

# Using GIS for management of conflicts in natural protected area in Cindrel mountains

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**Abstract.** This study reflects the possibility of using the GIS technology for the management and resolution of conflicts between stakeholders in the management of protected natural areas that cover large surfaces, such as Natura 2000 sites. The research is accomplished in Frumoasa site from Cindrel Mountains, where a conflict of a legal nature was analysed, in the extinguishment of which the technology of geographical information systems was used. In this sense, the presence of the species and habitats that are found on the surface of the incriminated forest was analysed and the comparison with the list of species and habitats that was the basis for declaring the surface as a nature 2000 site. In the next stage, both the site management plan and the forest management plan were analysed in order to identify inconsistent potentials. Then, maps of the presence and distribution of species and habitats were made, with the protection and conservation measures adopted. Also, special attention was paid to the identification of primary and old-growth forest, their distribution and measures for their conservation. The conclusions include improvements can be made to the management of the incriminated areas, accompanied by the geo-database.

## 1 Introduction

With the accession to the European Union, Romania has made environmental commitments [1] on the implementation of the Union's policy on environmental protection. The implementation of the provisions of the Habitats Directive 92/43 / EEC [2] and the Birds Directive 79/409 / EEC [3], which later materialized in Directive 2009/147 / EEC [4], have been implemented in national legislation by Government Ordinance 57 since 2007 [5].

In order to fulfil the obligations assumed, as an integral part of the environmental legislation, Romania applied to the network of protected natural areas Natura 2000 [6, 7] by designating areas that cover not less than 20% of the country's surface, with a number of 435 SCIs (Sites of Community Importance) and 171 SPAs (Special Protection Area for Birds) [8].

The European Union's (EU) Natura 2000 network is the world's largest network of protected areas [9]. Natura 2000 sites have a rich and valuable biodiversity [10], along with

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the provision of ecosystem services that can contribute to the long-term well-being of society.

Among the Natura 2000 sites is Frumoasa, a site that covers 4 counties (Alba, Sibiu, Vâlcea and Hunedoara) and 24 localities [11]. The site was designated as a Protected Natural Area (NPA) in 2007 as an Avifauna Protection Area (SPA) by Ministerial Order 1284, covering an area of 130,890 hectares, and as a Site of Community Importance (SCI) by Ministerial Order 1964, having an area of 137,256 hectares. The Frumoasa site has been designated a Protected Natural Area (NPA) for the protection of 16 habitat types of Community interest, of which 5 are priority, 26 species of Community interest, of which 4 are mammal species (bear, wolf, lynx and otter), 2 species of amphibians, 3 species of fish, 11 species of invertebrates and 6 species of plants (4 species of moss and 2 species of higher plants) [11].

The implementation of management plans for the conservation of biodiversity over very large areas, as is the case of the Frumoasa site, can be achieved only with the active participation of stakeholders [12, 13]. Due to the fact that ecosystem services are very diverse, conflicts will inevitably arise between landowners, local entrepreneurs, environmental organizations, beneficiaries of ecosystem services and authorities that the administration of the protected natural area must manage. Management must aim, on the one hand, to implement the measures provided for in the management plans and, on the other hand, to carry out activities which do not contradict the provisions of the management plans so that ecosystem functions can be provided [14, 15].

This paper presents the course of resolving a conflict that arose during the implementation of the management plan, and as an essential tool for interrogating spatial data - the suite of GIS geographic information management programs [16]. Stakeholders' participation in conflict resolution is seen as a particularly effective tool [17, 18]. One of the key elements is that the necessities to be in line with the local context and at the same time to respect the procedures [19].

After joining the European Union, civil society was increasingly present in terms of environmental protection, making its voice heard through large-scale protests that led to the revision of environmental policies [20-22]. Forests have been a sensitive subject, being often viewed as a timber resource [23-25]. Lately, environmental organizations have become increasingly active, taking a stand against possible violations of environmental legislation [26, 27]. Forest management plans are an integral part of protected natural area management plans, so when designing, adopting and approving premiums, they must be brought into line with protected natural area management plans [5]. One of the stages of adopting forest management plans is to comply with environmental legislation, so that at this stage stakeholders can express their views. The present study examines an adopted forest management plan that went through the environmental stage, but an environmental organization (environmental NGO) opened a legal dispute in court for non-compliance with the environmental procedure, so in the first stage the court decided to suspend its application.

The court has set the task of determining the extent to which the forest management plan affects and produces adverse effects on ecosystems, habitats, species and virgin forests. Among the issues reported are those related to the activities provided by the forest management plan that potentially endanger the ecosystem to the detriment of protected species and habitats, as well as the identification of virgin forests.

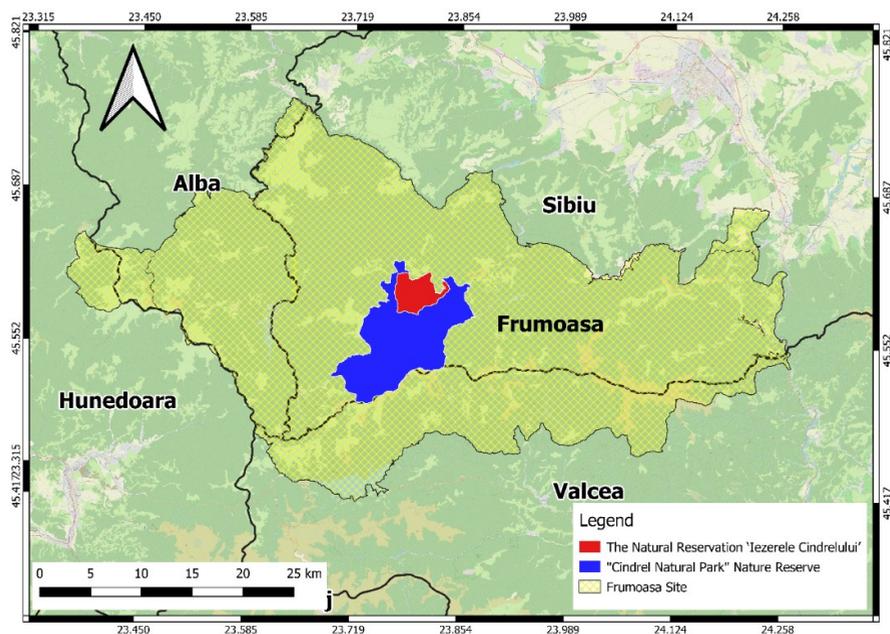
## 2 Materials and methods

### 2.1 Study area

The Frumoasa site stretches on the surface of Alba, Sibiu, Valcea and Hunedoara counties, having the coordinates  $45^{\circ} 34' 45''$  lat. N, respectively  $23^{\circ} 49' 08''$  long. E.

The Frumoasa site is classified as a protected natural area by category IV in the IUCN (The International Union for Conservation of Nature) classification. There are other protected natural areas, such as reservations (IUCN category IV), or natural parks (IUCN category V).

In figure 1 it is shown the area where the study was performed, highlighting the three protected natural areas.



**Fig. 1.** Study area.

The area on which this study was developed is represented by the forests included in the forest management plans located in the Frumoasa site, which includes the "Iezerlele Cindrelului" Reservation and the "Cindrel Natural Park" Natural Reservation.

The "Iezerlele Cindrelului" reservation has an area of 609 ha, having the coordinates  $45^{\circ}35'53''$  N  $23^{\circ}47'57''$ E, with two glacial lakes: Iezerul Mare, located at 1970 m altitude and 13.3 m depth, respectively Iezerul Mic, at 9146 m altitude and 1.7 m depth.

"Cindrel Natural Park" Natural Reservation with 9873 ha, is located on the coordinates  $45^{\circ}33'21''$ N  $23^{\circ}46'54''$ E, with the Cindrel peak located at an altitude of 2244 m. The vegetation is represented by juniper, blueberry shrubs and by the *Rhododendron kotschyi*.

### 2.2 Materials

The present study used data taken from the management plan of the Frumoasa site [11], vector data provided by the Ministry of Environment, as well as other vector data available from the website of this ministry [28].

To address the issues raised, the study used data on:

- distribution of invertebrate species, fish, amphibians, carnivores, birds;
- the distribution of forest habitats means a place to live, respectively the abiotic environment in which a distinct organism or biocenosis lives [29];
- the distribution of virgin forests defined in the literature as natural ecosystems consisting of forests not affected by anthropogenic activity.

### 2.3 Methodology

This kind of conflict management involves verifying the issues reported by stakeholders and formulating a scientifically reasoned response. In order to provide results and meet the set objectives, we proceeded to the spatial representation of the distribution of forests in the forest management plan and to the intersection with the species and habitats protected by the management plan of the Frumoasa site. Distribution maps were obtained using the open source licensed QGIS application suite.

## 3 Results

### 3.1 Identified species

On the incriminated forest area and the protected natural area have been identified four species of invertebrates, two species of fish, one amphibian, five species of carnivores and eleven species of birds. The measures provided by the management plan of the protected natural area provide for organizational measures for the conservation of habitats in order to protect the protected species materialized through an active management of the forest ecosystems [11].

To obtain the results, the GIS database provided by the Ministry of Environment was used, from which the data related to the distribution of the species were extracted, and then the thematic maps were generated (fig. 2). This method generated a map for each species, so that the conservation and protection measures provided by the management plan.

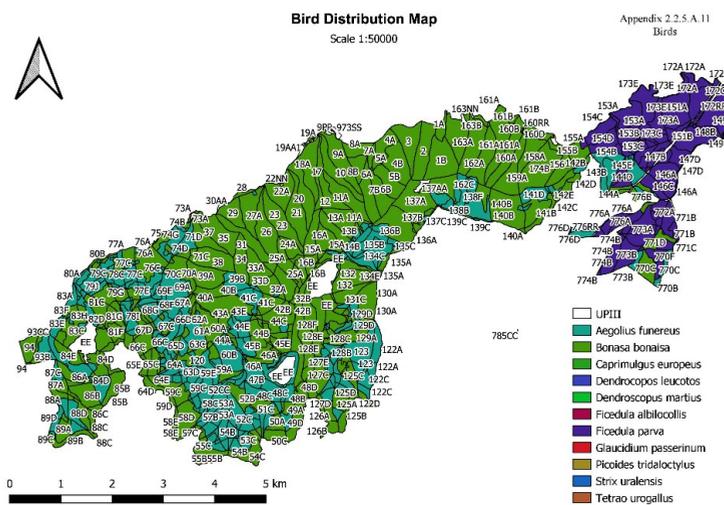


Fig. 2. Bird distribution map.

### 3.2 Identified habitats

Forest management plans include information on the composition of forest species and a correspondent of the Natura 2000 habitat type under the name Forest Type. The studied forest area has four types of habitats, one of which is a priority, marked with \*. In this case, too, habitat distribution maps were drawn up, according to figure 3.

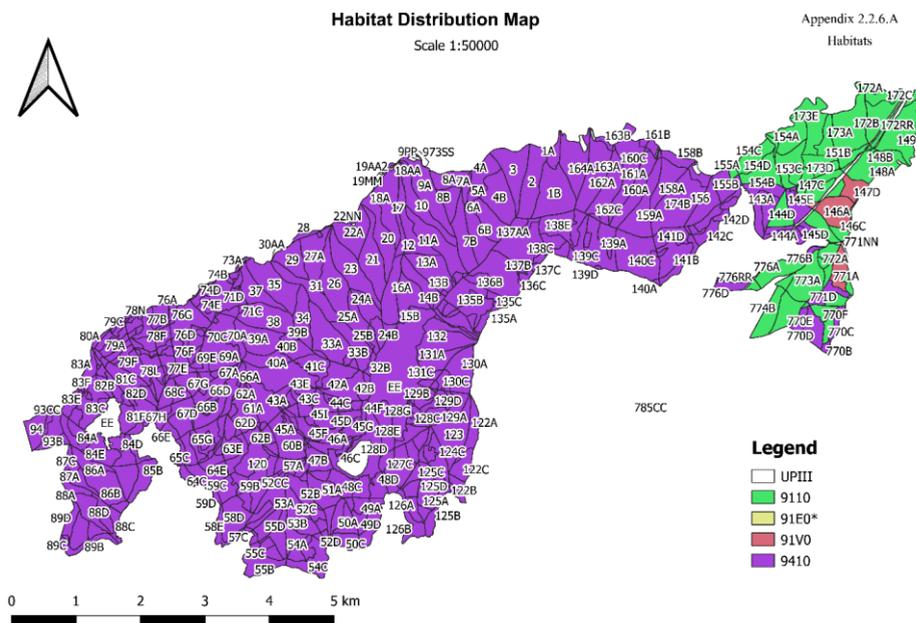


Fig. 3. Habitat distribution map.

### 3.3 Virgin forests

The term of virgin forest includes those natural forest ecosystems unaffected by human intervention, in which there are trees of all ages, in all stages of development, from young seedlings to old trees at the limit of physiological longevity, where the dead wood that is present and it is host for other species of flora and fauna, ensuring a biodiversity not found in other habitats and ecosystems.

In order to designate a forest as a virgin forest, it must cumulatively meet a number of criteria regarding naturalness and area. Following the research, 14 areas were identified that meet the conditions for classification as virgin forests.

## 4 Discussions

On the studied surface were identified only a part of the species and habitats described at the time of the establishment of the protected natural area. The protected natural area management plan provides specific measures for the protection and conservation of species and habitats, and all management plans that provide actions on the objectives on this area, including forest management plans, must be agreed with it.

The identification of the distribution of species and habitats could be achieved only with the help of GIS programs, and in this context the specific measures for their protection and conservation were determined.

Another major objective was to identify the areas occupied with virgin forests and include them in the "National Catalog of Virgin Forests", as well as the measures, or rather the adoption of the status of non-intervention area, provided in forest management plans.

## 5 Conclusions

At the time of the designation of the protected natural area [6, 7], the standard form included numerous species and habitats, which, following the studies, were only partially confirmed. As these studies were developed in a short period of time, the access of stakeholders was limited and thus a number of perplexities arose. The forest management plans are made by institutes specially authorized by the Ministry of Environment and in order to be approved by Ministerial Order, they also go through the environmental approval stage where the interested public can bring into question any confusion. The present study sheds some light on the issues raised by one of the most vocal environmental NGOs, so that the suspicions related to the adoption of environmental plans can be clarified. As Natura 2000 sites usually cover very large areas, in our case over 130 000 ha, the analysis of the distribution of habitats, species and the identification of virgin forests is particularly laborious and difficult. The use of GIS technology has led to the identification of species and habitats, as well as areas occupied by virgin forests. The management act must be in line with the interests of all stakeholders [30] and seek to resolve conflicts, even if their occurrence is inevitable [31]. In this case, through the use of studies, the distribution of species and habitats, it was possible to draw conclusions on the adoption of forest management plans and the extinction of a conflict of a legal nature.

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