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APPROACHES TO HABITAT DISTURBANCES IN THE DANUBE DELTA BIOSPHERE RESERVE

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Key words: *habitat, disturbances, indicators, vulnerability, Danube Delta*

INTRODUCTION

Based on the DPSIR (Drivers, Pressures, States, Impacts and Responses) concept, we consider habitat disturbances: on a large scale, climate change effects and, at regional scale, human activities. Presently, climate change effects on environment, economy, health safety and food production represent a widespread perception and issue for our losses (UNFCCC, 2007). On the other hand, human activities as the main driver induce by land use and land cover change, by different ways of pollution, habitat fragmentation, intensive water use and discharge, introduction of alien species and selective species exploitation ongoing disturbances on habitats (Frankhauser, 1995; Gitay, Suárez & Watson, 2002). By the all meanings above mentioned, biodiversity is threatened with decrease and uniformity (Miller, 2005; Wittenberg, 2005). Predictions, either made in relation with human activities or climate change effects, or both, are difficult to build because of parameters selection and interpretation. Nevertheless the general awareness, whatever model is applied, shows results on climate change that can induce significant effects on different environmental and economic sectors of Romania (Cuculeanu, Tuinea & Bălteanu, 2002). The case study for this analysis is the Danube Delta Biosphere Reserve (DDBR), as a wetland area. A great significance is the designation of the Danube Delta as a site of community importance, which comprises 39 types of habitats in the steppe bioregion and 18 types of habitats in the Pontic bioregion within the European ecological network Natura 2000.

The mosaic of habitats developed in DDBR, is the most varied in Romania and hosts a large variety of plants and animals species whose number was presently assessed at 7256 species (Oțel & Marinov, 2009). In order to identify potential disturbances, we choose, according to DPSIR concept, a set of indicators that can be applied in DDBR.

For this reason, regional driver can be considered the land use (either aquatic or terrestrial) that involves human activities in changing of natural environment in artificial areas. As for pressure and impact, we consider habitat loss reflecting on biodiversity composition and habitat quality (invasive vs. indigenous species) as being the main indicator. The connection among drivers, pressures and impacts is habitat state which is specified by the presence of species with conservation status. Therefore, derived from previous investigations, we designed vulnerability maps on flooding in relation with land use and habitat status, in order to identify the most sensitive survey units and effectively use them as key areas for the monitoring of climate changes.

MATERIAL AND METHODS

For the analysis of the land, we have worked on the digitized vegetation map made by Hanganu *et al* in 2002; the interpretation has been carried out with the help of ARCview 9.1 software. The vulnerability maps on flooding for natural and man-made habitats were elaborated at the DDBR cantons level taking into account the DDBR ecosystems maps elaborated by Gâştescu *et al* in 1998. All these maps have the Double Stereographic (1970) projection and coordinate system.

Concerning the habitat loss indicators, we focused on existing field data regarding the plant species and communities, insects (namely grasshoppers, locust and crickets – ord. *Orthoptera*), hydrological features and vegetation coverage. Both plant and insect group species have been monitored on the basis of quantitative and qualitative population indices, after Gomoiu and Skolka (2001), Cristea, Gafta and Pedrotti (2004), Sârbu and Benedek (2004) for three years (2007, 2008 and 2009). The reason for choosing these two groups is the position in the food chain.

Out of DDNI biodiversity database, updated in 2010, we have extracted plant and insect species according to the following criteria: origin, area, spreading at local level (GPS points) and abundance in Danube Delta (scale Braun-Blanquet). By means of the invasive species impact index made by Skolka and Gomoiu (2004), which has been modified for alien plants (Doroftei, 2009), we quantified the spreading potential of susceptible plants. On the basis of all these indicators, we have carried out thematic maps, on the entire territory of Danube Delta, in order to spotlight the vulnerability level of habitats depending on: regional drivers; flooding; habitat status (invasive plant species, biological indicators) and land use/cover.

RESULTS AND DISCUSSIONS

Regional drivers

A driver, in our context, means the factor that influences the habitat evolution, either natural or manmade. Furthermore, the main regional driver in DDBR is considered to be the human intervention in nature through three major land use activities: fish-farms; agricultural polders and forest arrangements. Each one has a different administrator and objectives plan, economically directed, that sometimes are in conflict with DDBR management plan. As a result of DDBR stakeholders' economic interest, correlated with inhabitants needs, the vulnerability to pollution, hazards, biodiversity and habitat loss are increasingly higher. The fish farms comprise 45,232 ha (7.65 %) of water surfaces permanent or short-term, of which 12,500 ha (2.11 %) are abandoned. Economic fish stock regression and developing of exotic fish species less valuable are the main issues (Staraş, 1998). On the other hand, the active agriculture areas (52,945 ha, 8.95 %) (Gâştescu & Ştiucă, 2008) are ineffective, because of drought conditions and adaptation of alien species (e.g. *Amaranthus sp*. and *Xanthium sp*.). The abandoned areas (arable land, pastures, vineyards and orchards) of 16,065 ha (2.72 %) (Gâştescu & Ştiucă, 2008) increase the dryness conditions in Danube Delta during the drought period, 3-4 consecutive months (Octavia Bogdan, 2001). Apart from Letea and Caraorman forests (5,075 ha), the rest of the areas are plantations and controlled or economically directed (17,445 ha) (ICAS, 2004). The hybrid poplar (*Populus x canadensis*), black locust (*Robinia pseudoacacia*) and green ash (*Fraxinus pennsylvanica*) plantations are the most disturbing areas for natural surroundings. The indigo bush (*Amorpha fruticosa*), which also considered an invasive plant species, forms a shrub layer within poplar plantations and from here, its spread in natural habitats.

Before the exploitation of wood poplar the shrub layer need to be removed; consequently, this causes economic losses.

Flooding

Flooding is an environmental stress in many natural and manmade ecosystems worldwide (Bailey-Serres & Voesenek, 2008). Temporary floods differ in seasonal timing and with much variation in durations, depths and frequencies (Vervuren et al. 2003). In DDBR, the most important element is the hydrological system (branches, channels and lakes). Fundamentally, this means water circulation and distribution, that is to say, the core of this wetland. In 1910 - 1911 I. Vidraşcu created the first map of flooding potential by hydro-grades values; currently, this map does not apply because of manmade and natural reshaping. Nowadays, the protection dams ensure security for specific areas, prevent the material losses with important expenses for rehabilitation and prevent human life loss. The liability to flooding of the deltaic space, as a complex hydrologic process, is very important in the evolutionary dynamic of all the natural system's elements. A good way to estimate these hydrological events was to build up a hazard map, taking into account the maximum and minimum to have a picture of the extremes. This hazard maps, combined with the socio-economical component of the studied area, could give some data regarding risks in the area. The risk is a function that takes into account the hazard component and the vulnerability component from a system. The main premises that condition the process of liability to flooding delta are its hypsometric particularities, amplitude and periodicity of the maximum levels of Danube. To these, the reduction of the surfaces liable to flooding is added at present, as a result of embanking certain areas.

In the present analysis of liability to flooding the deltaic territory, the fact that it is complicating a lot should be taken into consideration, as approx. 30% of Danube Delta surface (namely 100 000 ha) is embanked, not being subject of liability to flooding (Gâştescu & Ştiucă, 2008). The value of one hydrograde (1 hg) at a certain point represents 1/10 of the amplitude value of that point during the entire period of observations. In the differentiate estimation of a hydrograde value, the maximum levels have been taken into consideration ratified at present at various hydrometric stations towards "0" surveyor's rod reported to The Black Sea level - r. M.N. (Driga, 2004).

Frequent for DDBR, hydrograde 7 – 7.5 corresponds to the medium of large waters maximum (350 - 375 cm r.M.N. at Tulcea); reaching and exceeding these values mark the beginning of the flooding process in the surface on the entire delta territory. When reaching hydrograde 10, delta surface is flooded in proportion of 93.4 % (309 470 ha), the volume of accumulated water being estimated at 6.2 billions m^3. At this hydrograde, the highest areas on Letea, Caraorman, Stipoc sand dunes remain un-flooded, except Sărăturile and Chilia Plain; it has to be mentioned that in Dranov unit only 0.3 % (namely 961 ha) remained uncovered by waters (Driga, 2004).

In view of the response of the habitats (natural and controlled ones) to the flooding events there were elaborated two maps (fig. 1 and 2) of their vulnerability to this event. In order to have this vulnerability assessment closer to the management point of view, all the vulnerability values of the habitats from a certain canton were included to the concerned canton. These values were calculated as weighted average taking into account the surface of each habitat within each canton. Furthermore, the potential disturbances can be more effective on manmade habitats than on the natural ones. Being a wetland area, most of the fluvial delta habitats are obviously much resistant to flooding stress for a certain period of time, having a larger capacity of water retention. As for fluvial-maritime habitats, the most recent observations showed that bushes such *as Tamarix ramosissima*, *Amorpha fruticosa*, *Elaeagnus angustifolia*, *Lycium barbarum* cannot resist more than three months under water.

Habitat status

The growing number of alien plant species is seen as an indicator of uniform vegetation. At the level of DDBR, there was elaborated for the first time a list of 128 alien plant species, which represents 30% from total 435 alien plant species inventoried at the national level (Anastasiu & Negrean, 2005). From this list, 116 species (65 ligneous species, most of them being cultivated in localities) were identified recently in the field (Doroftei & Covaliov, 2009). Some of the plants included in this list present a higher frequency, being widespread both in natural habitats, and in those controlled by man.

From the list of the alien plants identified in the Danube Delta, the species with the highest impact index (competitive ability index) have been extracted on the basis of ecological features. Species such as *Ailanthus altissima* [1], *Amorpha fruticosa* [2], *Conyza canadensis* [3], *Elodea canadensis* [4], *Fraxinus pennsylvanica* [5], *Gleditsia triacanthos* [6], *Morus alba* [7] and *Robinia pseudoacacia* [8] are considered the most widespread invasive plant species from DDBR. Furthermore, other species (*Acer negundo* [9], *Azolla filiculoides* [10], *Lycium barbarum* [11] and *Vallisneria spiralis* [12]) that until now were not considered a threat are observed in new habitats (table 1). However, the presence of a high number alien species and then expansion of invasive species is a clear indicator of climate change that allowed the emergence of both new species and associations, non-specific to deltaic territory so far.

Table 1 Establishment site potential of invasive species in DDBR habitats according to G.P.S. points

Vegetation type	Alien species [x]	%
Forest/bush vegetation of flood lands		**54,45**
Natural flood plain forest	1, 2, 5, 6, 7, 8, 9	42,66
Planted flood plain forest	2, 5, 6, 7, 8	9,58
Seashore vegetation	2, 7, 8, 11	2,21
Marshy vegetation		**29,34**
Tall reed vegetation on mineral soils	2,10	17,87
Mixed reed vegetation on mineral soils	3	7,47
Open water/Reed vegetation and bushes on floating reed beds	4, 10, 12	2,13
Sedge vegetation	10	1,87
River levee grassland		**7,07**
Grassland on medium high river levee	1, 2, 3, 7	3,87
Grassland on high river levee	1, 2, 3, 6, 7, 8, 9	3,20
Beach/sea dune vegetation		**2,40**
Vegetation on flat marine / alluvial deposits slightly salinised	2, 10	1,33
Coastal low dune (0,5 – 1 m) vegetation	2,5, 9, 11	1,07
Miscellaneous		**6,74**
Agricultural polder	1, 2, 3, 7, 9	6,74

As a result of the fieldwork efforts, the collected data were transposed in a map showing the exposure of each habitat to neophyte species across the entire Danube Delta Biosphere Reserve. (fig. 3). On the map, it can be seen very easily that there are some nucleus of habitats vulnerable to invasive plant species that are related, in direct way with the accessibility in the Danube Delta. The accessibility ways in the delta could be a driver factor for invasive plant species spread. Relating to this and the vulnerability of the habitats, in the future, a map of prediction of the spreading pattern of invasive plant species can be drawn.

This could help the administration of the DDBR to mitigate the perturbations in structure of the biodiversity in order to preserve it.

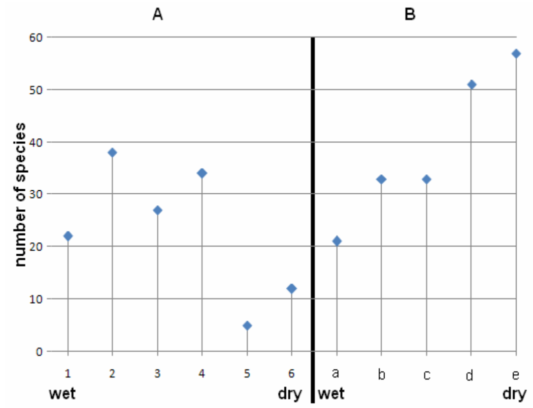
As for the biological indicators, it has been pointed out by various authors that a warming climate will inevitably cause changes in habitats in Europe, particularly in regions with climatic influence from the south and in the extreme north.

Therefore, more changes in distribution of species can be anticipated. No doubt that the current changes in the climate are providing plenty of opportunities for the appearance of new species that are coming from the south. The elements outside of Europe characterize in this way flora and fauna of the Danube Delta territory. The insect species, for example, are very sensitive to temperature and are especially characteristic of warm and sunny regions.

Their numbers and species diversity decline from north. Only a few species occur as far north as the sub-arctic zone or at high altitudes in alpine regions. Therefore, the insect species are particularly good indicators of climate change. Observations carried out on Orthoptera fauna elements indicate climate modifications which entail species presence in new types of habitat where plant communities include neophyte species. The stability of habitats shown by the presence of endemic species such as *Isophya dobrogensis* (Kis, 1994) is put to test by the migration of steppe to west. It draws not only obvious climatic changes, but also a series of species, of which *Saga pedo* is mentioned, the largest Orthoptera species of Europe, which extends its distribution area towards western continent.

Another species worthy to be mentioned is *Metrioptera amplipennis*, species considered endemic to Belgrade area. It has been seen in the Danube valley (near Cernavoda) for the first time (Iorgu, 2006), then recorded as a new species for the fauna of Danube Delta (Lupu, 2011). Older observations should be taken into account, too. In 1976-1978, Kis Bela identified the presence of 21 species of Orthoptera with Mediterranean origin at national level, 15 elements being present in Danube Delta's Orthoptera fauna (Kis, 1993). Presently, in DDBR, being identified 27 species of Orthoptera with Mediterranean origins, continental Dobrogea (the southern proximity of the deltaic territory) being characterized by the presence of 25 species with Mediteranean origins (Lupu, 2009).

Concerning the habitat distribution and ecological preferences of the species, we can say that, in DDBR, most of the Orthoptera fauna are xerophilous and mesoxerophilous elements distributed mostly in mesophilous meadows, xerophilous grasslands and forest fringes (graphic 1).



Graphic 1. Species presence in habitats (A) and species ecological preferences (B)

1-hygrophilous meadows; 2-mesophilous meadows; 3-forest fringes; 4-xerophilous grasslands; 5-saline areas; 6-sand dunes; a-hygrophilous elements; b-hygromesophilous elements; c-mesophilous elements; d–mesoxerphilous elements; e-xerophilous elements

Land use/cover analysis

Land cover as indicator presents further information about different levels of occupation from the survey units' point of view. However, it can suggest a reduced amount of information about the dynamic process that establishes the decline/degradation of the habitats from the area. The coverage represents the projection of the above ground of the vegetation, water surface, bare areas and settlements on the analyzed surface.

From side to side, its values can quantify the degree of human land use (HLU) and natural land coverage (NLC). Therefore, these areas can be core spots that can highlight the changes at the local level. The HLU (17, 07%) and NLC (82, 93%) data, obtained from the layer trans-boundary vegetation map, were extracted for each DDBR district using ARCview software. We characterized the districts by the relative amounts of natural and human-altered land, which included all land uses, but because we were focusing on changes (manmade or natural), the sites were characterized by low to high land use/cover. The land cover from DDBR was classified in 11 survey units.

Each district was separated in human land use and natural land cover as follows: Somova-Parcheş – HLU (23,71%), NLC (76,29%); Şontea-Fortuna – HLU (32,99%), NLC (67,01%); Pardina Polder – HLU (87,18%), NLC (12,82%); Matiţa-Merhei – HLU (0,08%), NLC (99,92%); Gorgova-Uzlina – HLU (24,87%), NLC (75,13%); Razim-Sinoe – HLU (2,91%), NLC (97,09%); Dunăvăţ-Dranov – HLU (0,22%), NLC

(99,78%); Grindul Letea– HLU (4,32%), NLC (95,68%); Grindul Caraorman – HLU (4,17%), NLC (95,83%); Roşu-Puiu – HLU (2,81%), NLC (97,19%); Sea side area– HLU (4,51%), NLC (95,49%).

Table 2. Land use/cover units in DDBR

Survey units		DDBR district									
	Somova-Parcheş	Şontea -Fortuna	Pardina Polder	Matiţa -Merhei	Gorgova - Uzlina	Razim Sinoe	Dunăvăţ - Dranov	Grindul Letea	Grindul Caraorman	Roşu - Puiu	Sea side area
Human land use	%										
Settlements	18,94	1,97	0,56	-	1,02	-	-	4,17	2,97	0,21	-
Fish ponds	-	1,20	1,56	0,01	8,25	2,91	0,22	-	0,24	2,09	-
Agriculture areas	-	20,35	83,52	-	6,84	-	-	0,15	-	0,51	-
Planted flood plain forest	4,77	9,47	1,54	0,07	8,76	-	-	-	0,96		4,51
Natural land cover	%										
Natural flood plain forest	4,42	15,78	2,63	1,02	5,61	-	0,31	-	0,78	0,04	-
Natural dune forest	-	-	-	-	-	-	-	9,32	5,62	-	-
Marshy vegetation	54,79	33,88	5,04	76,42	41,73	2,31	74,05	55,43	51,06	22,47	8,5
Lakes	15,58	13,20	0,93	21	20,28	94,66	21,73	3,15	0,07	73,93	1,39
Sea dunes	-	-	-	-	-	-	0,92	15,51	6,57	0,16	85,6
Steppe/dry areas	-	-	-	-	-	0,12	0,14	11,54	31,57	0,24	-
Grasslands	1,5	4,15	4,22	1,48	7,51	-	2,63	0,73	0,16	0,35	-

As a general image, from HLU point of view, the most vulnerable habitats are Pardina Polder, Şontea-Fortuna and Gorgova-Uzlina. The general vulnerability map shown in Figure 4 reveals amounted information about the vulnerability of the natural and manmade habitats to flooding events, invasive species and biological indicators. The importance of this map is linked to the analyses of the land cover/use that was specified. This map combined with the information related to the land cover/use extracted from DDBR vegetation map will provide complex information focused on the influence of human impact and the level of weakness of the habitats to the natural extreme events. Referring to extreme floods events, even though Somova-Parcheş has a high HLU coverage percentage, this district has a controlled hydrological regime and, therefore, is not vulnerable to floods.

Flooding average vulnerability on manmade habitats (fig. 1) is higher in and around the settlements, in arable lands and plantations in districts such as: Pardina Polder; Roşu-Puiu (east part), Şontea-Fortuna (west part), Gorgova-Uzlina (east and south part) and Grindul Letea (south part). As for average flooding vulnerability in natural habitats (fig. 2) we can say it is lower in the central part of DDBR, and higher in the north at Tatanir and Tătaru area; in the south at Grindul Lupilor and Grindul Istria; in the east at Canalul Sondei area. Vulnerability to drought is considered to be higher in districts with agriculture areas and settlements (if we take in account the households) such as: Pardina Polder, Somova-Parcheş and east parts of Şontea–Fortuna and Gorgova-Uzlina.

Concerning the spreading of invasive plants, we highlight the most exposed areas in and around the settlements, arable lands and plantations. In the same category, we can include also branches and channels, which are frequently dredged.

CONCLUSIONS

The changes of the meteorological characteristics and the influence of this in habitats disturbances are revealed by the migration of insect species from the south to the temperate zone. Referring to biological indicators, the Danube Delta follows the same direction and the heating of the climate bring here some Mediterranean elements from south Europe. Species of Orthoptera are one of the most important indicators that show this phenomenon is real.

For example, looking back, on specialized literature of 70 years, it was described 21 species of Mediterranean Orthoptera at national level from a total number of 170 species.

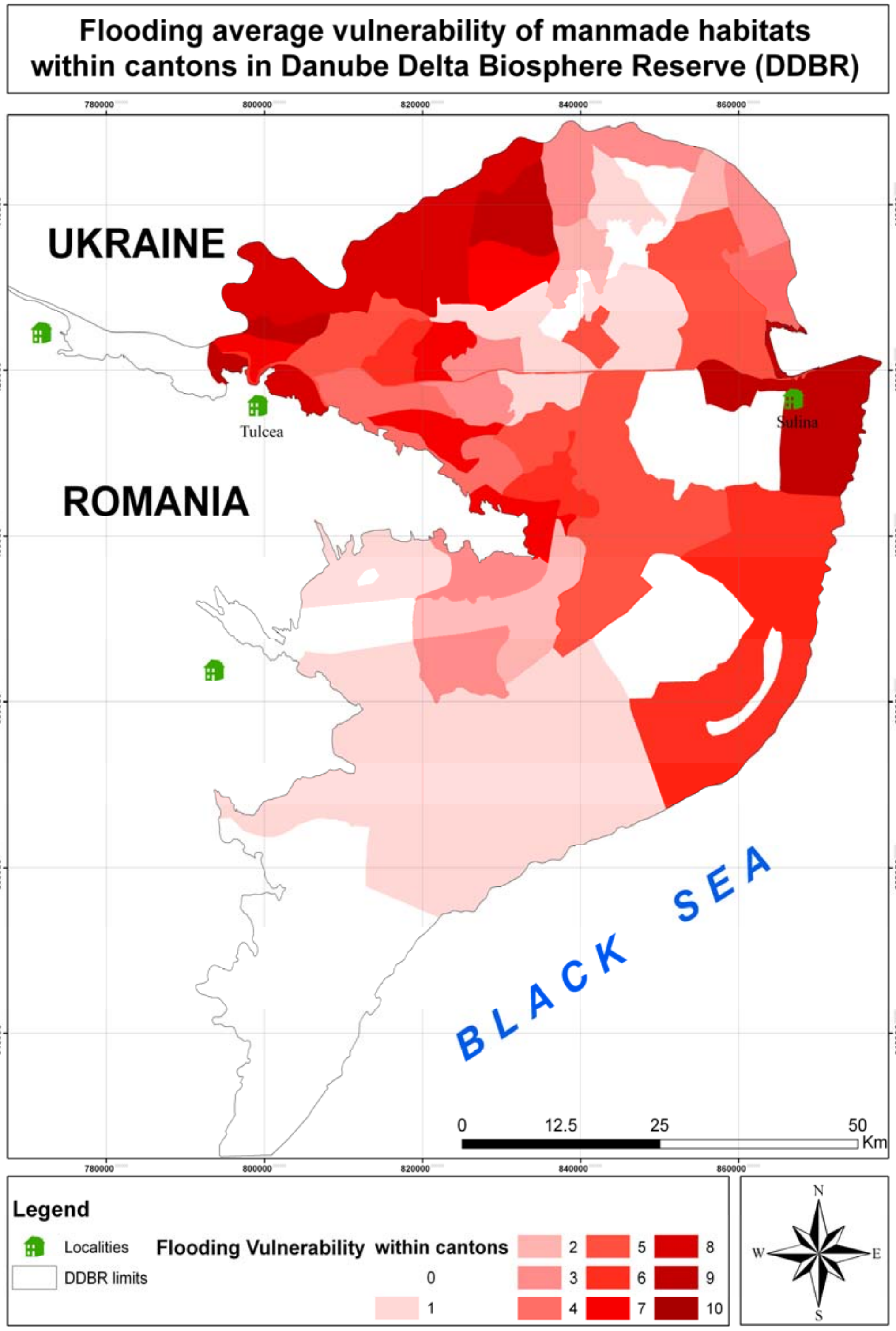


Fig. 1. Flooding average vulnerability of manmade habitats within cantons in DDBR

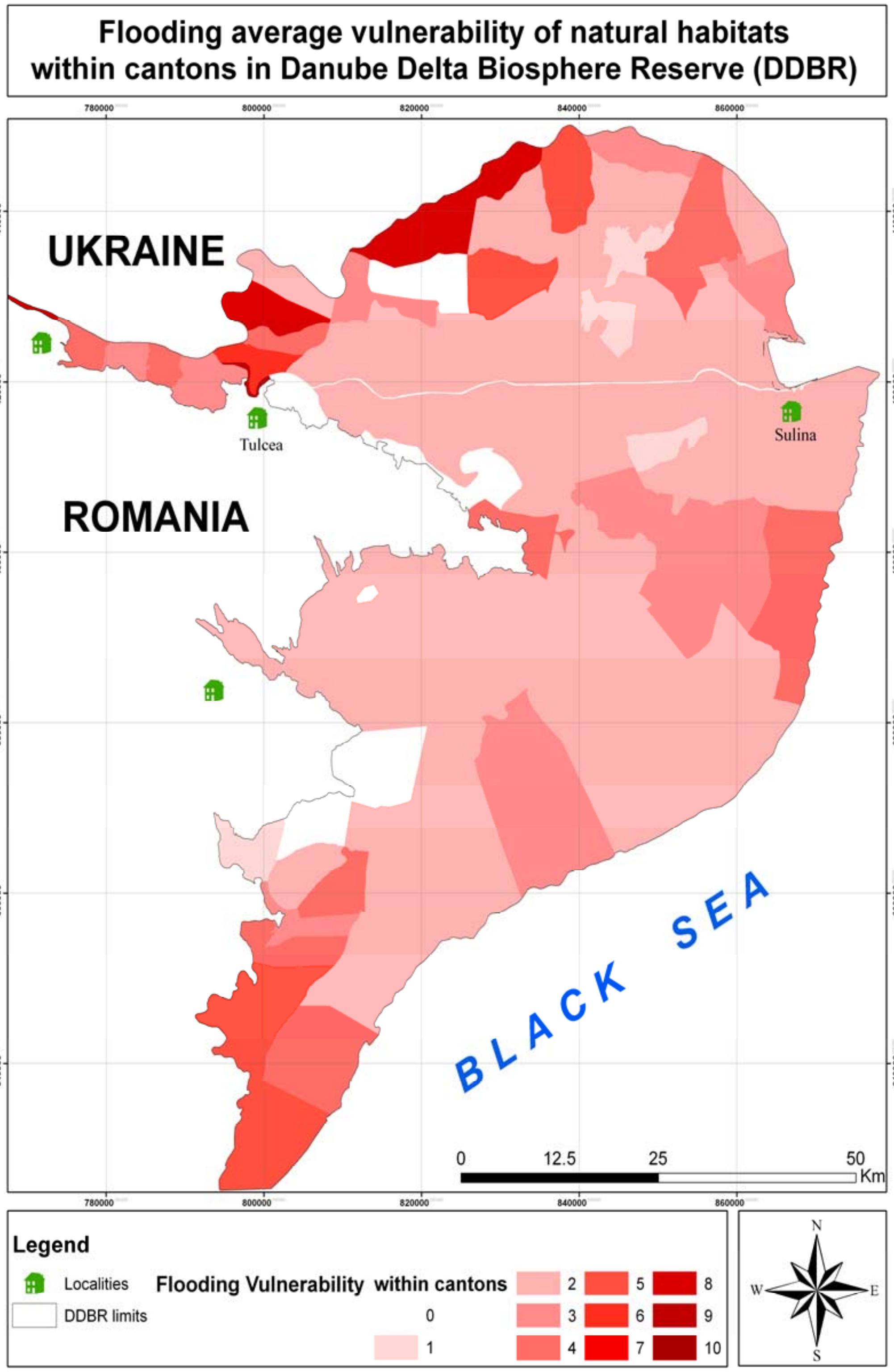


Fig. 2. Flooding average vulnerability of natural habitats within cantons in DDBR

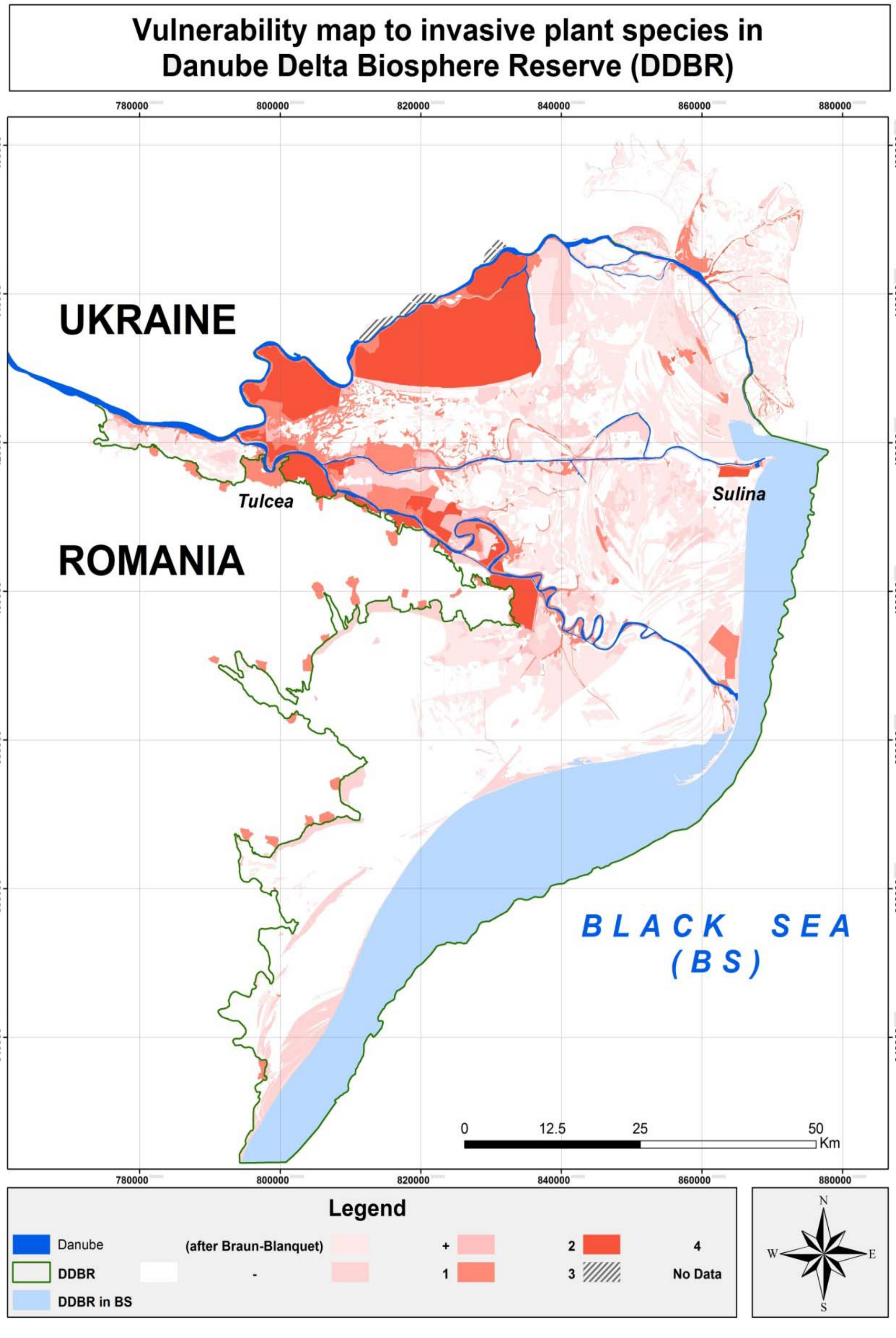


Fig. 3. Vulnerability of natural and manmade habitats to invasive plant species

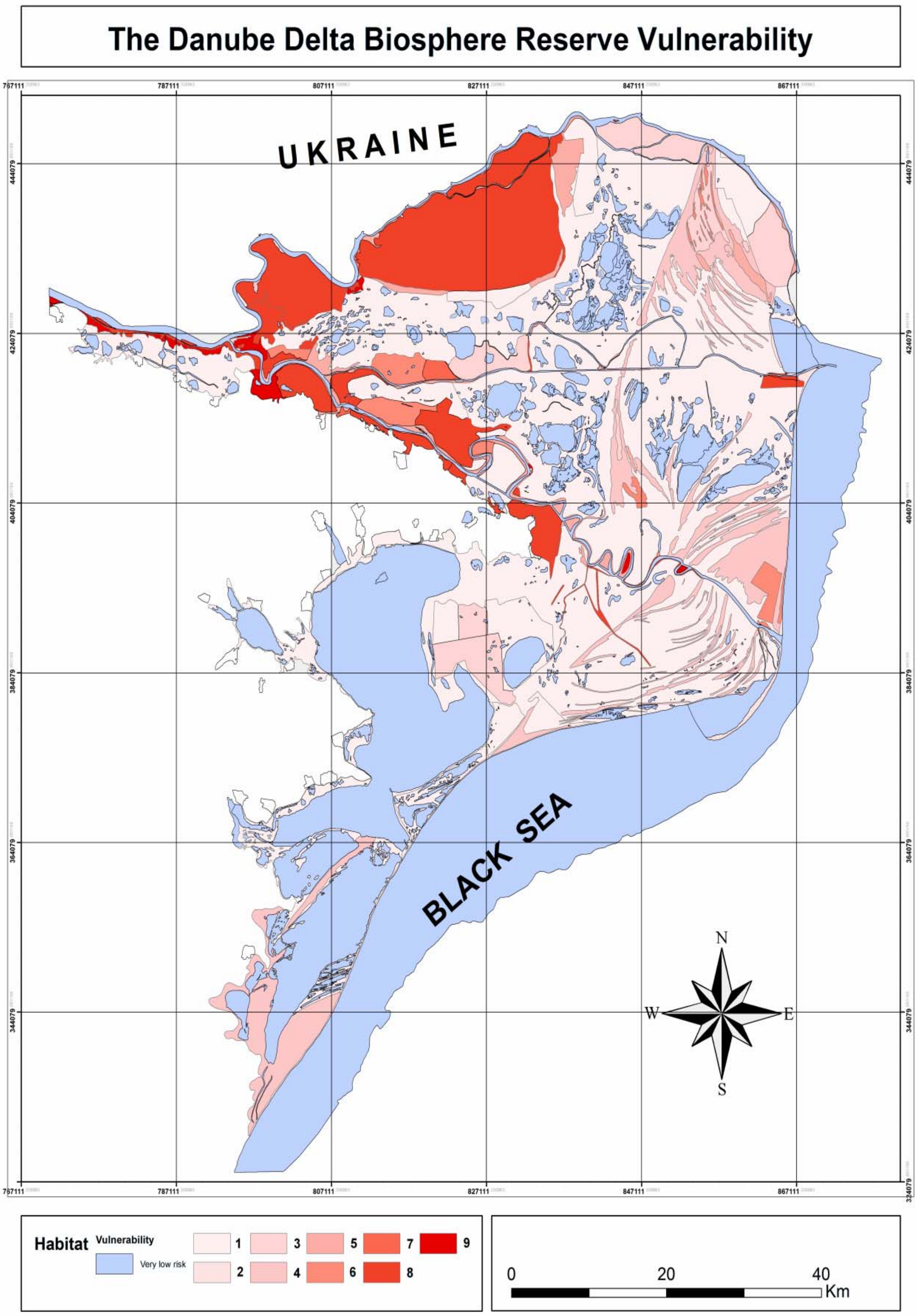


Fig. 4. DDBR vulnerability within habitats

At this moment, in Romania, there were described 187 taxa, and from this, only in the

Danube Delta, there are 27 species of Orthoptera with Mediterranean origin.

Taking into account the land use and flooding point of view, the most HLU sensitive habitats are Pardina Polder, Şontea-Fortuna and Gorgova-Uzlina. As for NLC, the most sensitive habitats are in Tatanir and Tătaru area; in the south, at Grindul Lupilor and Grindul Istria; in the east at Canalul Sondei area.

The assessment of land cover in proportion to invasive plant species reveals that the most sensitive habitats are natural flood plain forests, tall reed vegetation, planted flood plain forests and agricultural polders.

ABSTRACT

The study case for disturbances analysis, with regards to climate change, is the Danube Delta Biosphere Reserve (DDBR), as a wetland area. In order to identify potential disturbances, we choose, according to DPSIR concept, a set of indicators that can be applied in DDBR.

Therefore, the vulnerability maps emphasise the most sensitive habitats from flooding, species invasiveness and biological indicators correlated with land use/cover assessment. The most sensitive habitats are natural flood plain forests, tall reed vegetation, planted flood plain forests and agricultural polders. Thus, they can be effectively used as key areas in order to identify changes in habitats, either manmade or natural.

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REFERENCES

1. ANASTASIU PAULINA, NEGREAN GH., 2005 - Alien plants in Romania (I). IN: Scientific Annals of „Alex. Ioan Cuza" - University of Iaşi, seria II. Vegetal Biology, tom LI
2. BAILEY-SERRES J, VOESENEK L.A., 2008 - Flooding stress: acclimations and genetic diversity. Annu Rev Plant Biol. 59: pp.313-319
3. BURTON J. F., 2003 - The apparent influence of climatic change on recent changes of range by European insects (Lepidoptera, Orthoptera). Proceedings 13th international colloquium European Invertebrate Survey, Leiden, 2-5 September 2001: pp.13-21
4. CRISTEA V., GAFTA D., AND PEDROTTI F., 2004 - Fitosociologie. Editura Universității Babeş-Bolyai Cluj-Napoca. 394 p.
5. CUCULEANU V., TUINEA P., BĂLTEANU D., 2002 - Climate change impacts in Romania: Vulnerability and adaptation options, Kluwer Academic Publishers, The Netherlands, GeoJournal 57: pp. 203–209
6. DOROFTEI M., 2009 - Cercetări ecologice asupra unor specii de plante lemnoase alohtone din Delta Dunării, Teză de doctorat, Universitatea „Ovidius" Constanța, Facultatea de Științe ale Naturii şi Științe Agricole, 230 p.
7. DOROFTEI, M., COVALIOV, S., 2009 - Check list of alien ligneous plants in Danube Delta, Scientific Annals of DDNI, pp.19-24.
8. DRIGA B.V., 2004 - Danube Delta water circulation system, Science Book House, Cluj Napoca, 256 p.
9. FRANKHAUSER S., 1995 - Valuing climate change – The economics of the greenhouse, Earthscan Publications Limited, London, 177 p.
10. GOMOIU M. T., SKOLKA M., 2001 – Ecologie, Metodologii pentru studii ecologice. Ovidius University Press, Constanța, 144 p
11. HANGANU J., DUBYNA D., ZHMUD E., GRIGORAŞ I., MENKE U., DROST H., ŞTEFAN N., SÂRBU I., 2002 - Vegetation of the Biosphere Reserve Danube Delta with Transboundary Vegetation Map, 1:161.000, Danube Delta National Institute Romania, Institute of Botany and Danube Delta Biosphere Reserve Ukraine and RIZA The Netherlands, 88 p
12. IORGU I., 2008 – Diversitatea ortopterelor (Insecta: Orthoptera) din estul României şi semnificația lor ecologică. Teză de Doctorat,Universitatea „Alexandru Ioan Cuza" Iaşi, Facultatea de Biologie, 437 p.

13. KIS B., 1976 - Cheie pentru determinarea ortopterelor din România. Partea I Subord. Ensifera, Muzeul Brukenthal Ştiinţele Naturii Studii şi Comunicări, Sibiu, 20: pp.123-166
14. KIS B., 1978 – Cheie pentru determinarea ortopterelor din România - Partea II Ordinul Caelifera. Studii şi comunicări , vol. 22: 233 – 276, Sibiu
15. KIS B., 1993 - Originea faunei de ortoptere din Rezervaţia Biosferei Delta Dunării. Analele ştiinţifice ale institutului Delta Dunării, Tulcea, pp.63 – 66.
16. LUPU G., 2009 - Mediterranean Elements in Continental Dobrogea orthopterofauna. Ovidius University Annals of Natural Sciences, Biology – Ecology Series, Constanţa
17. LUPU G., 2011 – Metrioptera (Zeuneriana) amplipennis – new orthoptera species (Insecta) for Danube Delta Biosphere Reserve. Romanian Journal of Biology - Zoology, Romanian Academy, Institute of Biology, Bucharest - in press
18. MILLER J.R., 2005 – Biodiversity conservation and extinction experience, Trends in Ecology & Evolution, Elsevier Ltd., Volume 20, Issue 8, August 2005, pp. 430-434
19. OCTAVIA, BOGDAN, 2001 - Climatic individuality of Dobrogea Plateau, Geographical. Review. VII, new series, Bucharest
20. OŢEL V., MARINOV M., (coord.), 2009 - Raport privind starea mediului în RBDD, Raport intern ARBDD http://www.ddbra.ro/rapoarte.php, Tulcea, 321 p.
21. SÎRBU I., BENEDEK A. M., 2004 – Ecologie practică. Editura Universităţii „Lucian Blaga„, Sibiu, 260 p.
22. SKOLKA M., GOMOIU M.T., 2004 – Specii invazive în Marea Neagră, Impactul ecologic al pătrunderii de noi specii în ecosistemele acvatice, Ovidius University Press, Constanţa, 185 p.
23. VERVUREN P.J.A., BLOM C.W.P.M., de KROON H., 2003 - Extreme flooding events on the Rhine and the survival and distribution of riparian plant species. Journal of Ecology 91, pp. 135–146
24. WITTENBERG, R. (ed.), 2005 - An inventory of alien species and their threat to biodiversity and economy in Switzerland. CABI Bioscience Switzerland Centre report to the Swiss Agency for Environment, Forests and Landscape. The environment in practice no. 0629. Federal Office for the Environment, Bern. 155 p.
25. ***United Nations Framework Convention on Climate Change (UNFCCC) 2007 - Climate change: impacts, vulnerabilities and adaptation in developing countries. Climate Change Secretariat, Bonn, Germany, 68 p.
26. *** 2004 – Amenajament Ocolul Silvic Tulcea, Regia naţională a pădurilor ROMSILVA, Institutul de Cercetări şi amenajări silvice, Bucureşti, 170 p.

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