

ASPECTS OF HABITAT FRAGMENTATION – ANALYSING A NATURA 2000 SITE: OLT-DANUBE CONFLUENCE AREA

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Abstract

Our study area - the Natura 2000 site Danube-Olt confluence occupies a surface of 21.285,4 hectares and it is situated within Danube fluvial corridor; the natural protected area is part of continental biogeographic region. The methodology used for this paper was the approaching of potential threats which caused habitat alteration, habitat loss and habitat fragmentation on the basis of analyzing satellite images and orthophotoplans combined with multiple field surveys. The need for approaching this topic is in strict correlation with conservation strategies and future management plans which must include studies and assessment of state conservation for habitats included in the list of Habitat Directive 92/43/EEC.

Keywords: *habitat fragmentation, Natura 2000 network, fluvial corridor of Danube*

MATERIAL AND METHODS

Our study area - the Natura 2000 site Danube-Olt confluence occupies a surface of 21.285,4 hectares and it's situated in fluvial corridor of Danube; the natural protected area is part of continental biogeographic region. Delimitation of our study area was made on the basis of satellite imagery and Google orthophotoplans combined with our field measurements and investigations. Visual assessment along a structured walk is recommended for monitoring habitat and vegetation structure, and the presence of indicators of local distinctiveness. We had applied this method along the main canal to observe the red duck. Aerial photographs can offer a convenient means of rapidly assessing these habitats. The methodology used to assess fragmentation and patch connectivity, combines GIS analysis of a landscape, land-use map with spatial dynamic modeling and field survey on our study area. More than 70% of the protected area is situated in Teleorman county (14 984,2 ha) and 30% in Olt county (6301 ha). It is important because the habitats host over 20 000 birds during the migration period, a strong premise for acquiring a new designation: Ramsar site.

We tried to debate the concept of "habitat fragmentation" studying more than 200 related articles in ISI databases (*Science Direct, Springer Link*, etc) in order to establish and correlate, as possible, mainly, the causes/threats, the patterns of habitat fragmentation, aspects of fragmentation with complex effects upon the species and natural vegetation). It is also very diverse, with different authors measuring fragmentation in different ways and, as a consequence, drawing different conclusions regarding both the magnitude and direction of its effects. Habitat fragmentation is usually defined as a landscape-scale process involving both habitat loss and the breaking apart of habitat. To correctly interpret the influence of habitat fragmentation on biodiversity, the effects of these two components of fragmentation must be assessed independently. Our paper needed to determine the factors (threats) that lead to positive versus negative effects of fragmentation. Our goal in this review is to discuss the information available on the effects of habitat fragmentation on biodiversity. To meet this objective we first need to examine the different ways in which habitat fragmentation is conceptualized and measured. Many studies of the effect of habitat fragmentation on biodiversity conform to this definition by comparing some aspect(s) of biodiversity at "reference" sites within a continuous landscape to the same aspect(s) of biodiversity at sites within a fragmented landscape (*Bowers & Dooley 1999, Cascante et al. 2002, Diaz et al. 2000, Groppe et al. 2001, Laurance et al. 2001, Mac Nally & Brown 2001, Mahan & Yahner 1999, Morato 2001, Mossman & Waser 2001*).

RESULTS AND DISCUSSIONS

Habitat fragmentation is often defined as a process during which "a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original" figure 2 (*Wilcove et al. 1986*)

By this definition, a landscape can be qualitatively categorized as either continuous (containing continuous habitat) or fragmented, where the fragmented landscape represents the endpoint of the process of fragmentation. Although this approach conforms to the definition of fragmentation as a process, it has two inherent weaknesses. First, because habitat fragmentation is a landscape-scale process (*McGarigal & Cushman 2002*), the sample size in such studies, for questions about the effects of habitat fragmentation on biodiversity, is typically only two, one continuous landscape and one fragmented landscape. With such a design, inferences about the effects of fragmentation are weak.

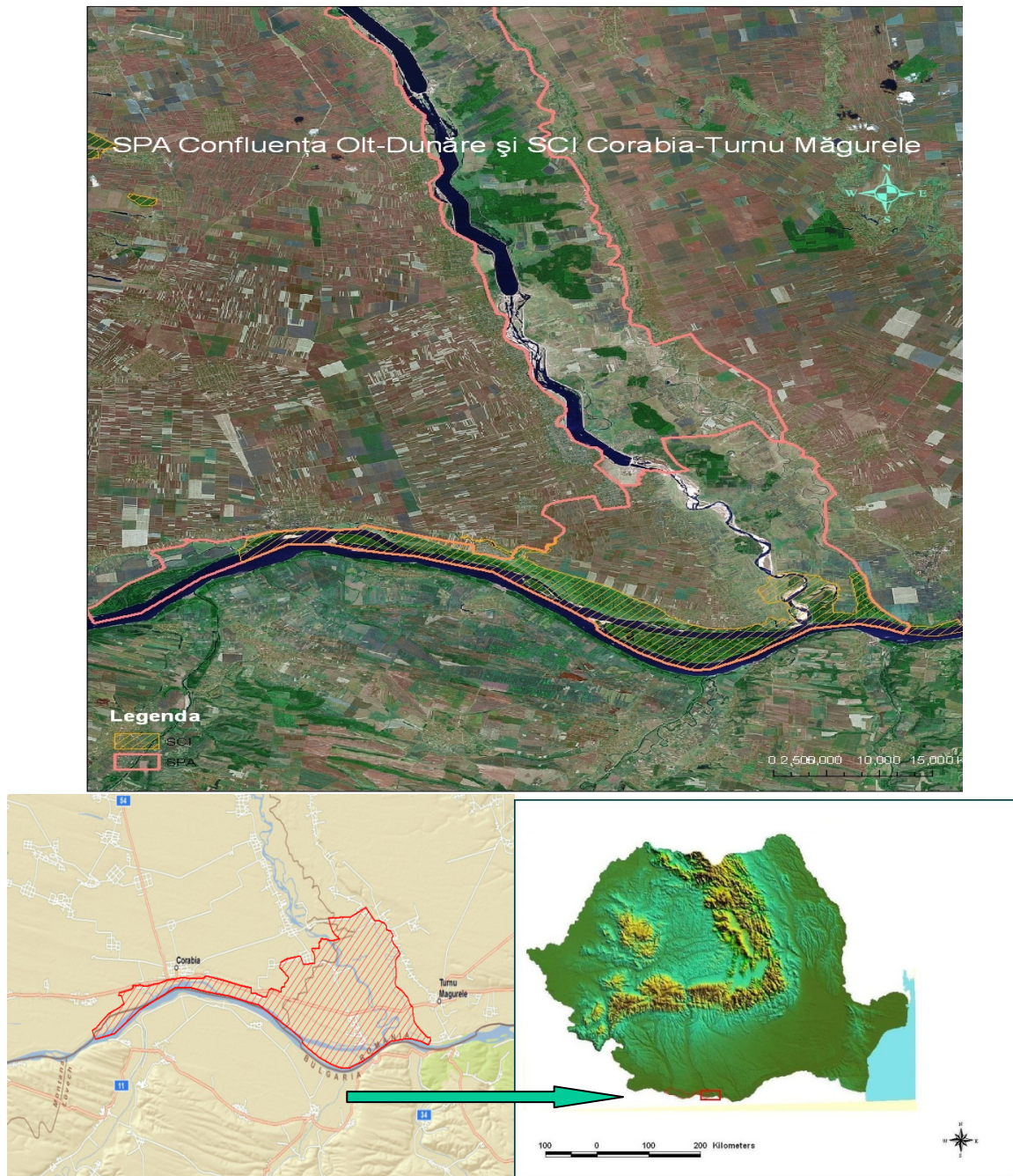


Figure 1. Study area Olt-Danube confluence - (a- ortophotoplan in GIS, b- GIS <http://natura2000.eea.europa.eu> c – localization at national territory scale)

Second, this characterization of habitat fragmentation is strictly qualitative, each landscape can be in only one of two states, continuous or fragmented. This design does not permit one to study the relationship between the degree of habitat fragmentation and the magnitude of the biodiversity response.

Quantifying the degree of fragmentation requires measuring the pattern of habitat on the landscape. The diversity of approaches in the fragmentation literature arises mainly from differences among researchers

in how they quantify habitat fragmentation. These differences have significant implications for conclusions about the effects of fragmentation on biodiversity.

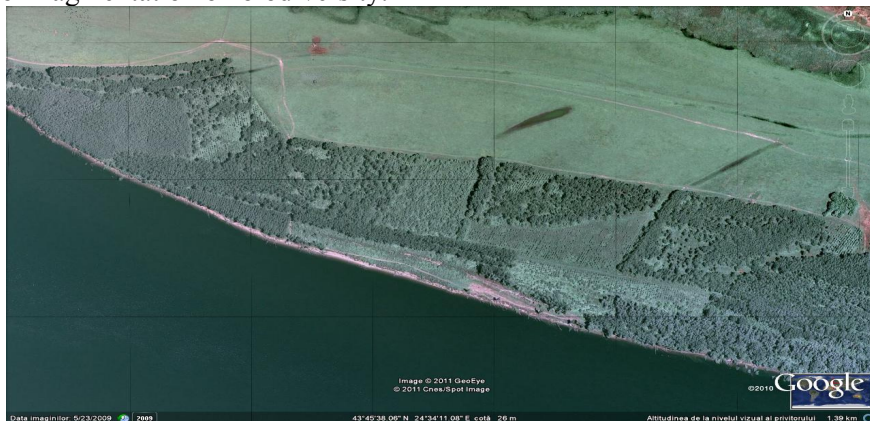


Figure 2. Habitat patches in riverine forest Garcov forest

Fragmentation as pattern: quantitative conceptualizations

The definition of habitat fragmentation above implies four effects of the process of fragmentation on habitat pattern:

- (a) reduction in habitat amount,
- (b) increase in number of habitat patches,
- (c) decrease in sizes of habitat patches,
- (d) increase in isolation of patches.

These four effects form the basis of most quantitative measures of habitat fragmentation. However, fragmentation measures vary widely; some include only one effect (e.g., reduced habitat amount or reduced patch sizes), whereas others include two or three effects but not all four. Negative effects of fragmentation are likely due to two main causes (*threats to habitat*).

First, fragmentation implies a larger number of smaller patches. At some point, each patch of habitat will be too small to sustain a local population or perhaps even an individual territory.

Species that are unable to cross the non-habitat (**figure. 3**) portion of the habitat will be confined to a large number of too-small patches, ultimately reducing the overall population size and probability of persistence.

The second main cause of negative effects of fragmentation is negative edge effects; more fragmented landscapes contain more edge for a given amount of habitat.

This can increase the probability of individuals leaving the habitat and entering the matrix. Overall the amount of time spent in the matrix will be larger in a more fragmented landscape, which may increase overall mortality rate and reduce overall reproductive rate of the population (*Fahrig 2002*).

In addition, there are negative edge effects due to species interactions. Probably the most extensively studied of these is increased predation on forest birds at forest edges (*Chalfoun et al. 2002*).

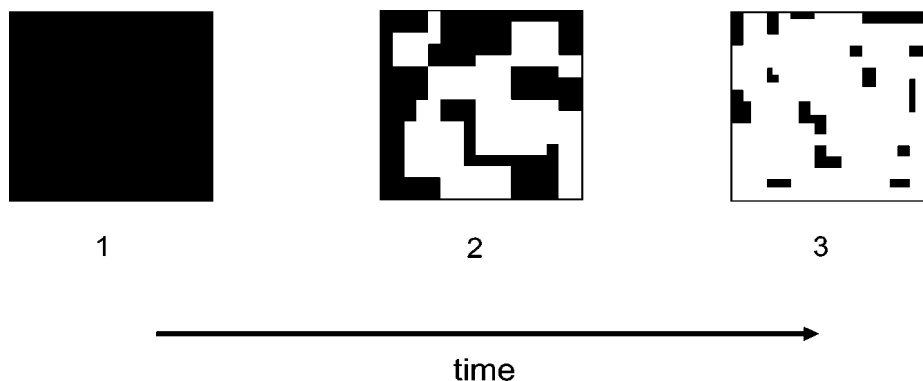
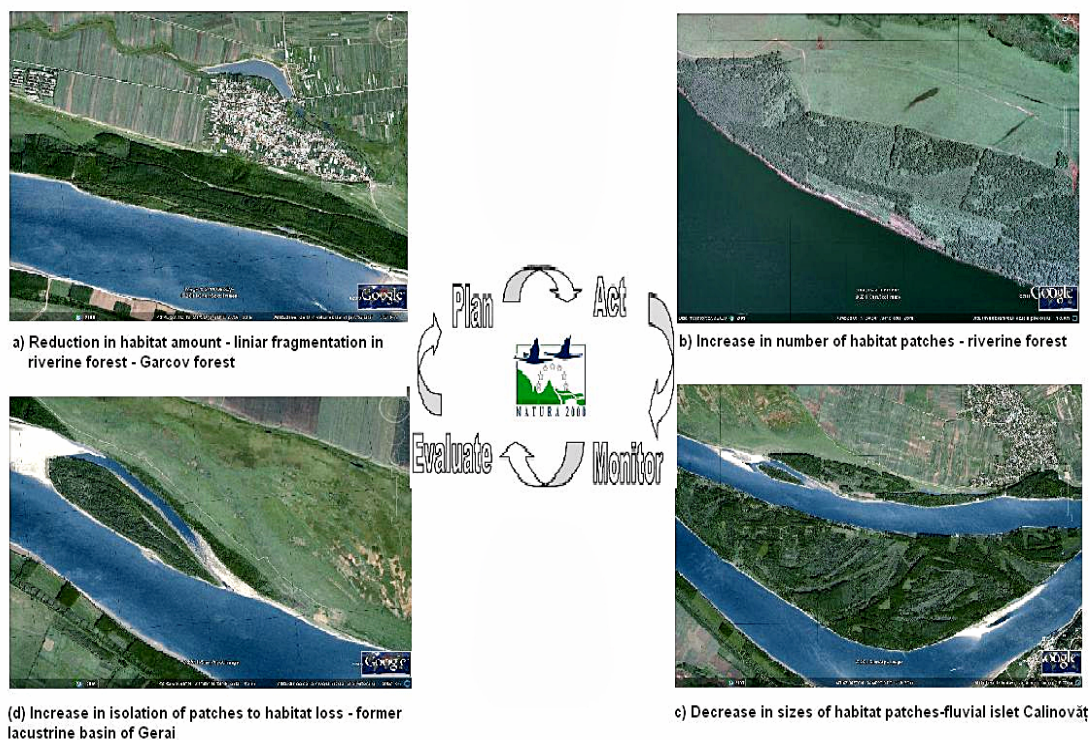


Figure 3. The process of habitat fragmentation, where “a large expanse of habitat is transformed into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original” (Wilcove et al. 1986). Black areas represent habitat and white areas represent matrix.



PATTERNS OF HABITAT FRAGMENTATION IN OUR STUDY AREA

Figure 4 Patterns of habitat fragmentation in our study areas

Threats for corridor habitats.

When a habitat is destroyed will remain habitat fragments, mostly isolated by a strongly changed and modified landscape. The margins of this patches will be exposed to new or more intensified threats also called edge effects.

In many cases habitat fragmentation is a result of severe habitat loss (Gerai lacustrine basin), fragmentation caused by roads which burdens species mobility. Fragments of habitat appears as island of initial habitat (island theory) in hostile landscape dominated by antropic modified elements. "Habitat fragmentation is recognized a major threat to fluvial corridor's biodiversity", because many species could not adapt to the new modified environment conditions (biotope conditions).

Habitat fragments characteristics differs from the initial, mostly unaltered habitat:

- fragments have a total length of edge bigger than the initial habitat (increasing the edge effects);
- the core of each habitat fragment is closer to the edges;
- a initial continuous habitat with much population is divided in fragments with less population;



Fig. 5 (a,b) Edge effects in ecotone areas (overgrazing effects)

Projecting a secondary anthropogenic network of irrigation and sanitation canals induced habitat fragmentation in forests ecosystems, floodplain lawns and palustrine ecosystems; habitat fragmentation process is about „a large continous habitat divided in two or more parts”(Pătroescu and al., 2007, Primack and al., 2008).

Habitat fragments are visible as islands in riverine landscape, with no connectivity and this process represent a real threat to river's biodiversity because some of the species are not able to adapt for the new modified environment conditions. We had observed during our monitoring period the mobility of species within Gerai's habitats (*Phragmites* habitat) that wild pigs are more exposed to villagers attacks (edge effects on species). Increasing fragmentation in habitat patches decreases the probability of successful dispersal between these patches and increases the potential for nest predators from nearby non-habitat. Therefore, areas that have less habitat edge and are a greater distance from the edge provide better habitat quality. We noticed that several small patches are located in the vicinity of larger one (figure 4); if these patches could be connected together, the genetic pool shared within these habitat patches would increase and therefore could decrease the extinction risk of the species population they host. Consequently, similar type of outputs could be useful to help decision making for the selection of habitat corridor locations, by accessing their potential impact on the long-term survival of species. After multiple fields investigation we have identified some threats for *corridor habitats* (we have decided to nominalyse those habitats as corridor habitats because more than over 20.000 birds use the habitat's conditions (*Aythya nyroca*, *Phalacrocorax pygmaeus*, *Philomachus pugnax*) including localization, habitat type and impact:

- ruderalization of vegetation in alluvial lawns *Cnidion dubii* (code Natura 2000: 6440) induced by human activities as a result of previous concrete management measures absence (alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*-(*Alno-Padion*, *Alnionincanae*, *Salicion albae*); riparian forests with *Quercus robur*, *Ulmus laevis*, *Fraxinus excelsior*, *Fraxinus angustifolia*; floodplain forest with *Salix alba* and *Populus nigra*);
- overgrazing (sheep and cows) in the Garcov village neighborhood (Olt-Danube confluence); overgrazing intensifies the edge effects at the level of ecotones (alluvial forest-alluvial lawns and alluvial lawns – *Phragmites* (figure 8);
- extention of invasive species (amorpha – american native species extended alongside the access forest road and the enlargement of this road induced and accompanied the process of ruderalization for forest habitats and substituting gradually the natural biocenoses (Garcov forest - figure 6)
- invasion of domestic animals into habitat of wild animals increasing the exposure to diseases, when the contact between domestic and wild animals is constant (figure 9)



Figure 6 Linear extention of invasive species (amorpha) in forest habitats



Figure7. River system channelization in Garcov forest



Figure 8. Overgrazing in alluvial lawns 6440



Figure 9. Invasion of domestic animals

For next decades the changes in land use will constitute the main cause of habitat fragmentation for the terrestrial habitats followed by natural resources overexploitation, climate change and the extinction of invasive species (*IUCN 2004*). As a result the future key management option for biodiversity conservation will focus on *habitat conservation*.

Habitat fragmentation in conservation strategies and management measures

Habitat fragmentation represents a concept rarely transposed in conservation strategies and management plans for natural protected areas.

We could consider that habitat fragmentation process is similar to habitat loss in management strategies because we are focusing on habitat management and habitat conservation for increasing the connectivity throughout the natural (*unaltered*) habitat.

In our next field observations we should take into account questions that raise the guidelines for the appropriate management measures and conservation strategies:

1. Are fragmentation patterns within the protected areas similar to or different from areas surrounding the site, with similar patterns indicating an ineffective site boundary, and differing patterns (along with increasing amounts of natural vegetation cover) indicating effective site boundaries?
2. Does the double designation and the conservation measures of this site limit/should the habitat fragmentation process?

Scaling land cover conversions from natural vegetation to anthropogenic land cover will help us to improve the biodiversity conservation strategies?

The monitoring group (the custodian and partners) may also consider compiling a spatially explicit database of the existing conservation network, derived from national, state and local protected areas, habitat enhancement, restoration and mitigation projects, as well as other initiatives that enhance wildlife habitat and ecosystem integrity. Till now only a major environmental project could be taken into account for this protected area. This site is part of Green borders project (Life Nature project-Cross-border conservation of *Pygmy Cormorant Phalacrocorax pygmaeus* and *Ferruginous duck –Ayrtha nyroca*). The main objective of this project is to protect these two species; the population of these species is diminishing as a result of the habitat fragmentation process of this Danube easily flooded region. The destruction of nesting areas of the population of pygmy cormorants and ferruginous ducks represents the main threats for both species. In this case the restoration focus is the option of ecological reconstruction of former lacustrine basin of Gerai, which is the most preferred habitat for these two species within the protected area surface.

Though the natural, unfragmented, continuous habitat still exists within this protected area, the land cover with natural habitats is poor; the unaltered, unfragmented habitats are alluvial forest with salix and populus species situated on fluvial islets, with a high degree of regeneration (**Natura 2000 code: 92 A0**). Habitat fragmentation is the inverse of habitat connectivity; restoration and ecological reconstruction works are due to increase the habitat connectivity; thus, maintaining the habitat connectivity means that the habitat is continuous, not fragmented.

For a better understanding and application of the management measures we should focus on “habitat conservation as a measure-unit in biodiversity conservation” activities for Natura 2000 network:

- expand the area of habitat protected for nature conservation;
- maximize the quality of existing habitats;
- minimize impacts from surroundings threats (mainly land uses);
- promote connectivity of natural habitat;

Complete data to define the habitat often are not yet available, so the usual implication is that the data needed to do landscape scale modeling and monitoring will be incomplete. For all of the species, their habitats extend well beyond installation boundaries (distance to food sources, nesting areas). Therefore, management of the species must extend beyond site’s boundaries and be in cooperation with other local agencies and stakeholders. The benefits of healthy ecosystems (eco-regions or landscapes) flow through the entire matrix to benefit both the natural and man-made landscape.

CONCLUSIONS

For summarizing all the discussions and field situation of our study area we can establish that if we discuss about terrestrial habitats it is obvious that habitat fragmentation is just the inverse of habitat connectivity. We can discuss and analyse habitat fragmentation in most of the cases only when we are dealing with terrestrial habitats, semi-terrestrial or quasi-terrestrial habitats (fluvial islets – Gârcov, Calnovăț, hydrophilic lawns); in the other cases we can state that we are dealing with habitat loss, habitat alteration and habitat degradation, because logically speaking we should deal with fragments, after the loss of habitat, visible in landscape matrix. We have noticed that in riverine forest habitats that extension of invasive species is going in parallel with the process of vegetation ruderalization along the forest roads. This represents a double threat to habitat integrity and should be taken into account for future management measures for this protected area. Another aspect which must be assessed about the problem of habitat fragmentation, it is the

necessity to identify the remaining corridors that are available to the species for foraging and migration. Different threats which caused habitat fragmentation process within this natural protected area have induced a graduated diminution of ecosystem services and functions for easily flooded region of Danube. When an ecosystem becomes so fragmented that only portions of it at particular stages of their lifecycles can be preserved, conflicts can emerge that require conflicting management actions. Management measures must include areas beyond the site's boundaries at a regional scale, and must be carried out in cooperation with agencies and stakeholders with like interests. In the present moment this protected area is managed by Equilibrium Association after the attribution process of custodian convention with no. **0003/19.02.2010** by Ministry of Environment and Forests - Biodiversity Protectorate; for this natural protected area there are no management plans or conservation strategies for biodiversity legally approved. The space of this natural protected area has been strongly affected, especially the former lacustrine basin of Gerai and the forest situated on fluvial islet (Calinovăț) and in the dyke-bank area. It will be difficult for the environmental managers or custodians to reestablish the ecological state of equilibrium and to accomplish the main management objectives; but environmental projects such as **Green borders** (with programmes of ecological reconstruction of Gerai basin) are due to facilitate the application of appropriate management measures.

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