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The Contradiction between Taxa of Conservation Significance and Invasive Species – a Case Study of Sustainable Development in Mala Planina

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Abstract
The research identifies, investigates and analyses taxa of conservation significance in Mala Planina and the negative influence of invasive species in the area as a major threat to biodiversity. The study follows UN's Sustainable Development Goal 15.
Cameral research, including exploration of the Red Data Book of the Republic of Bulgaria has been done. Remote methods are represented. ArcGIS maps examining the localities of the species are provided. Several terrain expeditions add value to the study. The territory is home to 21 plant, 4 fungal species and 30 animal species included in the Red Data Book. Some of them cannot be found anywhere else in the country. This impressive richness is in contradiction with the fact that 24 invasive species are a part of the flora and some of them are included in the List of "Worst invasive alien species threatening biodiversity in Europe". Although some invasive species are dispersed through the area, there are many species of conservation importance that also thrive there. The study can be used as a base for further investigation, as well as an example for other studies, concerning sustainable development.

Keywords: biodiversity, taxa of conservation significance, invasive species

1. Thesis statement

Humans have greatly altered the global environment and some scientists support the thesis that we currently live in a new geologic epoch - the Anthropocene (Steffen et al., 2011; Rockström et al., 2009; Zalasiewicz et al., 2011; Lewis & Maslin, 2015). Human population increases permanently and the overall human impact has led to the conversion of Earth's land to agricultural or urban landscapes, the number of trees worldwide is dropping by the minute and global biodiversity loss continues at increasing rates (Barnosky et al. 2012; UN, 2004, 2011; Population Reference Bureau, 2012; Vitousek et al., 1997, Haberl et al., 2007; Foley et al., 2011; Vitousek et al., 1986; Crowther et al. 2015; Hansen et al., 2013; Butchart et al., 2010; Wintle et al., 2011; Rosenzweig et al., 2007; Richardson & Poloczanska, 2008). Species extinctions are also altering key processes important to the sustainability of Earth's ecosystems and if trends continue, within 240 years Earth may face the sixth mass extinction (Barnosky et al., 2011; Holt, 2014). We also cannot omit the problem with invasive species. According to the IUCN invasive alien species are the second cause of global biodiversity loss after

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direct habitat destruction and non-native plants nowadays are an inseparable feature of ecosystems across the globe (Vellend et al., 2013, Dlugosch et al., 2015). M. van Kleunen et al. (2015) who conduct a unique research about non-native plants, find out that 13,168 plant species, corresponding approximately to the size of the native European flora, have become naturalized on the globe as a result of human activity. When ignoring differences in total area, North America has the highest cumulative number of naturalized species (n = 5,958), followed by Europe (n = 4,140). Therefore, the overall picture has some dark shades and sustainable development is the key for the better future.

The current research aims to show the undisputed connection between the taxa of conservation significance and the invasive species in Mala Planina to the fulfillment of UN's Goal №15 and its targets (http://www.un.org/sustainabledevelopment/biodiversity). This is undoubtedly a matter of current interest and the circumstance, that the studied mountain is at an immediate proximity to the capital of the Republic of Bulgaria, adds weight to the fact that sustainability is under pressure. Although the country isn't among the largest in the world, and Mala Planina covers an even smaller area, the functioning of the ecosystems in the mountain have their respectable place in the process of sustainable development.

2. Methodology

There are 1 634 951 species (http://www.gbif.org/) in the world today while t*he Plant List (*http://www.theplantlist.org/*)* includes 350 699 accepted plant species names. Bulgaria has a significant biodiversity - according to the Red Data Book of the Republic of Bulgaria (2015), there are 3823 species of angiosperms in the country, as well as 30 000 species of animals, but it is believed that these lists are a bit richer. The transitional geographic position of the country is a big advantage, because its territory is a location where both the boreal and the subtropical effects converge.

The object of the current study is Mala Planina, which is a part of the Western Balkans. The boundaries of the mountain are examined by Grigorov & Assenov (2015). It is situated in western Bulgaria, to the west of the Iskar river gorge, to the north of Sofia valley and the capital city of Sofia, and to the south of the mountains Ponor and Chepan (fig. 1). The mountainous area is a part of the biogeographic region of the Balkans, Assenov (2006). Habitats of the Western Balkans are examined by Vassilev (2012) and Vassilev et. al. (2008, 2011), at the same time Tzonev et al. (2013) did a very important research in a Mala Planina, which is central to the current study. In 2009 Petrova & Vladimirov publish "Red List of Bulgarian vascular plants" and this data is also important to the present research. Unfortunately, there are invasive species among the conservation species in Mala Planina and important source for identifying them is the book of Petrova et al. (2013).

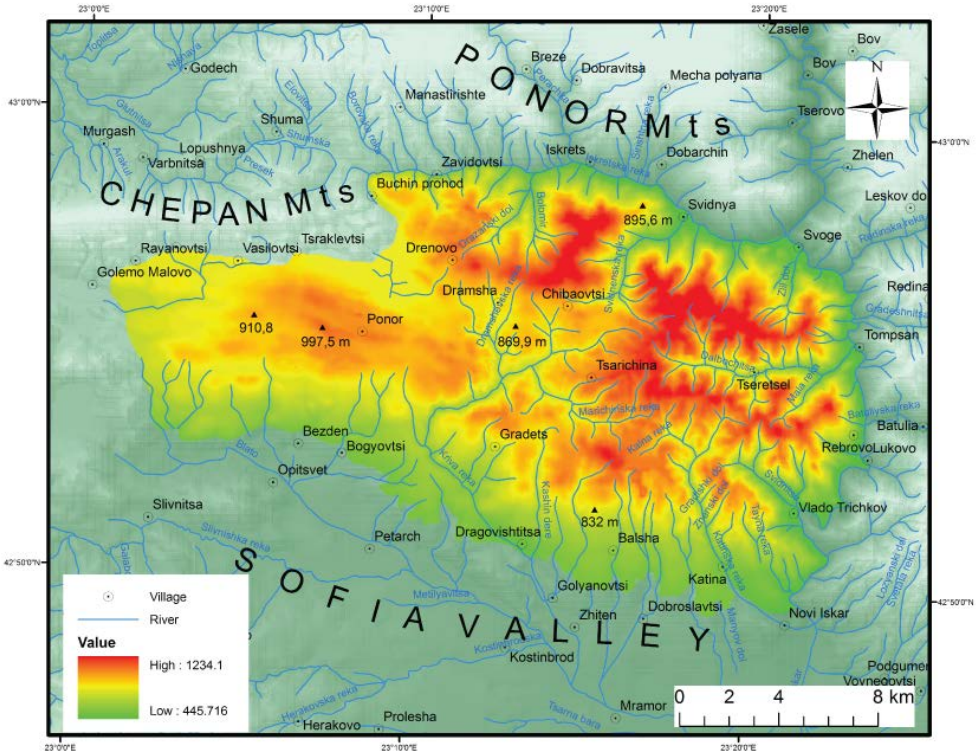

Fig. 1. Map of the location of Mala Planina.

3. Results

The 1977 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) today protects more than 30 000 species (http://www.cites.org) while after a thorough examination of the sources of information and terrain research, we unveiled that there are 21 plant, 4 fungal species and 30 animal species of conservation importance in Mala Planina. Some other species are also included in the research, but it is not confirmed that they are found in Mala Planina. 24 invasive plant species also inhabit the mountain and they are a direct threat for the sustainability. These species were examined by Grigorov (2016) and their description will not be included in the current research. Six of these 24 invasive species (*Acer negundo, Ailanthus altissima, Ambrosia artemisiifolia, Amorpha fruticosa, Bidens frondosus, Robinia pseudoacacia*) are included in the "top 10" list of the most problematic invasive species in Bulgaria (Petrova et al., 2013). Hamaoui-Laguel et al. (2015) recently revealed concerning information - by 2050 airborne ragweed pollen (*Ambrosia artemisiifolia*) concentrations will be about 4 times higher than they are now and Mala Planina isn't an isolated place in the environment. Another problem is that the list of invasive alien species targeted for action under the January 2015 EU legislation includes just 37 entries

(http://ec.europa.eu/environment/nature/invasivealien/index_en.htm), while the 24 invasive plant species are described only in a small mountainous area in Bulgaria. And last but not least, information (http://www.worldmrio.com/biodivmap/) about consumption in Bulgaria warns that this activity threatens 131 species domestically and 15 species abroad, which is a sustainability problem.

Table 1. Species of conservation importance - Flora and Fungi

Species	Status Description	Distribution
Pedicularis palustris **L.**	Critically endangered	Near Tsraklevtsi village
Digitalis laevigatta **Waldst. & Kit.**	Endangered, Balkan endemic	Within NATURA 2000 site
Jurinea tzar-ferdinandii **Davidov**	Vulnerable, Balkan endemic	Chepan, Mala Planina - not confirmed
Astragalus wilmottianus **Stoj.**	Endangered, Balkan endemic	Western Bulgaria (Chepan)
Bromus lanceolatus **Roth**	Critically endangered	Near Svoge town
Galanthus elwesii **Hook.**	Endangered	Many habitats in the country
Eleocharis carniolica **Koch**	Endangered	Aldomirovsko Blato
Tuber aestivum **Vittad.**	Endangered	Ponor village in Mala Planina
Boletus luteocupreus **Bertea & Estadès**	Critically endangered	Localized only in Mala Planina
Dactylorhiza incarnata **(L.) Soó**	Endangered	Sofia region
Astragalus pubiflorus **DC.**	Endangered	Near Dragoman - not confirmed
Viola pumila **Chaix**	Endangered	Tsraklevtsi village in Mala Planina
Daphne cneorum **L.**	Endangered	Znepole region
Phylloporus pelletieri **(Lév.) Quél.**	Endangered	Sofia region – not confirmed
Endoptychum agaricoides **Czem.**	Endangered	Znepole region
Artemisia chamaemelifolia **Vill.**	Critically endangered, glacial relict	Western Balkan range
Himantoglossum caprinum **(M. Bieb.) Spreng.**	Vulnerable	Karst areas of Mala Planina
Paeonia mascula **(L.) Mill.**	Endangered, relict	Found in Mala Planina
Paeonia tenuifolia **L.**	Endangered interglacial relict	Near Ponor village
Edraianthus serbicus **Petrovic**	Endangered, Balkan endemic	Western Bulgaria
Trifolium phleoides **Willd.**	Critically endangered	Malo Malovo, Ponor and Vasilovtsi in Mala Planina
Tulipa urumoffii **Hayek**	Vulnerable, Bulgarian endemic	Western part of Mala Planina
Echium russicum **J.F. Gmel.**	Vulnerable	Western part of Mala Planina
Leptodictyum humile **(P. Beauv.) Ochyra**	Vulnerable	Iskar river valley near Svoge town

Table 2. Species of conservation importance – Fauna

Species	Status Description	Distribution
Romanogobio kesslerii **(Dybowsky, 1862)**	Endangered, *Cyprinidae*	Iskar River – not reported after 1985
Sabanejewia balcanica **(Karaman, 1922)**	Vulnerable, *Cobitidae*	Iskar River – not reported after 1985
Barbatula barbatula **L.**	Vulnerable, *Balitoridae*	Iskar River – not reported after 1985
Lota lota **L.**	Endangered, *Gadidae*	Iskar River – not reported after 1985
Barbus barbus **L.**	Vulnerable, *Cyprinidae*	Iskar River – not reported after 1985
Alectoris graeca **Meisner**	Endangered, *Phasianidae*	Not reported after 1985
Aquila heliaca Savigny	Critically endangered, *Accipitridae*	Not reported after 1985
Circaetus gallicus **Gmelin**	Vulnerable, *Accipitridae*	Western Mala Planina before 2003
Buteo rufinus **Cretzschmar**	Vulnerable, *Accipitridae*	Several areas in Mala Planina after 2003
Falco cherrug **Gray**	Critically endangered, *Falconidae*	Not recorded after 1985
Falco subbuteo **L.**	Vulnerable, *Falconidae*	Western Mala Planina after 2003
Accipiter gentilis **L.**	Endangered, *Accipitridae*	Mala Planina - after 2003
Ciconia ciconia **L.**	Vulnerable, *Ciconiidae*	Western part of Mala Planina
Ciconia nigra **L.**	Vulnerable, *Ciconiidae*	After 2003 in Iskar river valley
Bubo bubo **L.**	Endangered, *Strigidae*	Eastern part of Mala Planina
Tyto alba **Scopoli**	Vulnerable, *Tytonidae*	Western Mala Planina since 2003
Botaurus stellaris **L.**	Endangered, *Ardeidae*	Dragomansko and Aldomirovsko Blato
Podiceps cristatus **L.**	Vulnerable, *Podicipedidae*	Sofia valley
Porzana porzana **L.**	Endangered, *Rallidae*	Dragomansko Blato before 2003
Melanocorypha calandra **L.**	Vulnerable, *Alaudidae*	Western Mala Planina after 2003
Phoenicurus phoenicurus **L.**	Vulnerable, *Muscicapidae*	Svoge town – not confirmed
Calandrella brachydactyla **Leisler**	Vulnerable, *Alaudidae*	Western Mala Planina after 2003
Circus pygargus **L.**	Vulnerable, *Accipitridae*	Sofia valley after 2003
Crex crex **L.**	Vulnerable, *Rallidae*	Mala Planina - after 2003
Burhinus oedicnemus **L.**	Vulnerable, *Burhinidae*	Western Mala Planina after 2003
Podiceps grisegena **Boddaert**	Endangered, *Podicipedidae*	Aldomirovsko blato before 1985
Gallinago gallinago **L.**	Critically endangered, *Scolopacidae*	Extinct in all parts of the country besides Dragomansko Blato
Porzana parva **L.**	Endangered, *Rallidae*	Dragomansko Blato before 2003
Picus canus **Gmelin**	Endangered, *Picidae*	Eastern and western parts of Mala Planina – after 2003
Coracias garrulous **L.**	Vulnerable, *Coraciidae*	Western Mala Planina
Anas querquedula **L.**	Vulnerable, *Anatidae*	Recorded in Sofia valley after 2003
Porzana pussilla **Pallas**	Critically endangered, *Rallidae*	Recorded in Sofia valley before 2003
Ixobrychus minutes **L.**	Endangered, *Ardeidae*	Localized in Sofia valley after 2003
Tachybaptus ruficollis **Pallas**	Vulnerable, *Podicipedidae*	Recorded in Sofia valley after 2003
Myotis emarginatus **Geoffroy**	Vulnerable, *Vespertilionidae*	Western Mala Planina before 2003
Lutra lutra **L.**	Vulnerable, *Mustelidae*	Mala Planina - after 2003
Spermophilus citellus **L.**	Vulnerable, *Sciuridae*	Western Mala Planina after 2003
Vormela peregusna **Guldenstaedt**	Vulnerable, *Mustelidae*	Northern Mala Planina after 2003
Canis lupus **L.**	Vulnerable, *Canidae*	Throughout the country
Felis silvestris **Schreber**	Endangered, *Felidae*	Mala Planina since 2003
Parastenocaris bulgarica **Apostolov**	Critically endangered, local endemic, *Parastenocarididae*	Before 1985 in the Dushnika cave in the Iskrets karst region

It is now clear that some areas in Mala Planina are of higher conservation priority, compared to others. A main focus in the research, as a territory of high conservation priority, is the Ranislavtsi Field, situated in the northwestern part of the mountain, where three protected areas are located (fig. 2), but before we get to this point, a short description of the other species of conservation importance is presented (Table 1 and Table 2), following the Red Data Book of the Republic of Bulgaria (2015).

The most important area of conservation importance in Mala Planina is the Ranislavtsi Field (fig. 2). It is home to three critically endangered plant species (*Lathyrus palustris, Plantago maxima, Salix rosmarinifolia*), the field is the only territory in the country where they can be localized and partly their populations are protected by the legislation. But why they inhabit this particular area? The Ranislavtsi Field is surrounded by hills - temperature inversions, fogs are typical and the climatic conditions are quite specific. According to an unpublished climate research a few years ago, a new lowest temperature for the country was measured in the field, but this data still awaits scientific approval. The Ranislavtsi Field is also a karst area where the short Provalia River loses its waters in pot-holes, but also contributes to the humid conditions. Thus, this field has specific geographic conditions that have led to the formation of long-term wet grasslands and marshes – the perfect conditions for the colonization by the three species, described in the following lines. Their exact locations are shown in fig. 2 and the information is provided by the Bulgarian Ministry of Environment and Water.

Lathyrus palustris **L.** or Marsh Pea (fig.2) is a critically endangered perennial herbaceous plant, included in Annex 2a of the Biodiversity Act and the new edition of the *Red Data Book of Bulgaria*, vol. 1. *Plants and Fungi*. Hayek et al. (2006), Tosheva et al. (2009), Tosheva et al. (2012) made a major contribution to the studying of the species. *Lathyrus palustris* is an example of species with destroyed populations in the country. In the past it was known from the Black Sea coast, Znepole region and Rodopi Mts but the only place where it can still be found today is near the villages of Tsraklevtsi and Buchin prohod – the Ranislavtsi area. It was found in the composition of the associations *Caricetum distichae* (Hajek & al. 2006) and *Caricetum acutiformis*. The altitude is 780 m and territory is included in BG0000322 Dragoman Protected Zone for conservation of the natural habitats and species (Directive 92/43/EEC) and in BG0002001 Rayanovtsi Protected Zone for conservation of the wild birds (Directive 2009/147/EC). Wet grasslands, bogs and marshes are its habitat while *Carex disticha, Dactylorhiza incarnata* (endangered species), *Epipactis palustris* (endangered) and *Pedicularis palustris* (critically endangered species) can also be found in the area. Part of the species' population is included in protected site "Nahodishte na Blatno Sekirtche [Locality of *Lathyrus palustris*] – Buchin Prohod Village Protected Site" (Vladimirov 2014). When the year is dry, the species does not flower. Drainage, ploughing, permanent stop of mowing, which leads to the piling up of dead organic matter, are major threats to it.

Plantago maxima **Jacq.** or Giant Plantain (fig.2) is a perennial herbaceous plant, recorded in Bulgaria for the first time by Tzonev & Karakiev (2007). The general distribution of the species includes Eastern Europe and Western Siberia, spreading to the European part of Russia (Grigoriev 1958; Ball 1976). The species is listed in the Red List of Bulgarian vascular plants as critically endangered (CR) (Tzonev & Karakiev 2009) and included in Appendix 3 of Bulgarian Biological Diversity Act (protected species). *Plantago*

maxima is found within habitat type "6410 *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)", which is listed in Annex I of the Habitat Directive (Council Directive 92/43/EEC). Locally, this habitat is in complex with "7230 Alkaline fens" (Tzonev & Karakiev 2007). The only one Bulgarian locality, also the only locality on the Balkan Peninsula of this species, is partly included in the protected site "Nahodishte na Gigantski Zhivovlyak [Locality of *Plantago maxima*] – Buchin Prohod Village Protected Site" (Vladimirov 2014). It falls into NATURA2000 sites - BG0002001 "Rayanovtsi" (declared under the Bird Directive) and BG0000322 „Dragoman" (declared under the Habitat Directive). Syntaxonomically, the phytocoenoses with *Plantago maxima* is related to class *Molinio-Arrhenatheretea,* order *Molinietalia coeruleae* and alliance *Molinion coeruleae.* Diagnostic species for *Molinietalia* and *Molinion* are presented: *Deschampsia caespitosa, Filipendula vulgaris, Lysimachia vulgaris, Juncus conglomeratus, Salix rosmarinifolia, Galium boreale, Potentilla erecta, Iris sibirica, Carex panacea, Gentiana pneumonanthe, Ranunculus acris, Sanguisorba officinalis, Lychnis flos-cuculi, Holcus lanatus.* It is to be pointed that *Plantago maxima* grows together with another rare and protected species - *Salix rosmarinifolia.* The communities of *S. rosmarinifolia* in this locality are mentioned to belong to ass. *Junco effusi-Molinietum caeruleae* Tuxen 1954 (Hájek et al., 2006; Tzonev et al., 2013). The final syntaxonomical status of the *Molinion* vegetation in Bulgaria is still not clear (Dimitrov & Roussakova 2015).

Salix rosmarinifolia **L.** or Rosemary Leaf Willow (fig.2) is included in Annex 3 of the Biodiversity Act and in the new edition of the *Red Data Book of Bulgaria*, vol. 1. *Plants and Fungi*; it was assessed as Critically Endangered shrub, 1-2 m high that grows in wet meadows, swamps and bogs. Apostolova & Tsoneva (2009, 2012) made a major contribution for the examination of the species. *Salix rosmarinifolia* was last recorded in 1929 in Choklyovo Blato and was considered to be extinct for a long time. Then in 2006 (Hájek et al., 2006), a new locality was recorded in Mala Planina (the meadows at the borders of the land belonging to Tsraklevtsi, Ponor and Buchin Prohod villages – the Ranislavtsi Complex). It is its only locality in Bulgaria and it is also one of the few in the Balkans (Romania and areas in the former Yugoslavia) (Tzonev et al., 2013; Skvortzov, 1999). Some of the coexisting species in the locality are *Bistorta major, Cirsium canum, Dianthus superbus, Filipendula vulgaris, Holcus lanatus, Ranunculus acris, R. polyanthemos, Sanguisorba officinalis* and another conservation important species is *Galium boreale*, which is also a vulnerable species. Part of the population of *Salix rosmarinifolia* is included in protected site "Rozmarinolistna vurba" [Locality of *Salix rosmarinifolia*]. It is a part of BG0000322 Dragoman Protected Zone for conservation of the natural habitats and species (Directive 92/43/EEC) and its total area is 18,157 ha.

Drainage and fires present a threat for the locality. Unfortunately, some marks due to fires were found during the terrain work and this should not be taken lightly. An example of needed conservation measures is the re-introduction of the species to Choklyovo Blato locality (Peev & al., 2015).

The occurrence of invasive species was researched as a fulfilment of the aims of the current study. No invasive species were discovered within the boundaries of the protected areas, but two alien species from North America were uncovered nearby. *Erigeron annuus* is one of them and there is a whole row of several *Robinia pseudoacacia* species just by the road, as well. However, there are some other species that are part of

Mala Planina's flora and pose a potential threat for the protected areas. Taking into account the characteristics of the following species: *Amaranthus albus, A. hybridus, A. retroflexus* which are ruderal species, growing near roads; *Bidens frondosus*, growing in wet, swampy areas; *Erigeron canadensis,* preferring neutral to slightly alkaline soils; *Galinsoga parviflora* and *Acer negundo* which grow in humid soils; *Sorghum halepense,* vegetating best in well drained soils and *Xanthium italicum*, preferring soils with pH 5,2-8, we fear that the penetration of these species may be a danger for the area.

According to Traykov & Tosheva (2015) the invasive plant species *Elodea nuttallii* has settled in the northern part of Dragomansko blato (Dragoman marsh) and this allows us making the presumption that this alien species could have dispersed in the Ranislavtsi Field due to the similar environmental conditions.

The fact that two roads, to the east and to the north of Ranislavtsi Field, pass in an immediate closeness to the protected sites, increases the possibility of new invasions. The road to the east connects Northern to Southern Bulgaria and it is intensively used, which adds even more anthropogenic pressure. Another factor for the entry of invasive species is the grazing of cows to the south of the protected area and the grazing of sheep in the western part of the protected area.

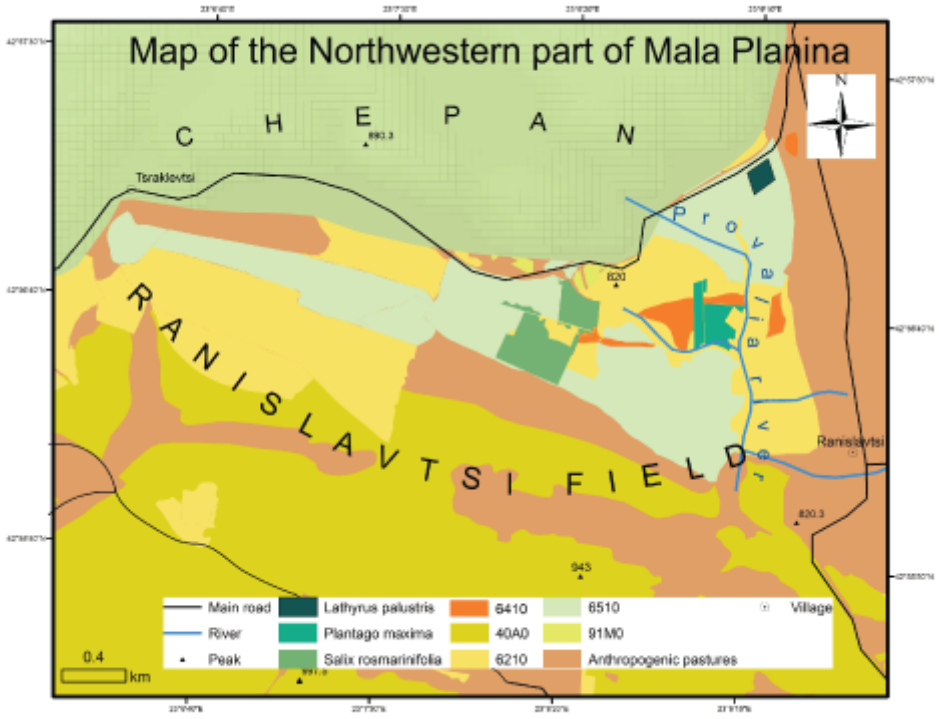

Fig. 2 Location of the protected areas of Plantago maxima, Lathyrus palustris, Salix rosmarinifolia

Conclusions and Implications

The current research, concerning the contradiction between taxa of conservation significance and invasive species in Mala Planina, as a case study for sustainability, is an attempt to understand in a deeper context the functioning of the landscapes in a mountain situated near the capital city. Mala Planina is an arena of collision, an example of a highly evaluated location from a biodiversity point of view, that has its western part included in NATURA 2000 zones, successfully sustaining 21 plant, 4 fungal and 30 animal species of conservation importance, although some alien plant species (24) also thrive there. Furthermore, it is the only refugium of three critically endangered plant species: *Lathyrus palustris, Salix rosmarinifolia* and *Plantago maxima* (single population in the Balkan Peninsula, as well), which cover the single, fragmented protected area in Mala Planina – the Ranislavtsi field. However, the presence of *Robinia pseudoacacia* and *Erigeron annuus* near the protected sites is a fact that should not be underestimated and although other invasive species such as *Bidens frondosus, Erigeron canadensis* and *Xanthium italicum* were not discovered in the area, their presence in Mala Planina is considered as a possible threat for the species of conservation importance. Possible measures for limiting the spreading of *Robinia pseudoacacia* are the use mechanical and chemical methods, such as removal of shoots, repeated chemical treatment during vegetation and mechanical treatment before flowering, while the use of herbicides can be used for *Erigeron annuus* (Petrova et al., 2013).

We are convinced that this study can be used as a base for other studies, concerning sustainable development. Our final implication is that the presented work shows promising results and it can be used as an example for more comprehensive and elaborate future investigation of the landscapes in the western part of the Balkans.

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