larger territory, half of the water level (max . 80 cm in high flood case) compared to options a)-b). In this case the channel was not included.

4.1. Key procedural elements of decision making process

The Interreg project had 3 types of SH involved - those who are ***directly exposed*** to the decision (micro regional association of municipalities, representing the local SHs; nature directorate responsible for the 40% management of the territory); those who ***indirectly exposed*** (water authority responsible for water management in the Tisza river, including the flood risk reduction; civic organizations in the region) and those who are ***having responsibility*** to describe the situation, represent the national and EU directives (research institutes and higher policy bodies).

First of all the process of decision making had to be formulated. It had several rounds in the project team and out of the project team as well. Key considerations were:

- Does the micro regional association represents the local land owners, municipalities affected interest?
- Can the nature directorate harmonize the needs for livelihood and nature water demands?
- What level external institutes (such as the RISSAC) can take part in the decision making level?
- Which information level is satisfactory for directly exposed SHs - detailed plans including parcels or general plan which has the option to modify?
- Which extend modifications can be incorporated after making decisions?
- How the alternatives should be presented to SHs directly affected?

These questions were discussed and finally the team got to the following procedural conclusions (with consensus based decision):

- Different focus group meetings with **specific interest groups** to debate the benefits, the future costs and responsibilities of maintenance, the level of involvement in case of flooding, compensation measures to pay for requested land use change or potential loss of crops, income. These meetings were initiated by the civic organization to get a neutral attitude at the meetings, not having influence by higher-powered decision makers.
- **Public involved** covers directly and indirectly effected people in the micro region, including farmers, municipalities fishermen, foresters, hunters via public hearings where all concerns could be shared. The requirements mentioned at the hearing were incorporated into the MCA.
- **Municipalities were part of the pre-decision process,** where councils were discussing the alternatives, evaluating the local impacts, potential losses and

benefits with technical support provided by all planning partners, including research institutes and moderated by civic organization. Preliminary results of MCA presented and improved at the 4 most effected and concerned municipality. After having individual decisions a joint meeting for all municipality leaders were debating the alternatives, decisions were collected (alternatives reduced to a) and c) and finally joined pre-decision is set by the meeting to have alternative c) with main channel to support water steering.

- **Final decision making panel** consists of water authority, financial responsible ministry, agency for catastrophe management, micro region association, regional civic organization and nature directorate, they are responsible for decision making having considerations on all options, public hearings results, research institute assessments and recommendations and CBA, MCA valuation.
- **Final decision is made by the director of water authority ,** based on the discussion in the panel. The explanation of the process from the water authority side was the responsibility to apply for funding and cross harmonization with the Ukraine initiatives. (Embedded approach of decision making).

4.2. Selection of polder – specific issues of decision making

Following the process the local opinion was supporting the soft polder (option c).), while the planners and water managers were in favour of option a) /traditional polder/. The MCA had an important role in the final discussion driving the attention on the additional benefits, and long term concerns, including climate change impacts of water balance and livelihood improvement in general and for those participating in the polder implementation. (the integrated value was slightly higher for the “soft polder” than for the “traditional”, while the Cost were increased by specific measures proposed by the water managers. Several measures were unnecessary but due to lack of time these discussions on final set of required measures and interventions are moved to the part of detailed planning.)

The soft /dynamic, more natural polder has been selected – but the work just starts now. Benefit transfer evaluation in the region and in the Upper Tisza catchments, the operational issues and other responsibilities for development of final plan is still under development, where further work to specify certain values of MCA parameters are turned to be important. The maps presenting the values and the GIS system, which can integrate criteria and allow statistical assessments, are also in development. Involved local people have not been satisfied with the transparency of the decision making process, and - which is more important - the reasoning on the measures proposed for final plans (eg. Higher roads which could be effected by flood level water (probability is 30 year /100 years) instead of allowing the water cover for 1-2 days not blocking the municipality access for larger cars; or protection or even replacement of high voltage pillars when in general baseline conditions with inland water stagnation similar water covers could occur).

The security of continuing the public debate and building local coalition among key SHs is also weak – after having finished the projects in the region it is up to the local SHs to get involved and keep receiving information from the water authority, which is a very difficult process since there is no tradition for open planning in Hungary and especially in less developed regions. Besides the river basin management planning can provide a frame of further actions, share of concerns and evaluate the use and non use values of the landscape functions, processes. This way the institutionalization of the actions can take place, set of relatively good measures can be selected.

5. CONCLUSIONS

The presented example of criteria-system is drawing the attention on the importance of combine the local and national, long term and short term perspectives both in landscape and water management investments as well as in the frame of the RBMP under the WFD. The criteria setting for the Bereg area had supported the development of a long-term infrastructure and land development program, which will define the future of the landscape and its society. It is promising that the society takes the responsibility of being part in the process, discussing the results of engineers, researchers and try to build consensus if resources (both financial and institutional) are secured to continue the process started. The

MCA application with combination of CBA provides new lessons for other floodplains as well, contribute a more sustainable development of the Tisza valley.

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