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COMPARISON AND ESTIMATION OF THE VALUES IN WETLAND AREAS: A STUDY OF RAMSAR SITES OBEDSKA BARA (SERBIA) AND LONJSKO POLJE (CROATIA)

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Abstract: The paper presents a case study comparing values of two internationally significant wetland areas: Obedska Bara in Serbia and Lonjsko Polje in Croatia, using the Wetland Assessment Model (*WAM*). The model is used to highlight differences and similarities between biological, ecological, educational, public awareness and aesthetic values of the two selected study areas. The model requires as an input expert evaluation of the criteria and individual locations in the protected areas using the Analytical Hierarchical Process. The presented method proved to be a feasible framework and a basis for evaluation of wetland values. The obtained results of the analysis showed overall similarities and important differences between these two observed wetlands and the 10 representative sites examined in detail. The analysis successfully identified locations and features of wetlands that require action for maintaining or increasing their overall value and function. The results can be used to identify locations and functions of wetlands that require conservational or other organizational improvements, and thus give valuable guidelines for decision makers. Further analysis using the presented model, with detailed local data and inclusion of other wetland areas, will contribute to the advancement of wetland research in the wider region of Southeastern and Central Europe, which was not sufficiently represented in previous studies.

Keywords: Wetlands, Ramsar Convention, Wetland Assessment Model, Analytical Hierarchical Process, Obedska Bara, Lonjsko Polje

1. INTRODUCTION

1.1. Wetland research and general aspects of Ramsar Convention on wetlands

In recent years, scientific researchers have increasingly recognized the comprehensive importance of wetland areas, which was reflected also in the growing number of publications about this subject. They have analyzed many anthropogenic and natural factors (agriculture, the expansion of settlements, infrastructural projects, drought, algae bloom, etc.) that affect the degradation and devastation of these kinds of areas (Uluocha & Okeke, 2004; Wang et al., 2012; Gebresllassie et al., 2014). Wetlands provide many important ecosystem services, like regulating water regimes and sources of biodiversity, as well as playing a vital role in global climate change adaptation. However, there are also those who disagree. Mitsch & Gosselink (1993) claimed that there was an attitude, which existed in the past among some researchers, which describe wetlands as a waste that could only be "improved" through drainage and destruction. This attitude is utterly unacceptable and inaccurate. Nowadays, (scientific) communities pay special attention in order to research and conserve the wetlands, as part of significant aquatic resources of any country. Wherever it is possible, wetlands should be rehabilitated, restored and use wisely.

The Ramsar convention (founded in 1971 in Ramsar, Iran), notes that "*wise use of wetlands is the*

maintenance of their ecological character, achieved through the implementation of ecosystem approaches, within the context of sustainable development" (Resolution IX.1, Annex A). This global convention influences the protection of wetlands, development and improvement, through local or national actions and international cooperation. This convention also emphasizes the global role of wetland areas in order to explain the numerous values of these areas. The Ramsar Convention Bureau classified inland wetlands in four dominant groups: riverine, lacustrine, palustrine and geothermal, which was a relevant base for many other research and classifications in this term.

Barbier et al., (1997) presented official Ramsar convention definition, which described wetland sites as areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing. Some of the most important values of wetland sites are educational (e.g. tour-guide service), scientific (e.g. knowledge on scientific issues), scenic (e.g. surrounding landscape), ecological (e.g. level of protection) (Španjol et al., 1999; Ward et al., 2002) and functional values for any community and were thus chosen as a basis for comparative analysis.

There are many examples of comparisons between wetland sites in the past (e.g. Zalidis et al., 1997; Stolt et al., 2000) and one of them is the study of Scott & Jones (1995). The authors made a comparison between sites within countries identified in the 1965 *MAR project* (Olney, 1965) and those designated as Ramsar sites in the same countries by July 1993. They demonstrated that there had been significant progress in the wetland inventory of potential internationally important wetlands over a 30-years period. As stated by Scott (1993) in his review of wetland inventories and their role in the assessment of wetland, there are three main types of inventory: comprehensive national wetland inventories, regional or global inventories of specific wetland types and national or international inventories of wetlands of special conservation importance.

Because of their extraordinary potentials, we chose two internationally relevant Ramsar areas: Obedska Bara (Serbia) and Lonjsko Polje (Croatia). The authors utilized the Wetland Assessment Model (*WAM*) to compare the values of the wetland sites in both locations. The criteria used for the assessment were based on some previous studies (Pereira et al., 2007; Polajnar, 2008; Vujičić et al., 2011; Petrović et al., 2013), with certain modifications explained in the text below.

The aim of the study is the comparison of two wetlands based on the analysis of the similarities and differences determined based on the evaluation of their values. The *WAM* should demonstrate similarities and differences between these two study areas at all relevancy levels - from the biological to the aesthetic. Similar comparison of the wetland sites has already been done in the study of Zalidis et al., (1997) and Stolt et al., (2000). The new model (*WAM*) represents a modified tool developed by authors Vujičić et al., (2011) and Petrović et al., (2013). Previous authors used this model to estimate the values of geo-heritage sites, but we deem that, with certain modifications, this approach may be applicable also on the wetlands, based on high flexibility of the model for different types of geographic features, such as geomorphological, geological and hydrological facilities.

Walker (2009) presented a model of law-enforcement and monitoring game theory to identify key variables useful in predicting the success of a protected area. This model can be used as a tool to help predict whether a proposed management policy will likely succeed in a given situation. Iojă et al., (2010) investigated two core topics critical to achieving conservation goals of protected natural areas: conservation value and resources for conservation. Moreover, Iojă et al., (2014) used a multi-criteria analysis to create a tool for integrating land-use conflicts into the strategies for territory planning by selecting ten main criteria for the analysis, divided them into two categories (spatial indicators and urban development indicators). Using the method of comparison, with an expert-opinion system, authors determined the relative importance of each criterion in the form of a criteria weight. According to Simić et al., (2014), some of the universal values of phenomena and sites of water areas, may include the following: scientific, ecological, educational, aesthetic, socio-cultural and value as a resource (primarily in terms of water management and tourism).

1.2. Study areas

To increase the understanding of their impact, this paper will highlight and compare general resource values of two internationally relevant Ramsar areas. These sites are natural, protected areas of Special Nature Reserve Obedska Bara in northern Serbia and Nature Park Lonjsko Polje in central Croatia (Fig. 1). The observed protected areas represent the territories in neighboring countries and more importantly, internationally significant Ramsar sites. Both areas are in the Sava River Basin, have similar hydrological and geomorphological characteristics and are suitable for comparative analysis.

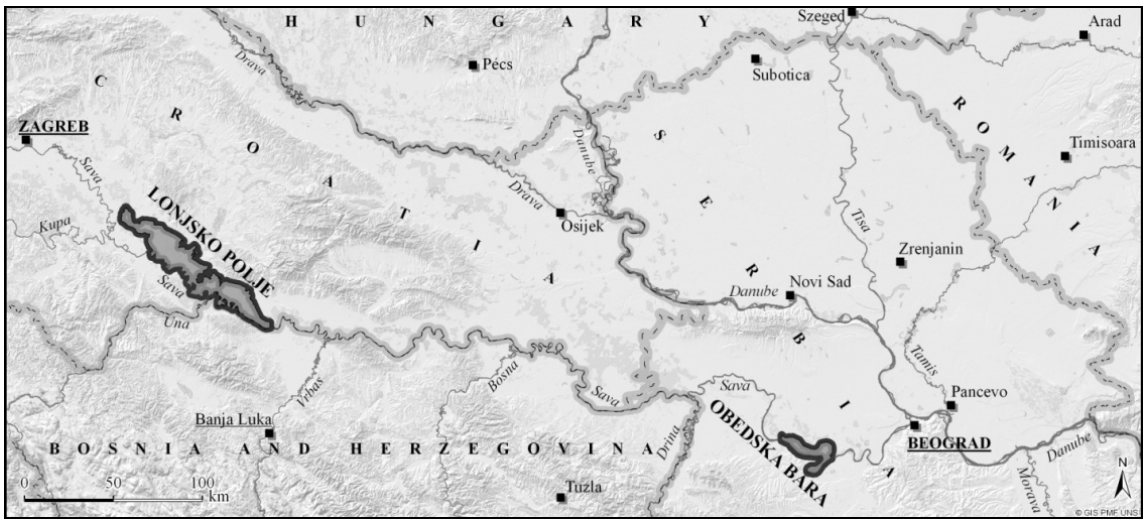


Figure 1. The position of two Ramsar wetland areas presented in the study

The Special Nature Reserve Obedska Bara represents a seasonally inundated area of the Sava river floodplain, with marshes, ponds and wet meadows surrounded by oak, willow and poplar forests (Fig. 2). The biggest swamp (Obedska swamp) is an authentic complex of backwaters, marshes, pits, marsh vegetation, wet meadows and forests (Letić et al., 2008; Krajić, 2011). It is one the most famous nature reserves in the region of Southeast Europe, situated in the southeast part of the Srem District in Vojvodina Province.

Figure 2. The landscape of the Obedska Bara (Obedska swamp in high-water period), (Photo: Dragoslav Pavić)

The area is part of the wider *Emerald ecological network*, with significantly preserved wildlife species and their habitat (Ćurčić & Đurđić, 2013). Moreover, Obedska Bara is defined as the region of Serbia that will be nominated for inclusion on the list of biosphere reserve under the UNESCO Man and Biosphere Program (*MAB Program*) (Markićević, 2002; Dobrojević et al., 2010).

On the other hand, ***the Nature Park Lonjsko Polje (incl. Mokro Polje)*** is one of the finest wetland areas in the whole of the Danube River Basin (Fig. 3). Moreover, the area is among the largest alluvial wetlands in all of Europe. The area is mostly situated in the Sisačko-moslavačka County and smaller, eastern part lies in the Brodsko-posavska County. The greater part of the Nature Park is covered by peat-lands, with many oxbow lakes and marshy, inundated forest complexes.


Figure 3. The scenery of the Nature Park Lonjsko Polje (flooded field near Puska village) (Photo: Authorized photo from the Head of Division for Promotion and Tourism, Management of Nature Park Lonjsko Polje).

The site is involved in the area of the Environmental Assessment (EA). Alluvial wetlands, inundations and all temporarily flooded lands, in the area of the EA, are wetlands according to Ramsar definitions, thus are covered by the Convention. An overview of the both study areas are shown in details in table 1.

Table 1. An overview of the two Ramsar wetland areas presented in the study

	Obedska Bara	**Lonjsko Polje**
Country	Serbia	Croatia
Geographical location	Sava River Basin	Sava River Basin
Geographical position	44°71´23´´ North Latitude 20°10´04´´ East Longitude	45°21´43´´ North Latitude 16°50´02´´ East Longitude
Surface	9,880 ha	50,650 ha
Elevation	72 – 77 m	90 – 110 m
National status of protection	Special Nature Reserve	Nature Park
History of protection	Since 1874	Since 1990
Regimes of protections	Three regimes of protection (I – III)	Five regimes of protection (I – V)
IUCN category	IV	IV
History of Ramsar list status	Since 1977	Since 1993
History of IBA status	Since 1989	Since 1989
History of IPA status	Since 2005	Since 2007
Number of animal species	> 90 species (Budakov et al., 1998)	> 110 species (Schneider-Jacoby, 1994; 1999)
Number of bird species	> 220 species (Budakov et al., 1998)	> 250 species (Mužinić, 1996)
Number of plant species	> 500 species (Budakov et al., 1998)	> 550 species (Nikolić & Topić, 2005; Nikolić, 2013)

2. METHODOLOGY

2.1. Description of the *WAM* model

The wetland comparison using the *WAM* model is performed through the following workflow (Fig. 4):

1. ***Establishing of evaluation criteria and sub-criteria***. The described assessment method was based on research by Pereira et al., (2007), Polajnar, (2008), Vujičić et al., (2011) and Petrović et al., (2013), with the scoring criteria adapted to the specific problem of wetland evaluation. The selection of wetland value indicators was based on their relevance to the objectives of the study and the availability of data.

The indicators are intended to assess five types of values or criteria for wetland comparison: biological, ecological, educational, public awareness and aesthetic. All five indicators consist of three sub-indicators. Each sub-indicator is used for qualitative assessment of individual locations, with a score from 1 to 5 and a corresponding score used in the Analytical Hierarchic Process - AHP (1, 3, 5, 7 and 9) (Saaty & Vargas, 2001; 2013) (Table 2).

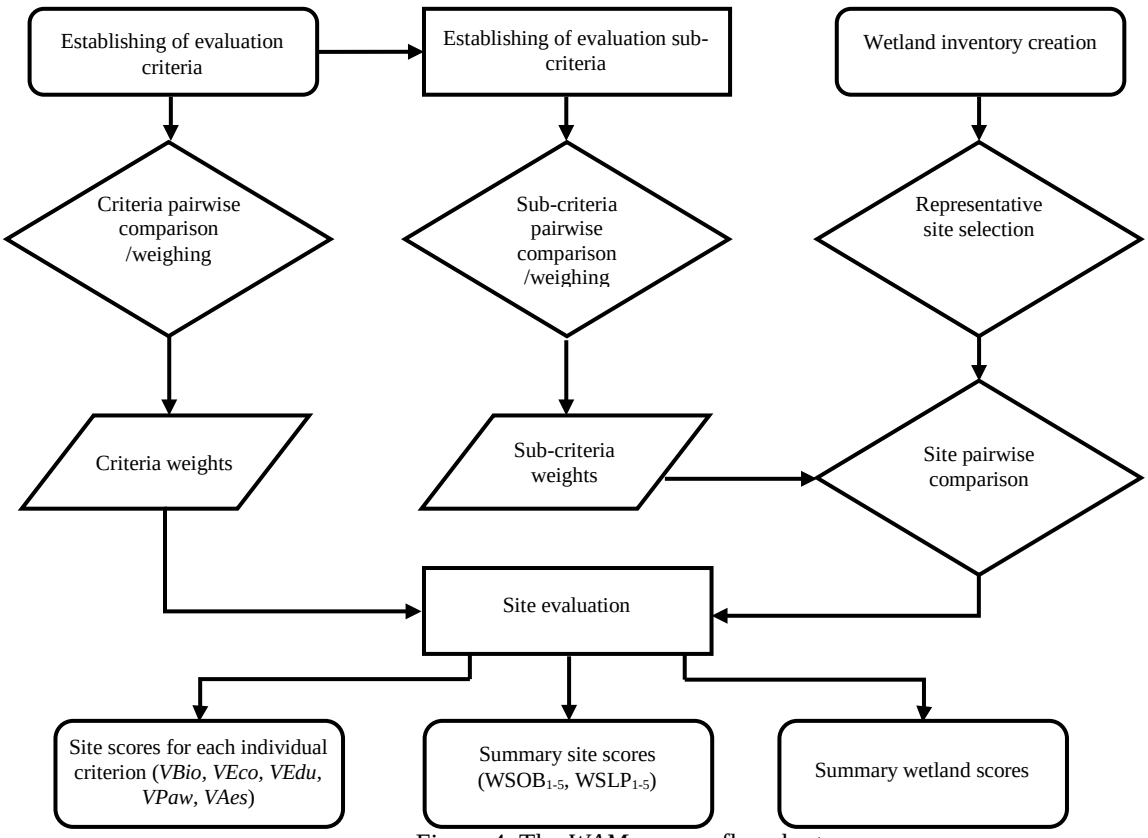


Figure 4. The *WAM* process flowchart

For each indicator and sub-indicator their relative importance or weight was determined using the AHP (Saaty & Vargas, 2001; 2013). The relative importance of the criteria was determined based on the evaluation by experts familiar with both studied wetlands, trough pairwise comparison, presented in the next section of the paper (Fig. 5).

2. The ***wetland assessment procedure*** that includes two main stages: *inventory* and *quantification*. During the inventory, the overall research areas are determined, which is followed by the selection of individual sites for in-depth analysis. Particular wetlands sites are chosen and characterized trough qualitative assessment. The results thereof serve as a basis for the further pre-stages in the inventory phase. During quantification, the importance of sites is determined by attribution of values to predetermined criteria, based on ranking through the AHP. This evaluative process allows comparison of the observed sites.

Based on the specified criteria, a total of 10 most representative hydrological micro locations were selected (oxbow lakes and swamps) - five for each study areas (Obedska Bara and Lonjsko Polje). According to Ramsar classification, all the observed locations belong to the riverine and lacustrine wetlands of perennial, seasonal or intermittent character. More precisely, these locations can be defined as floodplain wetlands and seasonal freshwater lakes.

Table 2. The comprehensive structure of the *WAM* model

Types of Values / Sub-values	**Scores (1-5)**				
	1	**2**	**3**	**4**	**5**
	Corresponding score for the Multi-criteria analysis (AHP)				
	1	**3**	**5**	**7**	**9**
Biological (*VBio*)					
1. Number of animal and plant species (*NumAnimPlant)*	Small	-	Medium	-	Large
2. Biologic representativeness *(BioRep)*	None	Low	Moderate	High	Utmost
3. Knowledge on bio-scientific issues *(BioSci)*	None	Local publications	Regional publications	National publications	International publications
Ecological (*VEco*)					
1. Ecological condition/Integrity *(EcoInt)*	Totally damaged (as a result of human activities)	Highly damaged (as a result of natural processes)	Medium damaged (with essential ecologic features preserved)	Slightly damaged	No damage
2. Level of protection *(ProtLev)*	None	Local	Regional	National	International
3. Vulnerability (*Vulnrb)*	Irreversible (with possibility of total loss)	High (could be easily damaged)	Medium (could be damaged by natural processes or human activities)	Low (could be damaged only by human activities)	Not vulnerable
Educational (*VEdu*)					
1. School/popular literature *(SchPopLit)*	None	Local	Regional	National	International
2. Interpretative panels *(IntPan)*	None	Low quality	Medium quality	High quality	Utmost quality
3. Tour guide service *(TourGuide)*	None	Low	Medium	High	Utmost
Public awareness (*VPaw*)					
1. Media *(Med)*	None	Local	Regional	National	International
2. Informing of local communities *(LocComm)*	-	Low	Medium	High	Utmost
3. Informing by managers of protected area *(InfoMng)*	None	Local	Regional	National	International
Aesthetic (*VAes*)					
1. Surface *(Surf)*	Small	-	Medium	-	Large
2. Surrounding landscape *(SurrLand)*	Very low	Low	Medium	High	Utmost
3. Environmental fitting of sites *(EnvirFit)*	Unfitting	-	Neutral	-	Fitting

Source: according to Polajnar, 2008 and Vujičić et al., 2011

It should be noted that the terms “oxbow lake” and “swamp” are defined in relation to the official names in both countries (Serb. / Cro. *mrtvaja* or *bara*), although they are identical hydrological features.

2.2. The *WAM* model parameters

The *WAM* model parameters were established based on expert assessment of the aspects of wetland areas deemed most relevant for the overall evaluation and comparison of the observed areas. The *WAM* model relies on expert knowledge for evaluation and categorization of individual parameters. In the first stage of the research, the weights of the established criteria were determined through the AHP method (Saaty & Vargas, 2001; 2013) by pairwise comparison (Fig. 5).

The obtained values reflect the relative importance of each individual criterion for the overall goal of wetlands evaluation and comparison (*VBio*, *VEco*, *VEdu*, *VPaw* and *VAes*) (Fig. 6). Accordingly, the most distinctive biological and ecological values obtained a higher priority weight, while the educational, public awareness and aesthetic values were ranked lower. The 15 sub-criteria, within the five criteria, were also evaluated in a pairwise comparison, with the weight score showing their relative importance in relation to the criterion which they contribute.

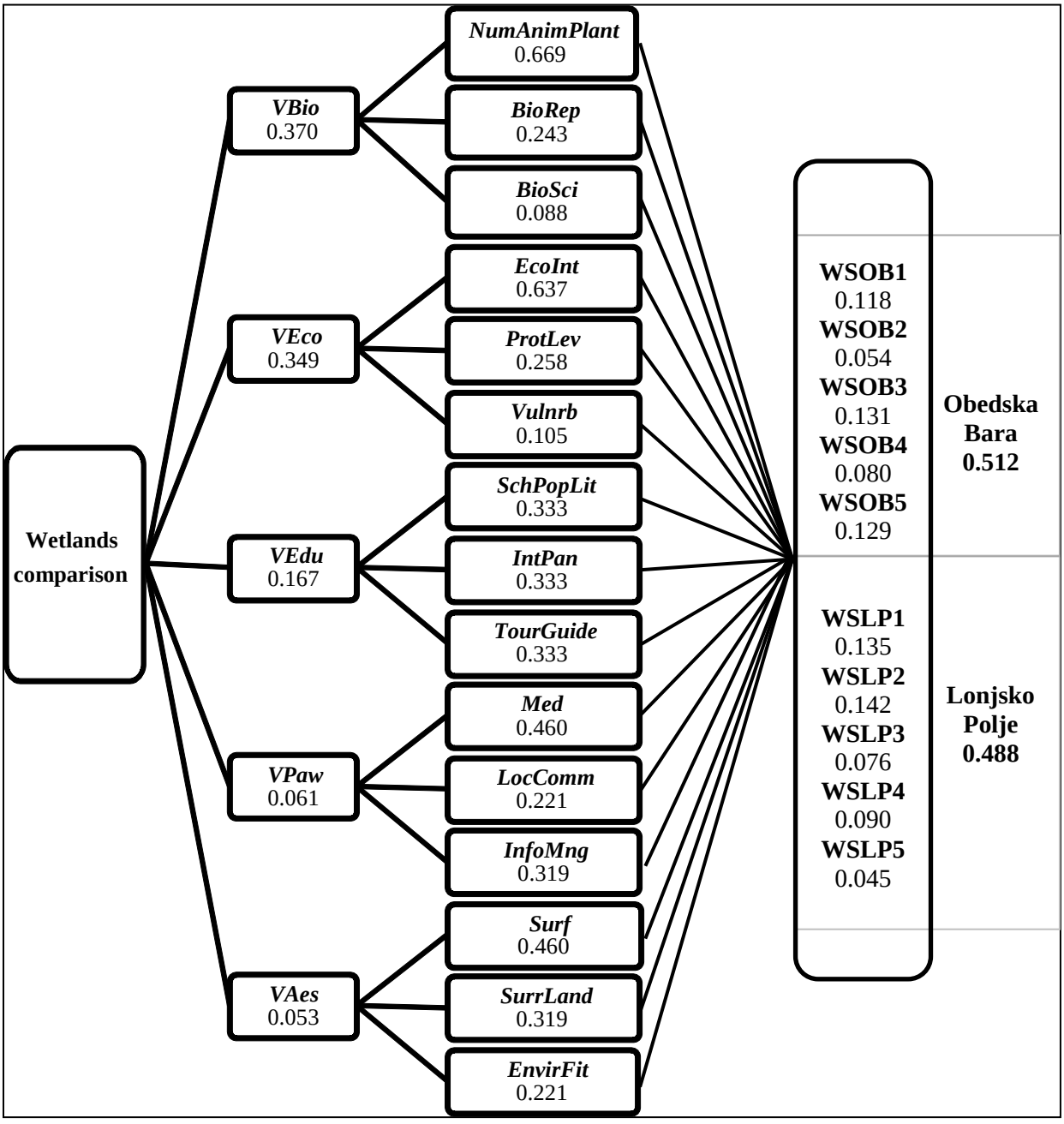


Figure 5. The hierarchy of values and scores obtained by and used in the multi criteria analysis

Finally, each 10 micro locations ($WSOB_{1-5}$ and $WSLP_{1-5}$) were compared in pairs with each other, based on the 15 sub-criteria (Table 2).

The **biological value (*VBio*)** emphasizes the *number of fauna and flora species*, as a significant feature of wetland sites. In this case, it points to a richness of biodiversity of the observed protected areas, which is crucial for the evaluation and comparison. The value of these characteristics is scored from small to large number of present species. The only condition for maximum score (5) was that both observed study areas have more than 300 species of animals (incl. birds) and the same number of plant species. According to Lévêque & Mounolou (2001), the number of 300 species is considered a large number of species in some protected natural area in this part of Europe (Continental/Pannonian biogeographic region).

The sub-value of *representativeness*, describes the exemplary and didactic features of observed sites, which is reflected through the quality of its presentation. The representativeness of sites is used with respect to reference space – commune, country, region (Reynard et al., 2007).

A significant item in the analysis is also the sub-indicator of *knowledge on bio-scientific issues* that is based on the number of publications that are written about the wetland site (Uluocha & Okeke, 2004; Wang et al., 2012; Dobbie & Green, 2013; Gebresllassie et al., 2014) and familiarity of the global (scientific) community on its value. This indicator describes the scope and number of scientific publications about the site on a scale from none, towards the numerous publications of international significance (Vujičić et al., 2011; Petrović et al., 2013).

The **ecological group (*VEco*)** considers ecologic condition, level of protection and vulnerability of the wetland sites. The sub-value of *ecological condition* is ranked from totally damaged to undamaged. The given scores considered the observed state of environment in the selected sites, with special emphasis on landscape changes and any degradation introduced by human activities (e.g. artificial surfaces and objects, infrastructure, drainage and water regulation), as well as deterioration caused by natural processes (e.g. visible signs of erosion, sedimentation, eutrophication, diseases, etc.). This indicator includes also the evaluation of the condition of native and autochthonous species and the level of penetration of invasive and tolerant species. The potential threats to the environmental, such as agricultural activities, land use change and habitat fragmentation, tourism, environmental pollution inside the protected areas, as well as other causes for environmental degradation in the immediate surroundings of the observed sites (industrial and communal facilities, roads, landfills, etc.), were also evaluated and included in the given score. The score was qualified according to Pereira et al., (2007). This sub-value is highly important because it deals with the contemporary problems of annihilation and disappearance of wetlands worldwide.

The *level of protection* is classified according to the status of protection of the observed site. Generally observed, it could be from none to international level of protection. The indicator of *vulnerability* is evaluated according to the overall sensitivity or resilience of the particular site towards damaging anthropogenic and natural processes. The indicator of vulnerability reflects the threshold of particular species and habitats towards environmental load, which was determined by field observations and surveys of the selected sites (Ćosić-Flajsig et al., 2000; Brundić et al., 2001; Stojanović, 2005).

International publications describe numerous well-known cases of vulnerable wetland sites (e.g. inland waters in Nigeria in the study of Uluocha & Okeke, 2004; Yellow river delta in the research of Wang et al., 2012; and Balkhash and Balaton lakes in the paper of Yerzhanova & Huszti, 2013). Among other information, the papers point out that the number of visitors is strictly controlled and limited, because of the level of protection and the level of vulnerability identified at the site (Newsome et al., 2001; 2005).

The **educational value (*VEdu*)** consists of three sub-values: school and popular literature, interpretative panels and tour guide service. The first sub-value, *literature about wetland site*, refers to the number and degree of promotional resources in any educational institutions, and it is estimated based on the overview of occurrences in available and publicly accessible sources of information. It influences the overall awareness and contributes to better understanding and exposure of wetland sites, especially to young people.

The *interpretative panels* have a highly important educational role (Weaver, 2001a; 2001b). This indicator reflects their number, visual quality, available information and representativeness of the evaluated location. The *tour guide service* constitutes a significant part of the educational program within protected area, where the interpretive skills of tour guide are especially important. The indicator was estimated based on: number of visitors per tour guides and the opinion from visitors' questionnaires.

Table 3. List of selected wetland (micro) locations of Special Nature Reserve Obedska Bara - $WSOB_{1-5}$

Label	Wetland site	Short description
$WSOB_1$	Obedska swamp (Potkovica)	Observed site is the most important hydrologic object within the boundaries of reserve (L=13.5 km; W=750 m; D=12 m). Potkovica (Eng. *Horseshoe*) represents a calm meander of left bank of Sava river, more than 2000 years old. The site makes a nucleus and start-point of any activity in the park, because its micro location is better than any other in the reserve. It should be noted that term Obedska Bara has two senses. The narrow one is as hydrological structure (Potkovica swamp) and in a broad sense, it is the name of protected area (Special Nature Reserve).
$WSOB_2$	Revenica swamp	This site is located in the surrounding of Obrež village. It is a part of the longest natural canal network, which connects Sava river (in the period of very high water) and Potkovica, from west side. One part of the canal goes back into Sava, but the other enters directly in Potkovica and give fresh water to it. The canal is seasonal and full of many depressions, so called *okno*, which have water supply the most of time of the year. The biggest *okno* is actually Revenica swamp (Bogdanović, 1982).
$WSOB_3$	Široka swamp	Represents the part of the most heterogeneous wetland area in the reserve – *Širine*. There are many rare species in this part of Obedska Bara, such as White-tailed eagle (*Haliaeetus albicilla*), Black stork (*Ciconia nigra*), Black kite (*Milvus migrans*), European beaver (*Castor fiber*) and European otter (*Lutra lutra*), which presents important part of the reserve (Dobrojević et al., 2010).
$WSOB_4$	Točkova swamp	The western part of the reserve, near Grabovci village, is the area of wealthy biodiversity (500 plant species) and cultural heritage (old village of Grabovci). Točkova swamp is surrounding by enormous peat-land surface, which is the most important fish hatcheries in Obedska Bara.
$WSOB_5$	Dugaja swamp	As a heterogeneous complex of wetland sites, Dugaja is situated in eastern part of the reserve, in surrounding of Obrež village. This swamp is neighbor to *Debela gora* (Eng. *Thick forest*), the largest inundated forest complex in Serbia. According to Puzović & Grubač (1998), this swamp offers significant flora species (Pedunculated oak - *Quercus robur)* and represents ornithological area with more than a 111 bird species of nesting. Thanks to these findings, this site enjoys protection since 1874, and today is a part of I level regime protection (the most rigorous one).

Public awareness (*VPaw*) refers to the relationship between the local community and the protected wetlands, which influence the level of understanding and support by the population towards protective and conservation efforts (Polajnar, 2008). In this respect the *media*, *informing of local communities* through other means (workshops, seminars) and *information by the managing authorities of wetlands* play a crucial role. These sub-indicators were evaluated according to the number and scope of available sources from the media outlets (e.g. documentaries, educational films, press articles, web sites, etc.).

Similar research regarding the importance of public awareness of protected wetland sites was conducted by Dobbie & Green (2013). Two years later, Do et al., (2015) use internet search behavior to assess public awareness of protected wetlands, citing former research of Polajnar (2008). According to all these results, the first sub-value (*the Media*) was ranked from none/little, to an international presence in global media.

The **aesthetic value (*VAes*)**, deals with *surface*, *surrounding area* and *environmental fitting of wetland sites* (according to Vujičić et al., 2011 and Petrović et al., 2013). Pereira et al., (2007), state that aesthetic aspects of sites to be considered are: visual singularity; panoramic quality; objects and color diversity and combination; presence of water and vegetation; absence of human-induced deterioration; and proximity to the observed features. These parameters were assessed based on former research (Vujičić et al., 2011; Petrović et al., 2013).

These items describe the whole surface of the site, where each site is considered in quantitative relation to other sites. In this case, disposition of water and soil, absence of anthropogenic degradation, level of natural contact (the interface of water and land) and appearance of natural shapes are the most relevant.

3. RESULTS

As previously shown, the first stage of the research involves the selection of micro locations for the comparison of wetlands. In the Special Nature Reserve Obedska Bara and the Nature Park Lonjsko Polje, we chose and present five most representative locations of each wetlands (Table 3 and Table 4), as a result of the inventory phase of the research.

Table 4. List of selected wetland (micro) locations of Lonjsko Polje Nature Park - $WSLP_{1-5}$

Label	Wetland site	Short description
$WSLP_1$	Tišina oxbow lake	A calm meander of the Sava river near Čigoč village. This outstanding biodiversity site is very suitable for educational purposes, considering wealthy flora and fauna species. Among them particularly significant are Grass Snake (*Natrix natrix*), Dice Snake (*Natrix tessellata*), Yellow water lilies (*Nuphar luteum*) and White water lilies (*Nymphaea alba*), Pond turtles (*Emys orbicularis*), Fire-bellied toad (*Bombina bombina*), Miniature lentil (*Wolffia arrhiza*), etc. (Schneider-Jacoby, 1999).
$WSLP_2$	Krapje đol oxbow lake	This wetland site is the first special Ornithological Reserve in Croatia, founded in 1963. Krapje đol is traditional breeding site for Eurasian Spoonbill (*Platalea leucorodia*) – 10% of European population (Mužinić, 1996; Dumbović, 2003). This bird species feigns a symbol of Lonjsko Polje and because of that, Krapje đol is currently one of the most visited sites in the park. The swamp is surrounded by meander of Sava river, in surrounding of Drenov Bok village.
$WSLP_3$	Suvoj oxbow lake	As a mosaic of typical floodplain-type natural forms, surrounding area of this oxbow lake includes many hydrological objects, such as little swamps and marshes. This site is covered by peat-lands surrounding by many inundated forest complexes.
$WSLP_4$	Mužilovčica oxbow lake	This wetland area makes a "bridge" between Sava, pastureland and large forest complexes. Area inhabited by large number of bats and nesting birds (songbirds, black storks, ravens, etc.). Flora and fauna of fishes, amphibians, reptiles, beetles, dragonflies and *Lepidurus* and *Triops* genera are particularly wealthy in this part of park. Mužilovčica is connected with Sava and it is possible to regulate its water regime (Mužinić, 1994; Bakota et al., 2003).
$WSLP_5$	Puska oxbow lake	Represents a significant hydrological object and its natural landscape form has large flooded areas and many alluvial biotopes, as well as specific microclimatic conditions.

Table 5. The site scores based on the five main comparison criteria obtained by the application of the *WAM* model and multi criteria analysis

Location / Value	***VBio***	***VEco***	***VEdu***	***VPaw***	***VAes***
$WSOB_1$	0.117	0.093	0.153	0.163	0.133
$WSOB_2$	0.052	0.039	0.058	0.065	**0.134**
$WSOB_3$	0.133	0.179	0.042	0.082	**0.134**
$WSOB_4$	0.102	0.085	0.042	0.022	0.074
$WSOB_5$	0.133	**0.189**	0.025	0.037	0.133
$WSLP_1$	**0.144**	0.077	**0.225**	**0.207**	0.100
$WSLP_2$	**0.144**	0.100	**0.225**	**0.207**	0.068
$WSLP_3$	0.048	0.094	0.090	0.082	0.100
$WSLP_4$	0.102	0.094	0.070	0.082	0.057
$WSLP_5$	0.025	0.050	0.070	0.053	0.067
Ramsar site Obedska Bara ($\sum WSOB_{1..5}$)	**0.537**	**0.585**	0.320	0.369	**0.608**
Ramsar site Lonjsko Polje ($\sum WSLP_{1..5}$)	0.463	0.415	**0.680**	**0.631**	0.392

The same number of wetland (micro) sites representing the identified values, similar accessibility and conditions were chosen from Lonjsko Polje for comparison (Table 3). As we did before, the selected five sites in this case also emphasized biological, ecological, educational, public awareness and aesthetic values.

Through the procedure summarized in figure 4, relative weights were obtained for:

- each site based on the five main comparison criteria (Table 5),
- summary scores for sites ($WSOB_{1-5}$; $WSLP_{1-5}$) based on the five main comparison criteria and - summary overall scores for wetlands (Obedska Bara and Lonjsko Polje) based on the 15 sub-criteria (Fig. 5).

The **summary scores for individual sites** based on the five main comparison criteria, shown in Table 5, demonstrate more variations, allowing comparative assessment of various aspects of wetland values.

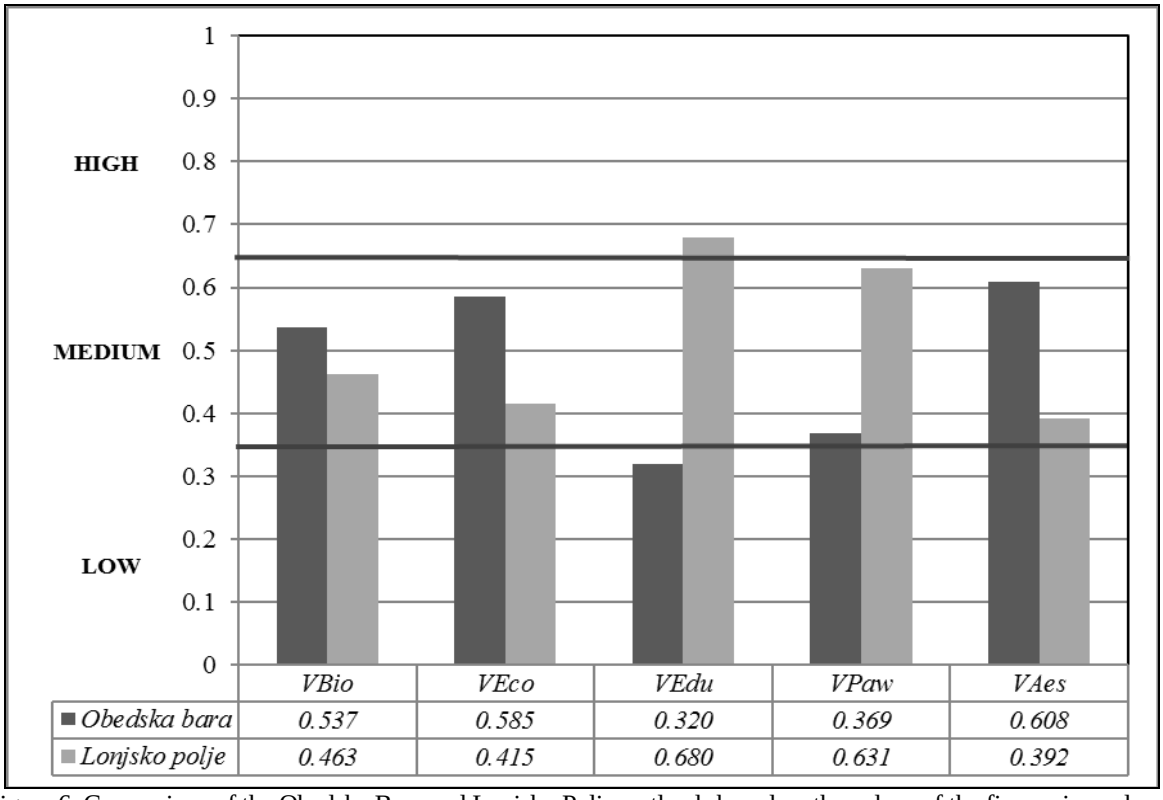
The values shown in table 5 and figure 6 indicate also the **summary ranking of individual micro-locations**, as well as overall **summary score for the two wetlands based on the five main comparison criteria**. This data shows that the observed protected areas have similar values, i.e. their biological, ecological, educational, public awareness and aesthetic values summary are approximately similar for both wetlands. The most

important criteria of Biological (*VBio*) and Ecological (*VEco*) values show relatively small differences between the two wetlands in the overall score, which is consistent with the fact that these are indeed very similar natural areas. The Ecological indicator (*VEco*) shows a somewhat higher value for the Obedska Bara, which reflects the influence of settlements within the protected area on the integrity of environment and levels of vulnerability.

The most notable differences in overall scores can be observed for the three indicators of Educational, Public Awareness and Aesthetic values. The Educational and Public Awareness indicators (*VEdu* and *VPaw*) show a more favourable setting for the Lonjsko Polje Natural Park, where the management of the protected area is more organized trough institutional support. This also illustrates the fact that media in Serbia may not pay enough attention to reporting on protected natural areas, or that the management of Obedska Bara did not make enough of an effort to get close to the public in the way of popularization of nature potentials (Stojanović, 2004; Mrkša, 2008). In the opposite, Lonjsko Polje is partially popular in many scientific TV shows in Croatia, as well as among local people in surrounding villages, and that is the reason why it is rated higher.

The Aesthetic value (VAes) gives a slight advantage to the Special Nature Reserve Obedska Bara as the human activities in Lonjsko Polje partly undermine aesthetic environmental values as well.

One of the reasons are that entire settlements are located within the borders of the protected area (e.g. villages of Jasenovac, Lonja, Kratečko, Čigoć, etc.), which obviously influence the natural landscape of the Nature Park. On the other hand, many inaccessible areas within Ramsar site Obedska Bara that remained 'untouched' and give the impression of complete, anthropologically unaltered landscape, despite the fact that the outer limits of this wetland complex are surrounded by settlements, agricultural land and industrial complexes in the vicinity. It is important to note that management structure of Obedska Bara and Lonjsko Polje should necessarily improve their administration plan and attain a higher level of protection and sustainable development for these protected areas. As these two investigated areas are less than 200 km away from each other (in the Sava River Basin), one of the development options could be collaboration of these complementary locations through an international and mutual offer that could improve and develop conservation and promotion of wetlands in a much wider region. Based on the results, a graphical representation of the assessment was created for a simpler visual interpretation (Fig. 6). The range of values between 0 and 1 is divided in three categories (0-0.33 is low; 0.33-0.66 is medium and above 0.66 is high difference).



	VBio	VEco	VEdu	VPaw	VAes
Obedska bara	0.537	0.585	0.320	0.369	0.608
Lonjsko polje	0.463	0.415	0.680	0.631	0.392

Figure 6. Comparison of the Obedska Bara and Lonjsko Polje wetlands based on the values of the five main analysed indicators

Through these categories the relative similarity/difference can be more easily assessed. In the case of the two described wetlands, the score rankings show similarity, as the majority of scores falls within the same category (medium), with the exception of previously described indicator of Educational value (*VEdu*).

4. DISCUSSION

The obtained results demonstrate the ***advantages and efficiency of the proposed method*** of wetlands evaluation and comparison, showing similarities and highlighting differences between locations and their values. Although the preparation for assessment and comparison requires thorough literature overview and field surveys, the required input data for the procedure is usually accessible and available for researchers. By utilizing the proposed method, a team of researchers can compare the wetland values efficiently. The method allows the integration and structuring of their individual assessment during the scoring process. By the complementary use of multi criteria analysis priority ranks can be established for the evaluation criteria and sub-criteria, as well as for individual sites. The utilization of the Analytical Hierarchy Process - AHP provided a framework for pairwise comparison of indicators, values and sites. The method is suitable for analyzing qualitative, descriptive data in a logical and internally consistent manner. This approach is also suitable for aggregation of different expert opinions in to one final hierarchy of indicators and scores (Saaty & Vargas, 2001; 2013). Through comparative analysis of the summary scores for individual sites, features and locations can be identified that have a markedly differing score and require certain actions for improving values. These actions include following: the changing of protective measures, increasing inclusion of the scientific, local and wider community in planning and implementation of protective measures, increasing institutional support and improving the management of protected area, contributing thus to overall increase in wetland values.

The *WAM* model can help further evaluation of the overall values in the observed protected wetland areas. The use of *WAM* model can be of real help to authorities and scientists in the decision-making and research process, especially in Southeastern and Central European countries, because this methodology can represent a starting point for similar assessments. Moreover, the model can be implemented on a national and regional scale, contributing thus to fundamental wetland research or used as a tool in management action planning and decision support.

Beside the previously shown advantages of the *WAM* model, some limitations of its application should be addressed. The main ***limitation of the method*** lies in the availability of data required for the construction of each criterion. In addition, no principles or guidelines are currently available to select the most representative criteria for comparison of wetland sites. Hence the choice of criteria relies on the availability of data and expertise of the researchers implementing the model.

Improvements should be pursued, via organizing more detailed expert-opinion sessions with specialists from different fields of scientific and industrial research (e.g. ecologists, biologists, managers of protected areas, etc.). Additionally, further research is necessary to analyze whether such assessment can be applied based on other criteria or on other study area(s).

5. CONCLUSION

The *WAM* model is used to highlight differences and similarities between biological, ecological, educational, public awareness and aesthetic values, which is shown on the example of Obedska Bara in Serbia and Lonjsko Polje in Croatia. These Ramsar sites were opted in order to explore the values in these two of the most representative wetland areas in this part of Europe. In addition, in both countries there are a small number of Ramsar sites (in 2014, Serbia had 10 sites and Croatia had five sites), and therefore Obedska Bara and Lonjsko Polje represent some of the most significant and interesting wetland areas.

The research presented in this paper is one of the first studies in Serbia and Croatia that combines biological, ecological, educational, public awareness and aesthetic indicators. Wetlands in Serbia and Croatia (as well as other wetland sites in former countries of Yugoslavia) have long been scientifically neglected and insufficiently researched. These selected study areas, as well as the other in the broader region, have not been studied in this scientific manner. Therefore, there is no specific methodology for assessing the values of wetland sites, so the presented model aims to facilitate further research in this direction (through the provision of guidance on what data should be collected for analysis).

The conclusions regarding the applicative and general significance of the presented results can be summarized in the following points:

- This kind of research has great relevance for

understanding the complexity of wetland areas, especially the internationally important ones.

- The *WAM* model represents a basis for scientific understanding of differences in two wetland areas and importance of adequate comparison of the most important (micro) locations within them.
- The model showed important differences between protected wetland areas, indicating the direction for further actions regarding their conservation and functional improvement.
- The model can be implemented on a national and wider scale, contributing thus to fundamental wetland research or used as a tool in management action planning and decision support.
- The model is useful as the basis for data collection / creation of a database for future (similar) research.
- The presented sets of indicators of the model are useful instruments for assessment and evaluation of wetland features, increasing the public awareness of the population and providing scientific, educational and aesthetic values of the observed area(s).

Our suggestion for future research is to increase the number of (micro) locations in both study areas. Future studies should include other wetlands in Serbia, Croatia and the surrounding countries (e.g. especially other Ramsar sites). In this way, the entire research would have increasing importance and data would be more comprehensive and useful for Sava River Basin and perhaps for the wider region of Southeastern and Central Europe.

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