LANDSCAPE APPROACH TO FLOODED AREAS – AN ISSUE OR A CHALLENGE?

KRAJINSKI PRISTOP K POPLAVLJENIM OBMOČJEM – TEŽAVA ALI IZZIV?

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IZVLEČEK

Poplave kot vse pogostejša težava v Evropi, tudi v Srbiji, zahtevajo poseben pristop k prostorskemu načrtovanju in urejanju porečij. V prispevku želimo s preučevanjem naravnih značilnosti in analizo stanja izpostaviti prepoznaven model za blaženje uničujočih posledic poplav na obravnavanem območju naselja Jaša Tomić (severovzhodna Srbija, Vojvodina) in na območjih, ki se spoprijemajo s podobnimi izzivi narave, ter tako prispevati k prostorskemu izboljšanju ogroženih območij.

Še en cilj prispevka je prostorsko izboljšanje območja na ravni sestave, pri čemer se hkrati izpostavita privlačnost okolja in njegova turistična prepoznavnost. Metodologija temelji na opredelitvi značilnosti območja (krajinsko odčitavanje, izdelava kontrolnih seznamov) in nadomestnih scenarijev. Izmed štirih možnosti se kot najbolj sprejemljiv za raziskovano območje pokaže scenarij z analizo AHP, ki smo ga dopolnjevali na naslednjih stopnjah razvoja ideje.

Na podlagi navedenega lahko ugotovimo, da obravnavano vprašanje zahteva multidisciplinaren pristop ter da ga je treba obravnavati s sociološkega, geografskega, planerskega in krajinskoarhitekturnega vidika. Tako je mogoče poiskati najustreznejšo rešitev za lokalno prebivalstvo in druge uporabnike prostora. Cilj, ki smo ga s predlaganim scenarijem tudi uresničili, je bil ustvariti prostor s trajnostnim značajem, v katerem se pristop »boja proti poplavam« umakne konceptu »živeti s poplavami«.

KLJUČNE BESEDE

poplave, prostorsko urejanje poplavnega območja, trajnostni razvoj, »živeti s poplavami«

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ABSTRACT

Floods, as a more and more present problem in Europe and in Serbia, require special treatment in spatial planning and regulation of river basins. Aimed at spatial improvement of the area and through the analysis of contemporary condition, this paper tends to emphasise a recognisable model for soothing a devastating influence of floods both in the settlement of Jaša Tomić (north-eastern Serbia, Vojvodina) and in the areas that are facing similar natural problems.

Furthermore, the paper is aimed at improving the area on the composition level as well for the purposes of making it more attractive and recognisable on the tourist market. Methodology is based on the characterisation of the area (landscape reading, elaboration of check lists) and identification of alternative scenarios. The most acceptable scenario for the researched area was chosen among the four possible ones using the AHP analysis. The scenario was further developed in the phase of idea development.

Based on the above mentioned, it can be concluded that the problem should have a multidisciplinary approach and that it should be observed from sociological, geographical, organisational as well as landscape architectural aspect so that the most acceptable solution to this problem and the environment could be found both for the local population and for other users of the area. The aim was to create the area of sustainable character whose principle of "Fight against Floods" will be replaced with the concept "Living with Floods". The above mentioned was achieved with the suggested scenario.

KEY WORDS

floods, spatial planning of flooded areas, sustainable development, "Living with Floods"

1 INTRODUCTION

Flood represents one of the greatest dangers for human population, and also significantly influences social and economic development. Several great floods in various parts of Europe and the world, that claimed great damages and losses of human lives in the last decade of the 20th century, made the flood problem once again the priority of public interest. Moreover, considering the fact that due to the great economic development there is a pressure for using the space of river banks, it became clear that the old principle of "Fight against Floods" needed to be replaced with the concept "Living with Floods". This is a new integrated concept of protection against the floods which fits perfectly into the internationally acquired concept of sustainable development and which tends to harmonize demands of "human" (protection of goods and human lives) and "ecological" component (preservation or restoration of natural functions and resources of the flooded area).

The risk level of the areas endangered by the floods is treated in each European country in a different way. In the UK, the residential are to be protected from great floods only when the need for the protection is proved to be economically viable. The Netherlands, however, adopted a law according to which the protection from great floods must be used when the flood is being expected to come back within 1250 years, or sometimes, 10 000 years. The European Union tends to equalize the level of flood protection on the territories of different countries that belong to the same river basin. What is more, the tolerance level of the public towards the flooding risk is different and depends on the social and economic development (Blyth et al., 2001; Casale & Samuels, 1998).

The Law on Emergency Situations of the Republic of Serbia (Službeni glasnik RS 111/09) states that a flood represents a natural hazard that occurs during a limited time period, in a clearly defined geographical area and with accurately predicted consequences. It is stated that natural hazard becomes natural risk when the interaction between people and natural processes results in a significant damage of property, injury or loss of life. Risk reduction is a professional implementation of activities aimed at reducing exposure of the area to hazards and vulnerability of people and their property.

If we talk about floods as a natural risk, depending on the accurately assessed level of hazard and aimed at adequate protection against the flood wave, it is possible to set up numerous technical objects such as: accumulations and retentions, security systems and embankments, levees or protecting walls, lateral canals, and different regulations of the watercourse (Nienhuis & Leuven, 2001). One of the additional forms of protection from floods is raising the protective forest belts along watercourses. Deforestation causes major torrents that carry material from mountains, bury fertile land and beds of major rivers, which cause them to change their course, pour out, flood fields, destroy villages and pollute waters (Kozlowski, 2002). In the system of landscape planning, for the purpose of arranging and greening river beds, the application of ecological engineering (eco-engineering) planning measures demonstrated itself as a good practice.

Besides the fact that in Serbia many embankments were made for flood protection (all of them close to 3500 kilometres long), that the river beds of many watercourses were regulated, and

that there are 39 different accumulations and retentions (Dragićević et al., 2011), the current state of the flood protection in Serbia is still unsatisfactory. The "Fight against Floods" principle has played the main role here, which means that plenty of significant and expensive technical objects were built.

In further dealing with the flood protection in Serbia, it is highly recommended to slowly implement measures that are in accordance with the principle "Living with Floods". The sustainability of the natural resources of a certain floodplain is very significant, not only from the water management point of view, but also from the ecological point of view (the preservation of highly productive forests, fish and animal communities) and other viewpoints (recreation etc.). In the process of landscaping the flooded banks, besides building technical objects and investing in the vegetation improvement, it is as well important to plan the walkways and viewpoints which would provide vistas on the surrounding landscapes, so that the area becomes both aesthetically and visually appealing as well as attractive for recreation, which is important when it comes to its primary function, that is, socialization.

Studying the problems worldwide, an American study for planning the floodplains has shown that the most common solution used for flood control is regulation of the water course, i.e. straightening of the same. Hence, it could be said that, despite the fact that this solution seems to be the simplest, later consequences are negative for the environment and it has been more and more often the case of putting the rivers back into the meander form in order for certain species to be preserved. The example of the river Colorado has shown that in this way numerous wetlands are being lost, and by swelling the sediments, the river banks also disappear. The successful matching of bank engineering and landscape design has been proved to be possible through the example of the park called "The Floating Gardens" in China (Yongning River), where the landscape architects had to design such landscape composition that would be approachable for both local community and tourists at the same time, and to think of an alternative flood control solution along the whole river bank. The project won an ASLA (American Society of Landscape Architects) prize in 2006.

2 MATERIALS AND METHODOLOGY

This paper deals with the flood problems, more precisely, with the approachability to the floodplain, and it leans on the world and European trends. The main object of this study is a village called Jaša Tomić that is located in the northeast part of Serbia (Figure 1), right next to the Romanian border, which has a natural character, composed by the River Tamiš. Throughout its history, the village has been plagued by numerous floods, as the river has made its way through the residential area into the loess terrace, Tamiš loess plateaus and the alluvial plain of the Danube, thus making a great number of meanders and forming a very interesting and visually attractive landscape.

In the last hundred years, the Tamiš River has flooded the village of Jaša Tomić five times. In April 2005, there was a catastrophic flood that destroyed more than 200 homes, and more than 2000 people were evacuated and resettled in surrounding villages. Additional 800 houses and

5000 hectares of agricultural land were under water (Blagojević et al., 2011). A lake with more than 120 million cubic of water which covers the area of more than 40 000 hectares was formed in Romania. Such intense flood indicates that existing flood protective measures in borderline areas of Vojvodina are not sufficient (Internet 4).

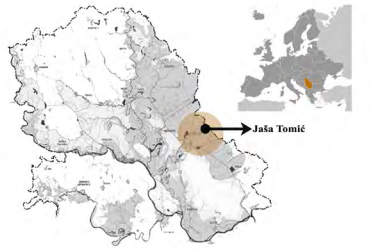

Figure 1: The position of the residential area Jaša Tomić (the northeast part of Serbia, Vojvodina, middle Banat) (Source: Internet 1, processed by Ivana Blagojević, 2012)

These intense floods point out the fact that the flood control needs to be improved. To overcome the nature of flood hazard it is not enough to study it just locally. For the purposes of flood control in the village of Jaša Tomić, the entire watershed area which covers an area partly in Romania as well should be explored. However, the subject of this study does not cover the problem in such a large scale, but we must follow certain international experiences in order to adequately face this type of problem.

Many experts, who have studied the issue of flood hazards (Daanish, 2003; Kandilioti & Makropoulos, 2011; Lamovec & Mikoš, 2011), have pointed out that there is no universal method, but that the methodology needs to be adjusted depending on the goal and the problems the researcher encounters. The research which this paper is based on was conducted between 2010 and 2011 and it consisted of several phases: the phase of characterization, the phase of evaluation, and the developing ideas phase.

The phase of characterization represented a qualitative approach which involved a study of the accessible literature sources and similar case studies. During this phase, we performed landscape reading while applying the mapmaking method and made checklists for the state of the terrain (checklist of aesthetical and visual qualities of the space and checklist of the vegetation analysis). The checklists were based on the methodology recommended by García-Montero et al. (2008), whose examining parameters were adjusted to the goals of the objective research (engineering solution for flood control and creating such landscape design pattern that would be ecologically, socially and economically sustainable) which favours the "live with the floods" principle. Their main goal was to analyze relevant criteria and parameters for the purpose of evaluating the current state of the research area, in order to facilitate the development of the ideas that would ensure good quality solutions for great landscape architectural, ecological and spatial composition of the place.

Looking at the vegetation analysis within the checklist, the criteria were valued for the purposes of examining the quality of the biodiversity composition. Six criteria were singled out: the vegetation category, the levels of vegetation, the vegetation composition, the vegetation mark,

the atmosphere of the place, and the exposure. Considering the complexity of the analysis of the aesthetical and visual quality of the environment, and in order to adequately sort the data, the criteria were examined on the following groups: the group of the landmarks, the group of the aesthetical quality and the group of visual quality. In both of the analysis, the criteria were examined using several different subcriteria. Each criterion could be given a mark: 1 – as bad, 2 – as good, and 3 – as very good.

The mapmaking method was conducted together with the orthophotographs of the research area that were processed by using AutoCAD 2010 software program and Adobe Photoshop CS3.

Referring to the set goals, the phase of evaluation was based on evaluating the data gathered during the phase of characterization. The results were used for making decisions regarding future strategy for the development of the researched area. The data gathered were analyzed by crossing the matrices of the AHP (Analytical Hierarchy Process) analysis, by using the method of eingenvalues (Srđević, Lakićević & Srđević, 2013) and the methodology that proved to be good in cases dealing with similar problems (Kandilioti & Makropoulos, 2011; Lakićević & Srđević, 2011; Saaty, 1980).

AHP analysis enables the preparation of the scenario of the decision making, and then evaluating in couples by using the appropriate matrices. Finally, all the evaluations are being synthesized and the figures of all the hierarchy elements are determined using a strict mathematical model. In the above mentioned research the criteria used are those that proved to be good after seeing the data gathered from the checklists, and the most agreeable scenario was the fourth one, known as an Expert scenario, which was later developed and the idea of it was described in much more detail.

3 RESULTS

Figure 2: The researched spatial units: A. The west part of the branch (the first spatial unit), B. The east part of the branch (the second spatial unit), C. The third spatial unit, D. The earth embankment (Photo: Ivana Blagojević, May, 2011)

Three spatial units have been examined for the purposes of this research (Figure 2), and these units stand for the most endangered places along the River Tamiš. These are: the part of the bank that directly faces the river (extracted as the third spatial unit) and the northern branch (divided into two spatial units – eastern and western) that directly flows into the Tamiš. The watercourse follows the earth embankment that was elevated on the level of 100-year flood after the hazardous flooding that occurred in 2005. The phases of characterization, evaluation, and developing of ideas will be discussed for each of the units.

3.1 The phase of characterisation

3.1.1 Analysis of the present conditions

As part of the analysis of the present state of the condition in the researched area and with the application of the cartographic method, linear (roads of the first and the second category, earth embankment, the River Tamiš and its branches) and nonlinear (urban core, agricultural fields, meadows, orchards and forests) landscape elements were recognised (Figure 3). It was concluded that this is one typical Vojvodina settlement, where main activities are farming and horticulture. Considering the fact that this area is highly endangered by floods, the area covered in forests makes just one small fragment.

Conducted checklist of the landscape vegetation (Table 2), showed the dominance of deciduous species (poplar and willow). The place has monotonous and monochrome appearance. The composition of the vegetation is quite modest and is based on forming vegetative groups. When it comes to the form, organic type dominates with the mixture of woods and meadows. The levels of the vegetation are not very prominent in any of the researched units.

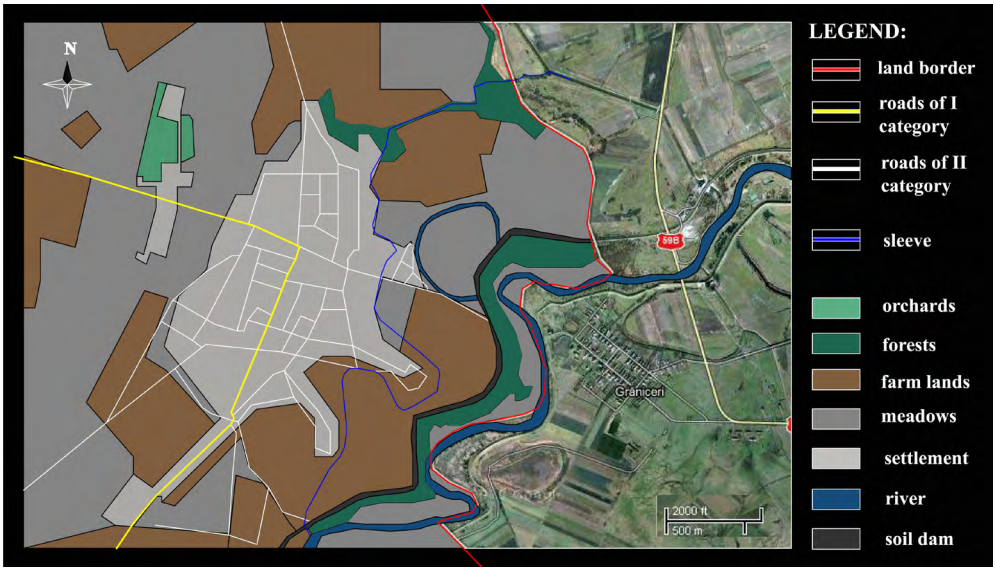

Figure 3: Map of the current state of the condition in the research area (Source: Google Maps, processed by Ivana Blagojević, 2011)

Open spaces dominates the first spatial unit, with bulrushes along the edge of the river bank, which clearly emphasizes the outline of the bank and wetland landscape. Mainly middle-sized vegetation (bushes and shorter woody plants) grow in the second spatial unit, while in the third spatial unit tall vegetation dominates (higher woody plants). The spatial unit of the embankment is covered with grass, which is good according to the measures prescribed for this type of flood protection. There are both physical and visual barriers in the area. They are poorly expressed in the first unit while a somewhat stronger effect is achieved in other spatial units, where the vegetation physically and visually isolates the landscape (the second spatial unit) and where vegetation physically isolates the river (the third spatial unit). On the one hand, these kinds of barriers bring positive influence to the landscape composition (thematic separation of this part of the landscape from the settlement). On the other hand, they serve as a good example for emphasizing the protecting role of vegetation in the floodplain.

Negative contribution creates a feeling of isolation and detachment from the settlement. When it comes to the analysis of the aesthetical and visual quality of the space (Table 1), uniformity and stillness dominate.

Aesthetic quality				**Average mark**
form	vertical	plain/horizontal	wavy	1 2 3
movement (users, wind, river)	without movements	still	dynamic	
coloration	monochrome	harmonious	rich in colours	
space elements	balanced	shapely	chaotic	
composition	closed	opened		
	monotonous	dynamic		
Visual quality				**Average mark**
ambience	pleasant	unpleasant	unsafe	1 2 3
attractiveness	monotonous	interesting	inspiring	
view	close	far	corridor	
maintenance	neglected	partially	well-maintained	

Table 1: Checklist of the average mark of aesthetic and visual quality of the researched area (Source: Ivana Blagojević, 2011)

There are no visible movements; even the river seems to be completely still. The values of the examined parameters are recognized, but they have not been used adequately in the researched space. According to the facts enclosed above, it is obvious that the researched spatial units lack harmonious landscape composition and design. Apart from the existing embankment, no other measures for flood control were taken into account. Eco-engineering measures are unknown in this area.

Category of greenery	**Number**		**(%)**		**Average mark**
conifers	group – dense complex		-		1 2 3
evergreen	-		-		
deciduous	group – dense complex		100		
Greenery height	**~ 10%**	**10-40%**	**41-70%**	**71% - 100%**	**Average mark**
high	-	x	-	-	1 2 3
medium-	x	-	-	-	
low	x	-	-	-	
lawn	-	-	x	-	
Composition of greenery	**~ 10%**	**10-40%**	**41-70%**	**71% - 100%**	**Average mark**
groups	-	-	x	-	1 2 3
lines of trees	x	-	-	-	
individual	x	-	-	-	
Maintenance	**Bad**	**Good**	**Excellent**		**Average mark**
greenery on the bank	-	x	-		1 2 3
greenery in water	x	-	-		
Feeling in space					**Average mark**
colouring	Monochrome		Rich in colours		1 2 3
	x		-		
lightness	Sunny periods		Shadow		
	20% 40% 60% 80% 100%		20% 40% 60% 80% 100%		
form	Geometric		Organic		
	-		x		
Physical and visual barriers	Positive contribution (%)		Negative contribution (%)		
	45		55		

Table 2: Checklist of the average mark of the vegetation of the researched area (Source: Ivana Blagojević, 2011)

3.1.2 Determining the criteria for the phase of evaluation

In order to gain the right information for making the acceptable decision when it comes to arranging a landscape in floodplains, it is necessary to define the criteria which are later to be examined through different scenarios. Kandilioti & Makrpoulos (2011) have developed a technique which deals with the evaluation of the group of the criteria for different scenarios

(alternatives) in the future. Following their methodology and as a result of the phase of characterization, four criteria were singled out. These criteria are tightly connected to the defined aims of the research and will be examined through four scenarios.

Population and tourism movements

First of all, the structure of the landscape development is largely determined by the factors that are actually demographic features. The number of inhabitants that live in Jaša Tomić has been slowly dropping in the last few decades. According to the statistics from 1991, the number of inhabitants in the village was 3544, of Serbian nationality; in 2002, it was 2982, of Serbian, Hungarian and Romani nationality, while in 2011 the number was 2382, mainly of Serbian nationality. The average age is 40-44 (Internet 2). The depopulation trend in Jaša Tomić village is most probably not going to change. Considering the fact that this is a village located at the border, the tourism could be based mainly on the attractiveness of the place, which is one of the options for its economic development. Certain studies have the same view on the subject (Lew & McKercher, 2006; Lew, 1991). They discussed the relationship between the space and tourism movement and claimed that the attraction of the locality that is being visited, is of an outmost importance, since it determines the image of the destination and has a great impact on creating its identity.

When it comes to overpopulation, according to the facts enclosed in this paper, it can be seen that Jaša Tomić village has no problems of this sort, even though floodplains usually have it, but, on the other hand, there is a problem with having no identity for its river bank, which makes the village isolated and not attractive for tourist visit, as well as the visit of local people.

European convention on landscape

Landscape is an important factor of the quality of people's lives, wherever they are: in urban or rural environment, in degraded areas or places of high life standard, in areas that have remarkable features, or in everyday surroundings. The European convention on landscapes, the document which proposes a global idea about landscapes as "European Legacy", was adopted in Florence in 2009. It deals with the protection, planning and managing of all types of European landscapes, whether they are urban, rural, degraded or remarkable ones. The Republic of Serbia signed the European convention on landscapes on 21st September 2007. Thus, it was made easier to work on the preservation and improvement of the landscapes, while the public, institutions, local and regional government were invited to acknowledge their significance and value and to participate in public decision making when certain problems arise (Vasiljević, 2008).

Considering already prescribed regulations on international level that deal with preservation of natural and cultural legacy and its management, as well as regional and space planning, local self-government and cross-border collaboration, especially European convention on cross-border collaboration between territorial communities or authorities (Madrid, 21st May, 1980) and its further protocols, the European Letter on local self-government (Strasbourg, 15th October, 1985), Convention on biodiversity (Rio De Janeiro, 5th June, 1992); the quality and the diversity of

European landscapes make a common wealth and it is important to collaborate successfully in order to rightly preserve, manage and plan them.

Vegetation

The literature on the influence of vegetation on slope bank stability is rich (Blagojević et al., 2011; Liu et al., 2000; Wu, Riestenberg & Flege, 1995; Wu, 2007), covering a broad spectrum of theoretical, expiremental and empirical studies. Vegetation is a rather important element in the management of open space especially due to its biological-ecological values as well as its aesthetic and visual values. It creates an open space by blocking ugly vistas while at the same time it visually unifies other spatial units, modifies microclimate elements, and provides habitat to numerous organisms. Thus, its three functions are to be taken into account: structural, ambient and visual.

Structural function deals with various forms of landscape (geometric, organic, open or closed composition). Ambient function it deals with the quality of air, water (improving their quality by purifying them from harmful substances, thus creating a favourable background environment) and soil (in phytoremediation - "green technology" where the plants are used with an aim for polluting substances removal from humans environment and their transformation into harmless forms), modification of the climate (increased humidity, temperature decreases and purify the air of harmful emissions and waste), and is useful for protection against erosion (its root system binds the soil and preventing it from slipping), floods (with specific vegetation that binds the soil components and absorbs excess water with its root system, harmful effects of flooding can be reduced) and other natural disasters. Finally, visual function can be used as a dominant spot in space and as a visual connection between two landscape elements.

In the rational use and protection of wetlands and watercourses, one of the key measures is the regulation of the water-protecting vegetation. As Dramstad, Olson and Forman (1996) emphasize, wetland vegetation, which has a high level of evapotranspiration, impacts the reduction of the level of ground water due to the power of absorption of underground plant parts. It also affects the slow flow of water to the stream, thus reducing the potential for spring flood, while at the same time more abundant waterways are created. The same authors point out that forest and park plantings at the banks of water bodies, due to their solidifying ability, fully demonstrate their function of protecting the soil (phytoremediation), the bank (erosion) and the water protection (floods), which is very valuable, because it is precisely in these areas where soil erosion processes are very intense.

Eco-engineering of the river bank arrangement

Eco-engineering can be defined as the long-term strategy to protect or restore a site, with regards to natural or man-made hazards. Its techniques involve the use of vegetation to stabilize a slope or arrest erosion. Ecological engineering covers the engineering processes of the river revitalization, habitat restoration, ecoremediation, etc. This technique is applied in combinations of living (plant) and inanimate (construction) materials, or any of them. When choosing an "inanimate" material, care must be taken of the material, which must not be toxic to plants and should form

a solid framework with interstices, filled with root systems or designed for the plant (Stokes, Mickovski &Thomas, 2004).

The work on the strengthening of coasts of rivers depends on the size of the slope and soil texture (Stokes et al., 2010). Technical procedures used to perform intensive solid fixations could be twofold. For larger and deeper water, concrete and stone dampers are built, while in mild and low coasts, the way of strengthening is simpler. Some of the ways of implementing eco-engineering measures (Figure 4) in regulating river banks are: topsoiling and grass turfing, setting the willow twigs, wattles and fascines - thick bundles of willow twigs (Gray & Sotir, 1996).

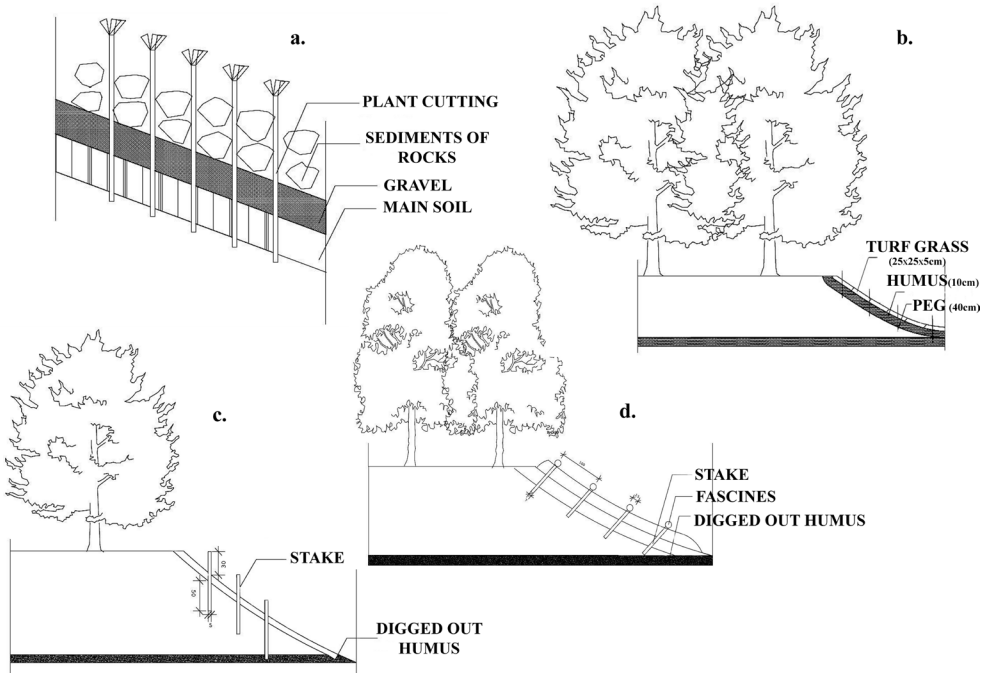

Figure 4: Technical solution of eco-engineering measures: a. setting the willow twigs, b. topsoiling and grass turfing; c. wattles; d. fascines (Source: Ivana Blagojević, 2011)

Besides the above-mentioned principle of eco-engineering, slopes and inclinations of river banks may be secured by planting bushes and woody plant species adaptive to natural environmental conditions. Willows are one of the most prominent species when it comes to vegetative reproduction, and for this purpose they are widely used in eco-engineering.

3.2 The phase of evaluation

According to all of the analyses carried out, four potential scenarios have been created for the further development of the area. The aim was to create a model for the river banks arrangement, which would satisfy all the criteria of the sustainable development, from the point of view of ecology, economy and sociology.

The first scenario, Trend scenario, stands for the the state of how the landscape of the research area would look like if nothing is further done considering development and improvement of the

area. Thus, a mosaic would be made out of different types of natural succession (biodiversity would be changed) – whereby one species would be replaced by another, successfully adapted to the new (changed) environmental conditions. Invasive species of plants would dominate the space.

The second scenario, Ecological scenario, is based on the idea of improving the researched area only in the direction of improving vegetation for the purposes of making the quality wetland habitat, with the vegetation that suffers heavy floods. Rare and exceptional species would be formed, significant and worthy of preserving. People would use less space, since it would be mainly dedicated to scientific research.

The third scenario, Design scenario, has a vision of improving the space on a compositional level, to commercialize it by creating lots of attractive contents that would be affordable for local people and thus bring more significance to the place itself, in the sense of its use, considering the current state of affairs.

The fourth scenario, Expert scenario, stands for connecting Ecological and Design scenario, based both on being eco-friendly, and introducing acceptable contents that are decent enough, but still attractive and challenging for the local people as well as for the potential tourists. Recreation would be the key element in this landscape scenario.

After defining the scenarios, the decision making has taken place, which means estimating the criteria and the alternatives in couples, referring to the superior elements in the hierarchy. The elements were compared (criteria relating to the goal and the alternative relating to the criteria) using Saaty's scale (Saaty, 1980). The standard version of AHP at all levels of hierarchy is used for checking the consistency of the estimation and it also calculates the total consistency of the decision-maker of the whole hierarchy.

Scenario 4	**Population and tourism movements**	**European convention on landscape**	**Vegetation**	**Engineering**	**Weight value (w_i)**
Population and tourism movements	1	3	1/3	1/2	0.29
European convention on landscape	1/3	1	1/2	3	0.32
Vegetation	3	2	1	1/3	0.39
Engineering	2	1/3	3	1	0.41

λ_{max} 4.0225; CI=0.0075; CR= 0.008

Legend: 1- equal importance, 3 - weak importance of one over another, 5 - essential or strong importance, 7 - demonstrated importance, 9 - absolute importance. If activity "i" has one of the above nonzero numbers assigned to it when compared with activity "j" then "j" has the reciprocal value when compared with "i".

Table 3: Matrix comparation, design on the crossing emphasized criteria (source: Ivana Blagojević, 2011)

If the level of consistency (CR) is lower than 0.10, the result is correct enough and there is no need for corrections in comparison and double-checking. If the level of consistency is higher than 0.10, the results need to be reanalyzed and the cause for inconsistency needs to be determined. To calculate the level of consistency, it is necessary to calculate the consistency index (CI) and the maximum eigenvalues of the matrix comparisons (λ_{max}) according to the relation presented by Saaty in his research (Saaty, 1980; Lakićević & Srđević, 2011). AHP analysis was used for the evaluating scenarios and the fourth scenario has been singled out (Table 3) as the scenario with the satisfactory level of consistency (CRi<0.10).

3.3 The developing ideas phase

In the first spatial unit the branch flows slowly and quietly. The left bank of the branch is slightly inclined, so the eco-engineering methods of grassing and topsoiling are recommended. The left bank is suitable for a small path, made both for pedestrians and bicycles, considering that this is a very small residential area, which should be networked with the paths on the second and the third analysed unit. On the right bank it is proposed to retain the existing hydrophilic vegetation with additional thinning (opening views to the river) and additional planting of new species, adaptive to natural environmental conditions in order to avoid the monoculture in the area.

As Stokes, Mickovski &Thomas (2004) point out; the combination of various grasses, bulrushes and trees is highly recommended in order to preserve the small watercourses. Since these have been already found in this spatial unit, it is advised that it should be only nourished adequately, meaning, be prevented from entirely obstructing the river flow.

For watercourses that are mostly composed of deciduous forest (which is the case in the study area), the most optimal planting kind would be black alder (*Alnus glutinosa* L.). However, in order to avoid the drawbacks of monocultures and to increase the biological diversity as well as the ecological effect (the interchange of light and darkness, the airflow of different temperature), it is advised to use, along with black alder, some more species, adaptable to native autochthonous habitats, such as: Narrow-leafed Ash (*Fraxinus angustifolia* Vahl), European White Elm (*Ulmus effusa* Willd), European Hornbeam (*Carpinus betulus* L.), etc. The root of black alder reaches 1.5 meter deep into the groundwater forming a dense palisade, which protects the lower parts of the slope from the erosion. In the zone of the fluctuating water level, the root system tightens the top parts of the surface, affects the forming of the biotopes and makes the whole landscape look even more beautiful. What is more, Black Locust (*Robinia pseudoacacia* L.) is a species that is considered suitable for slope stabilization. Root growth of black locust was observed at several studies (Wu, Riestenberg & Flege, 1995; Kokar, 2006) and the implication of root growth on stability was reviewed.

The space on the second research unit is much narrowed, which makes some more serious eco-engineering interventions impossible. Considering the vicinity of the residential area, which is situated closely to the left bank, it is necessary to be cautious in terms of its design. The left bank of the branch should be slightly levelled and the system of grass turfing should be used. To break the monotony of the landscape and yet to protect it, it is necessary to plant certain solitary trees which would give the whole landscape composition more sophisticated design. The recommended species is Weeping Willow (*Salix babylonica* L.). It goes well with the wetlands

and it has very attractive habitus. Hard paving is not recommended; maybe putting some coulee pavement in the grass would give the bank a more natural look. Seating is foreseen underneath solitary species, where the resting spots are designated too. The left bank is partially arranged, so there is no need for additional planting. The recommended eco-engineering methods are grassing or topsoiling.

The third spatial unit provides the most creative freedom for landscape design. Namely, this unit is vast and spacious and the vegetation is quite diverse with interesting sights and wonderful prominent loess terraces. Considering the fact that this bank is exposed to strong waves and rapid changes of water levels, this area needs afforestation which would ensure the stability of the soil and faster absorption of the water during the considerable rising of water level or the flood. The terrain of landscape should be levelled in order to make an adequate landscape composition. Especially recommended for planting are species of alluvial hygrophilic forests, white willow and poplar forests and oak forests.

To make the eco-engineering methods applicable, the banks of the river in this spatial unit need to be levelled first. The most suitable measures would be constructing the wattles and fascines. In this way, the banks would be secured and at the same time the vegetation of the area would be enriched. However, because of the attractive loess terraces that are present in this unit, any interference with environment has to be avoided. Therefore, any eco-engineering measures should be avoided except for the afforestation of the area.

As Vertelj Nared and Simoneti (2011) claim, when arranging green spaces, a good database about the existing vegetation is extremely important. Furthermore, this implies the fact that the existing vegetation should be spread at the expense of the indigenous flora, which helps to improve the whole biodiversity of the area. In the residential area Jaša Tomić it is recommended to connect the fragments of the existing vegetation so that the biodiversity is consolidated and brought to another higher level. At the same time, these biological methods will help to improve the control of flooding.

The analysis of the third spatial unit indicated that this area is very isolated from the rest of the residential area. However, the potential of the river proximity should be utilized for both passive and active recreation. A good example, where natural features of the river corridor with minimal landscape designing can drastically improve the quality of the area, is park Qinhuangdao on the River Tanghe in China (Figure 5).

Following this example, land art installation with paths of natural materials that would not damage the environment could be applied within the third research unit. In this way the area would become less monotonous, more vibrant in colours, more dynamic, attractive and most importantly it would become conceptually closer to the urban centre while the residents of Jaša Tomić will gain the opportunity to actively use the area. The shortcuts through the woods should open new view sights to the Romanian bank of the Tamiš River and towards the corridor itself. The visual and aesthetical quality will gain power, while the space will be given content and fine landscape design composition.

Figure 5: Park Qinhuangdao on the bank of the River Tanghe in China (Source: Internet 3).

To minimize the existing dangers and to increase the safety, the periphery of the river bank should be fenced. Fencing can be acheived with simple rustic fence which will not disturb the exisiting atmosphere and will maintain its functionality. Fence can be laid out along the line of planted biological material. The use of shrubbery species is advised since the ground is made more compact due to their dense root development.

The spatial unit of the embankment, apart from the basic adjustments to the space, does not require greater interventions. It may be suggested that the horizontal views towards the village and the river could open up by thinning the vegetation and making walkways (pedestrian and cycling) that would specially and thematically connect the village and the river. It is also recommended that vegetation highly adaptable to the natural features of the researched area (Common Dogwood - *Cornus sanguinea* L., Cypress - *Taxodium distichum* L., English oak - *Quercus robur* L.) should be planted near the walkway trees.

4 DISCUSSION AND CONCLUSION

Flood protection has been important in all historical periods, and its significance has risen together with the development of the civilization, which emphasizes the significance of the above-mentioned problem and the fact that people have been fighting this type of natural disaster ever since. Finding solution to this problem represents the basis of sustainable development in certain areas. In Serbia, the flood protection management is based on "Fight against Floods" principle by investing in numerous building constructions, supports around the river banks, walls and other expensive solutions. These kinds of objects usually aesthetically degrade the landscape, and people are not attracted to such spaces. In rural environments, the most common is an earth embankment. What is more, the river banks are in most cases unreachable, deserted, wild and unattractive.

Jaša Tomić village is especially interesting because of its geographical location and closeness to the border between Serbia and Romania and as such has a transitory character. For this reason, this village has a potential, even though it is slowly dying off, like many other villages in Vojvodina, as young people are constantly leaving the village.

By analyzing the landscape in the phase of characterization, it was concluded that the agricultural areas dominate the village, which tells us a lot about the local community and its primary activities, while the woods, that play the crucial part in flood protection, appear in fragments.

Moreover, the checklist was rather helpful, as it helped with sorting out the criteria, which were later used to discover the potential scenarios that would meet the goals, so that the concept of "Fighting against Floods" is changed with the concept of "Live with Floods". AHP analysis, as one of the most cutting edge methodologies, relating to the decision making, was extremely relevant in the very evaluation phase, and the best scenario was the one that made the synthesis between ecology and design, and which united the biology of the space with its landscape values that actually stand for its attractiveness in sense of tourism and its identity.

This paper provides an example of how the usage of wide methodology could provide an adequate solution for a certain area to adapt the concept of sustainability and abandon the rigid framework of "Fight against Floods" in a simple way, so that it becomes at the same time recognized from sociological, ecological and economical point of view.

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Literature and references:

Blagojević, I., Gačić, A., Čukanović, J., Mladenović, E. (2011). Vegetation as an biological measure for flood control. Contemporary Agriculture 60 (3-4): 367-376, UDC: 582:627.516.

Blyth, K., Baltas, E., Benedini, M., Givone, P. (2001). Riparius: Risk of Inundation - Planning and Response Interactive User System. Athens: National Technical University of Athens, Laboratory of Hydrology and Water Resources.

Casale, R., Samuels, P.G. (1998). Hydrological Risks: Analysis of recent results from EC research and technological development actions. EU: European Commission, Directorate General XII, Science, Research and Development, Environment and Climate Programme.

Daanish, M. (2003). Reinforcing vulnerability? Disaster relief, recovery, and response to the 2001 flood in Rawalpindi, Pakistan. Environmental Hazards 5: 71–82, DOI 10.1016/j.hazards.2004.05.001.

Dragićević, S., Filipović, D., Kostadinov, S., Ristić, R., Novković, I., Živković, N., Anđelković, G., Abolmasov, B., Šećerov, V., Đurđić, S. (2011). Natural Hazard Assessment for Land-use Planning in Serbia. International Journal of Environmental Research 5(2): 371-380, ISSN: 1735-6865.

Dramstad, E.W., Olson, D.J., Forman, T.T.R. (1996). Landscape Ecology Principles in Landscape Architecture and Land-Use Planning. Washington: Harvard University, the Graduated School of Design.

García-Montero, L., Otero Pastor, I., Mancebo Quintana, S., Casermeiro, M. (2008). An environmental screening tool for assessment of land use plans covering large geographic areas. Environmental science & policy 11(4): 285 – 293, DOI 10.1016/j.envsci.2007.10.002.

Gray, H.D., Sotir, B.R. (1996). Biotechnical and Soil Bioengineering Slope stabilization, a practical guide for erosion control. Canada: John Wiley & Sons, Inc.

Kandilioti, G., Makropoulos, C. (2011). Preliminary flood risk assessment: the case of Athens. Natural Hazards 61(2): 441-468, DOI 10.1007/s11069-011-9930-5.

Kokar, B. (2006). The importance of black locust and its applicative capabilities in landscape space designing. Journal for Agriculture "Annales of Scientific Work" 30 (1): 110-117, UDK: 582:738:712.

Kozlowski, T. (2002). Physiological-ecological impacts of flooding on riparian forest ecosystems. Wetlands 22(3): 550-561, DOI 10.1672/0277-5212(2002)022[0550: PEIOFO] 2.0.CO; 2.

Lakićević, M., Srđević, B. (2011). Application of analytic hierarchy process in landscape management (case study area: Košutnjak park-forest). Bulletin of the Serbian Geographical Society, tome XCI - No1: 51-60, DOI 10.2298/GSDS1101051L.

Lamovec, P., Mikoš, M. (2011). Analiza poplav z uporabo satelitskih posnetkov – primer hudourniške poplave v selški dolini leta 2007. Geodetski vestnik 55(3): 483 – 494, UDK: 556.166(497.4 Selška dolina).

Lew, A. (1991). Place Representation in Tourist Guidebooks: An Example from Singapore. Singapore Journal of Tropical Geography 12: 124–137.

Lew, A., McKercher, B. (2006). Modeling tourist movements, A Local Destination Analysis. Annals of Tourism Research 33(2): 403–423.

Liu, J., Qiu, C., Xiao, B., Cheng, Z. (2000). The role of plants in channel-dyke and field irrigation systems for domestic wastewater treatment in an integrated eco-engineering system. Ecological Engineering 16 (2): 235-241, DOI. 10.1016/S0925-8574(00)00061-6.

Nienhuis, H.P., Leuven, W.E.S.R. (2001). River restoration and flood protection: controversy or synergism? Hydrobiology 444(1-3): 85-99, DOI. 10.1023/A: 1017509410951.

Saaty, T.L. (1980). The Analytic Hierarchy Process. New York: McGraw – Hill International, USA.

Srđević, Z., Lakićević, M., Srđević, B. (2013). Approach of Decision Making Based on the Analytic Hierarchy Process for Urban Landscape Management. Environmental Management 51: 777-785, DOI. 10.1007/s00267-012-9990-7.

Stokes, A., Mickovski, S.B., Thomas, B.R. (2004). Eco-engineering for the long-term protection of unstable slopes in Europe: developing management strategies for use in legislation. IX International Society of Landslides conference, 2004, Rio de Janeiro, Brazil. Landslides: Evaluation & Stabilization (Eds. Lacerda, W. Ehrlich, M., Fontoura S.A.B., Sayao A.S.F.), A.A. Balkema Publishers, Vol. 2: 1685 – 1690.

Stokes, A., Sotir, R., Chen, W., Gheste, M. (2010). Soil bio and eco-engineering in China: past experience and future priorities. Ecological Engineering 36(3):247-257, DOI.org/10.1016/j.ecoleng.2009.07.008.

Vasiljević, N. (2008). The role of landscape planning in European landscape convention implementation. Bulletin of the Serbian Geographical Society, tome I, XXXVIII - N° 3: 51-60, UDC: 911.372.7(4).

Vertelj Nared, P., Simoneti, M. (2011). Analiza podatkovnih baz o mestnih zelenih površinah kot izhodišče za razpravo o povezavi med kakovostjo in uporabnostjo. Geodetski vestnik 55(2): 366 – 380, UDK: 004.6:659.2:712.25.

Wu, H.T. (2007). Root reinforcement: analzses and experimets. Eco and Groound Bio-Engineering: The use of Vegetation to Improve Slope Stability. Proceedings of the First International Conference on Eco-Engineering 13-17 September 2004, Netherlands. Netherlands: Springer, pp.21-30. ISBN-13 978-1-4020.5592-8.

Wu, H.T., Riestenberg, M.M., Flege, A. (1995). Root properties for design of slope stabilization. Proceeding of the conference: Vegetation and Slopes: Stabilisation, Protection and Ecology. UK: Institution of civil engineers, pp.52-60, ISBN: 0-7277-2031-7.

Zakon o vanrednim situacijama. Službeni glasnik RS 111/09, Beograd 2009.

Internet sources:

Internet 1: http://www.google.rs/imgres?q=vojvodina&um=1&hl=sr&biw=1280&bih=666&tbm=isch&tbnid=6LNX4sK0GKhkTM:&imgrefurl=http://www.eko.vojvodina.gov.rs/%3Fq%3Dnode/12&docid=1Ak40X33eybrCM&imgurl=, retrieved 14 December 2011.

Internet 2: http://popis2011.stat.rs/, retrieved 30 April 2013.

Internet 3: http://laud8.wordpress.com/tag/qinhuangdao/, retrieved 3 March 2011.

Internet 4: http://www.unicef.org/ceecis/media_1644.html, retrieved 27 October 2013.

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