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Detailed GIS mapping of communities of plants with conservation status and defining the touristic zones in the group "Kanarata and Quarry Drenaka" of the protected area "Pobiti Kamani" (Northeastern Bulgaria)

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Abstract

The aims of the present study were: 1) to perform a detailed mapping of the distribution of conservationally significant (endemic, vulnerable, endangered and protected) plant species in the group "Kanarata and Quarry Drenaka" of the protected area "Pobiti Kamani" for 2020 yr in GIS environment; 2) based on the overlap of the distribution sites of plant species, to determine the "hot spots" of plant biodiversity, access to which should be limited in order to protect them and at the same time to identify areas with no or low concentration of conservationally important species in order to trace and mark the tourist paths in the protected area. In order to investigate the distribution of six plant communities, a detailed GIS mapping was performed. As a result of the study, detailed distribution maps of investigated species communities in Central Group were drawn. Special attention is paid to the zones where two or more communities were overlapped. The identification of the areas with concentration of conservation-significant species and localization of "hot spots" is crucial for protection management of the group "Kanarata and Quarry Drenaka" of the protected area "Pobiti Kamani". The model of "hot spots" and the model of overlapping are applicable and in combination with detailed distribution maps are fundamental for more successful protection and conservation. The suggested touristic zones with lack of conservation species can be used to trace and to construct environmentally friendly tourist trail and paths without destroying and harming the species, their habitats, and the aesthetic and recreational value of the landscapes.

Keywords: Mapping; Protected area Pobiti Kamani; Conservation status; Vulnerability assessment

1. Introduction

The most important task in the conservation of plant species and their habitats is the identification and prioritization of the so-called "hot spots" [1]. They are geographic areas characterised by a high concentration of endemic species and loss of habitats [2, 3]. On a regional scale, the concept of "hot spots" can be used to prioritize locations within a protected area and to focus limited public financial resources to their *in-situ* conservation [4, 5]. On the other hand, the model of overlap of the distribution polygons of plant species can be used to determine the "hot spots" of plant biodiversity, access to which should be limited in order to protect species with conservation status and their habitats. This model can be applied in order to identify areas with absence or low concentration of plants with conservation status in order to trace and to mark tourist paths in the protected area also [1, 6].

The classical models for defining and categorizing the conservationally significant territories are based on an intuitive interpretation of the distribution and concentration of the species diversity and its conservation status [1, 5, 6]. The protected areas declared by normative acts are conservative units that changes relatively rarely and characterized by a

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low degree of dynamism, which is the basic principle of conservation biology. Therefore, monitoring and mapping of plant species are required in order to update conservational status [1].

According to the Bulgarian Protected Areas Act [8], the basic idea of management of protected areas is conservation of species and their habitats. On the other hand, protected areas have to provide opportunities for tourism, recreation, and education. A number of the Bulgarian protected areas are subject to intensive tourist activity, which requires monitoring of biodiversity and assessment of habitat vulnerability to be carried out more frequently. Conventional engineering solutions for the access restriction of tourists, for example wooden or stone paths or other environmentally friendly platforms, are not always applicable as they reduce the aesthetic and recreational value of the landscapes.

Protected area "Pobiti Kamani" reaches a total area of 253.3 ha and is divided into 14 groups. As one of the first declared protected area in Bulgaria, the plants communities were relatively studied [1, 6, 9, 10, 11]. Most of the studies were focused to the most famous and most visited groups "Center - South" and "Center - North". The others, including group "Kanarata and Quarry Drenaka", were less studied, less known to tourists, and have great touristic and recreational potential.

The aims of the present study were: 1) to perform a detailed mapping of the distribution of conservationally significant (endemic, vulnerable, endangered and protected) plant species in the group "Kanarata and Quarry Drenaka" of the protected area "Pobiti Kamani" for 2020 yr in GIS environment; 2) based on the overlap of the distribution sites of plant species, to determine the "hot spots" of plant biodiversity, access to which should be limited in order to protect them and at the same time to identify areas with no or low concentration of conservationally important species in order to trace and mark the tourist paths in the protected area.

2. Material and methods

The studies of the spatial distribution of the plant communities of the conservation significant species (Table 1) were carried out through multiple field studies during the vegetation period of 2020 yr. The conservation status is defined according to the Red Data Book of the Republic of Bulgaria and the Bulgarian Biological Diversity Act [8, 12]. The endemics and relics are defined after Red Data Book of the Republic of Bulgaria [12].

When drawing the maps, the following were used: UTM Zone 35 North map projection, WGS84 terrestrial coordinate system and the Baltic altitude system. The collected field data were further integrated and analyzed in a GIS environment using base maps and Digital Terrain Model (DTM).

3. Results and discussion

The protected area "Pobiti Kamani" is a geological phenomenon located in the North-eastern Bulgaria. It is natural limestone columns among the Eocene sands formed about 50 million years ago. The group "Kanarata and Quarry Drenaka" is part of the protected area "Pobiti Kamani" and was used as a sand quarry a few decades ago (Figure 1).

Figure 1 The group "Kanarata and Quarry Drenaka" of the protected area "Pobiti Kamani"

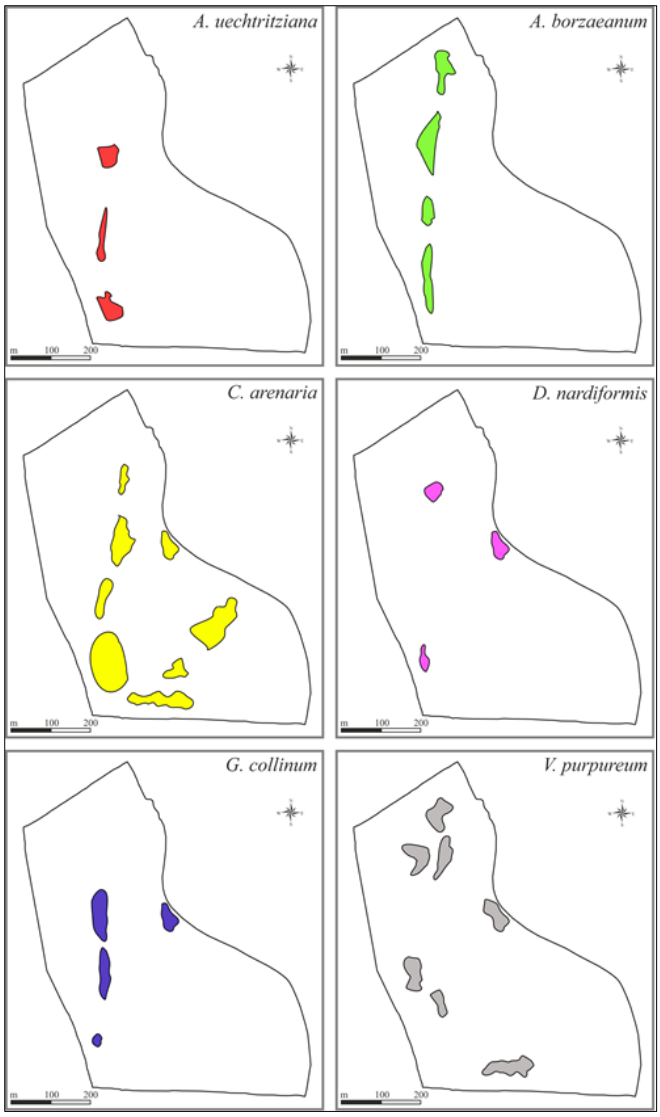

Figure 2 Detailed distribution maps of the investigated species

Table 1 Conservation status of the investigated species

Latin name	Family	BDA	RDB	IUCN	BC
Aurinia uechtritziana (Bornm.) Cullen & Dudley	*Brassicaceae*	+	En	-	+
Alyssum borzaeanum Nyár	*Brassicaceae*	+	En	-	+
Centaurea arenaria M. Bieb. ex Willd.	*Asteraceae*	+	-	-	-
Dianthus nardiformis Janka	*Caryophyllaceae*	+	En	R	-
Goniolimon collinum (Griseb.) Boiss.	*Plumbaginaceae*	+	-	-	-
Verbascum purpureum (Janka) Hub. -Mor.	*Scrophulariaceae*	+	En	R	+

BDA – Bulgarian Biological Diversity Act (2002) – Annex 3 [15]. RDB - Red Data Book of the Republic of Bulgaria [12], EN – Endangered. IUCN - International Union for Conservation of Nature (the World Conservation Union) UCN Red List of Threatened Plants [16], R – Rare. BC - Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

A total number of 247 vascular plants were identified over the field campaigns in the territory of the group. Six plant species with conservation status were recognized (Table 1). No species included in the Habitats Directive (Directive 92/43 / EEC) [13] and in Annex II of the Convention on International Trade in Endangered Species of Wild Fauna and

Flora (CITES) [14] were identified. *Verbascum purpureum* (Janka) Hub.-Mor. and *Dianthus nardiformis* Janka are Balkan endemics.

Detailed maps of the distribution of the investigated species in the GIS environment were drawn (Figure 2). A total number of 29 individual localities were identified.

A dynamic GIS-based model was built using the Model Builder module of the QGIS 3.0 Girona software product. The model is designed to assess the places of overlap of the range of species distribution [17] (Figure 3A), and to identify the areas where the concentration of conservation-significant species was observed (Figure 3B). A total number of 8 individual "hot spots" were identified. In order to protect viable populations of the species, a correction factor was applied in order to minimize the degree of defragmentation. By assigning corridors between the individual locations, enlarged spots were identified and drawn (Figure 3C).

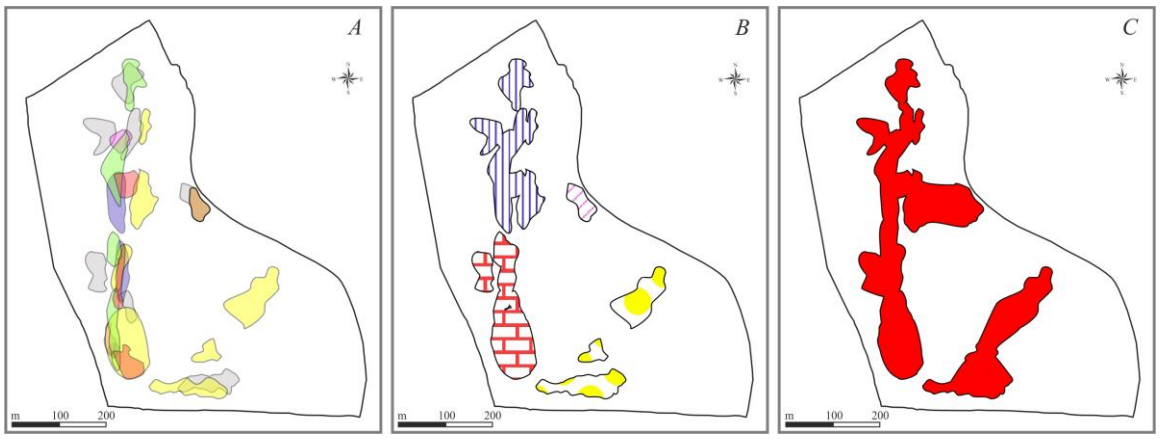

Figure 3 Detailed distribution maps of the investigated species

A - Overlaps of the plants distribution polygons; B - enlarged polygons overlaps of the plants distribution; C - enlarged polygons overlaps of the plants distribution without defragmentation.

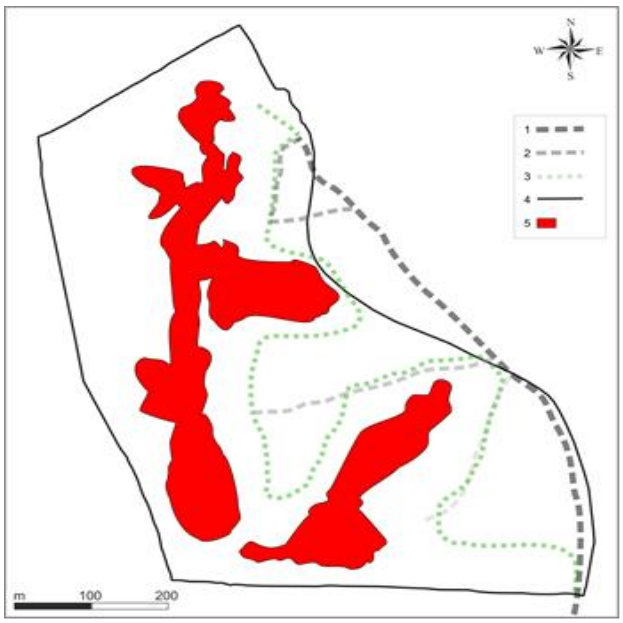

Figure 4 Detailed distribution maps of the investigated species

1. Current asphalt road; 2. Current dirt road; 3. Suggestions for tourist trail; 4. Borders of the protected area; 5. Polygons with plants with conservation status.

Based on the absence or presence of a smaller number of conservationally significant species, as well as their poor projective coverage, the potential locations for the location of tourist trails were defined and sketched (Figure 4).

4. Conclusion

The identification of the areas with concentration of conservation-significant species and localization of "hot spots" is crucial for protection management of the group "Kanarata and Quarry Drenaka" of the protected area "Pobiti Kamani". The model of "hot spots" and the model of overlapping are applicable and in combination with detailed distribution maps are fundamental for more successful protection and conservation. The suggested touristic zones with lack of conservation species can be used to trace and construct environmentally friendly tourist trail and paths, without destroying and harming the species, their habitats, and the aesthetic and recreational value of the landscapes.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare the absence of a conflict of interest.

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