ANNALS OF THE UNIVERSITY OF CRAIOVA

Series: ✓*Biology*
✓*Horticulture*
✓*Food products processing technology*
✓*Environmental engineering*

Vol. XXX (LXVI) - 2025

THE USE OF GIS IN THE ASSESSMENT OF ECOSYSTEM SERVICES

Diaconu Dan Nicolae[1], Popescu Simona Mariana[2], Ștefănescu Dragoș Mihail[2*]
[1]Master's Program - Ecological Management of Natural Resources, University of Craiova, A.I. Cuza 13, Craiova, Romania
[2]Department of Biology and Environmental Engineering,University of Craiova, A.I. Cuza 13, Craiova, Romania
* *Correspondence author. E-mail*: mihailstefanescu@yahoo.com

Keywords*:* ecosistem services, *GIS analysis, natural park*

ABSTRACT

Humanity is highly dependent on functioning ecosystems and natural capital, which underpin a constant flow of ecosistem services (ES) from nature to society. ES maps are a very important tool for bringing ES into practical applications. With the help of an ecosystem services potential assessment matrix and GIS analysis, a set of maps was created at the level of „Porțile de Fier" Natural Park, for 4 ecosystem services: global climate regulation, water purification, crop production, recreation and tourism. The park has a high potential for all of the ecosystem services mentioned, except production/crops. Forests offer the greatest potential for these services. Ecosystem services are the contributions of ecosystem structure and function (in combination with other resources) to human well-being.

INTRODUCTION

The term "ecosystem function" was originally used by ecologists to refer to the set of ecosystem processes that operate within an ecological system. In the late 1960s and early 1970s, some authors began to use the term "nature's functions" to describe the "work" performed by ecological processes, the space provided, and the goods delivered to human societies (Bouma and Beukering, 2015).

When describing the flow of ecosystem services (ES) from nature to society, the need to distinguish "functions" from the underlying ecological structures and processes has been emphasized to highlight that ecosystem functions are the basis for the provision of a service. Services are in fact conceptualizations ("labels") of the "useful things" that ecosystems "do" for people, which provide direct or indirect benefits (Kareiva et al., 2011)

Ecosistem services' maps are a very important tool for bringing ES into practical applications. Maps can effectively communicate complex spatial information, and people generally prefer to consult maps and explore their content and practical applicability. Thus, ES maps are very useful for raising awareness about the areas of supply and demand for ecosystem goods and services, environmental education about human dependence on functional nature and for providing information about interregional flows of ecosystem goods and services (Boerema et al., 2017). In addition, maps are mandatory tools for landscape planning, environmental resource management and (spatial) land use optimization. To meet the requirements of the above-mentioned applications, high-quality, robust

and consistent data and information on the supply, flow and demand of ES at different spatial and temporal levels are needed (Bouma and Beukering, 2015).

The interest of decision-makers, business and civil society in ES maps has been growing steadily in recent years. Bringing ES maps into practical applications and transforming them into useful tools for sustainable decision-making is an important step and a responsibility of all parties involved. Maps can be applied to illustrate trade-offs and synergies for ES, as well as spatial congruence or mismatches between supply, flow and demand for different ES (Martnez-Harms and Balvanera, 2012).

MATERIAL AND METHODS

In this study, GIS analysis was used to assess the potential of some ecosystems within the natural park „Porțile de Fier" in Romania, to provide ecosystem services. (Fig. 1). The park is known for its high biodiversity, varied habitats and sub-Mediterranean climate. As a characteristic, a type of vegetation formation imposed by the floristic composition specific to the sub-Mediterranean area, called șibleac, has been identified in the Park area. The Șibleac vegetation landscape occupies extensive areas in the Almaj Mountains. Șibleac appears in the landscape in the form of bushes and was born as a result of the explotation of thermophilic forests.

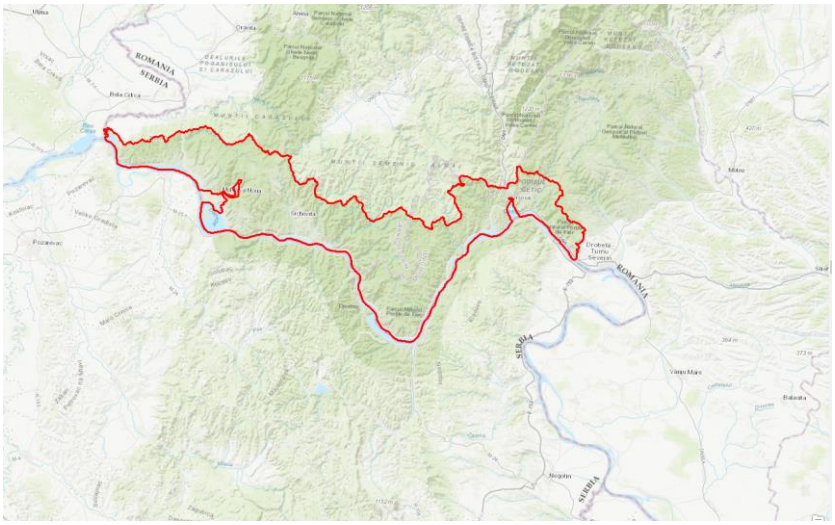

Figure 1. Location of „Porțile de Fier" Natural Park (ArcMap 10.4)

The ecosystem potential of this park in providing the following ecosystem services was assessed:

1) Global climate regulation;
2) Water purification;
3) Crop production;
4) Recreation and tourism.

The stages of this assessment were the following:

1) Obtaining the Corine Land Cover raster with the park's habitats for the year 2018 (the most recent year on the site) from the Copernicus site (https://land.copernicus.eu/en/products/corine-land-cover).

2) Ecosystem service matrices consist of ecosystem services (currently 11 regulating, 14 provisioning and 6 cultural services) on the x-axis and geobiophysical spatial units (e.g. the 44 CORINE8 land cover types used here) on the y-axis. A more detailed description of the method, is presented in Burkhard et al. (2014). Normalization to this relative 0-5 scale aims to make different ecosystem services (measured and evaluated through various indicators and units) comparable with each other (Burkhard et al., 2012; Burkhard and Maes 2017).
3) Forests, wetlands and water bodies received particularly good rankings. The more anthropogenically influenced land cover types (most at the top of the matrix) have considerably lower potential for ecosystem services, with the exception of some cultural ecosystem services available in urban areas. Many agricultural land cover types have high potential for providing food-related ecosystem services. This is typical of pre-harvest agricultural areas. The connection between freshwater supply from groundwater sources and above-ground land cover types is not always feasible. Therefore, only surface water bodies were considered for freshwater supply here.
4) The final maps of the four ecosystem services were coded as follows (Figures 3 - 6):
   - 0: no high potential;
   - 1: low relevant potential;
   - 2: relevant potential;
   - 3: medium relevant potential;
   - 4: high relevant potential;
   - 5: very high relevant potential.

All GIS analyses were performed using ArcMap 10.4 (https://www.esri.com/).

RESULTS AND DISCUSSIONS

The distribution of the main categories of ecosystems at the level of the area is shown in Fig. 2. Figures 3-6 show maps of the four ecosystem services analyzed and provided by the ecosystems of „Porțile de Fier" Natural Park for the year 2018. Regarding the ecosystem service of global climate regulation, the highest relevant potential was provided by forests and natural grasslands (value 5 in Fig. 3). All ecosystems with a strong anthropogenic character had a potential of 0.

Regarding the water purification service, the highest potential also belonged to natural forests and meadows (Fig. 4). Agricultural crops, orchards and vineyards provide the highest values of production-related ecosystem service (Fig. 5).

The recreational value of the park, as an ecosystem service, is quite high, if we analyze Fig. 6. More complex analyses can track how these ecosystem services have changed over time, thus highlighting areas of the park where these services have increased, decreased, or remained at a constant level.

These ecosystem services maps can be used in decision-making activities regarding activities carried out in the park, in actions to justify the need to protect its biodiversity, as well as in raising awareness among the local population about the immediate and future benefits they can obtain by protecting it.

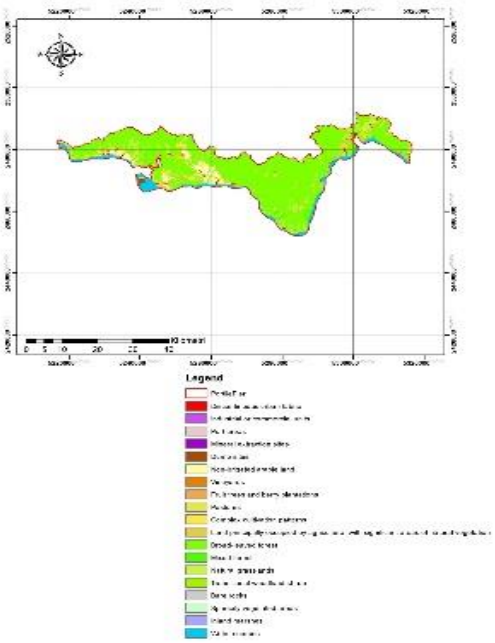

Figure 2. Distribution of habitats (ecosystems) at the level of „Porțile de Fier” Natural Park (ArcMap 10.4)

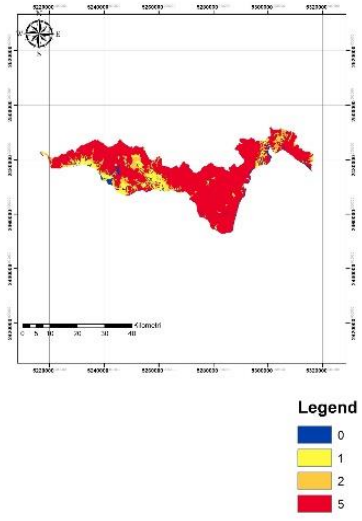

Figure 3. The potential of „Porțile de Fier” Natural Park ecosystems for global climate regulation (ArcMap 10.4)

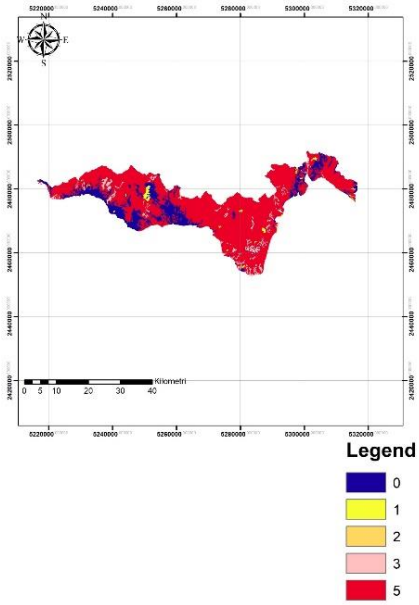

Figure 4. The potential of „Porțile de Fier” Natural Park ecosystems for water purification (ArcMap 10.4)

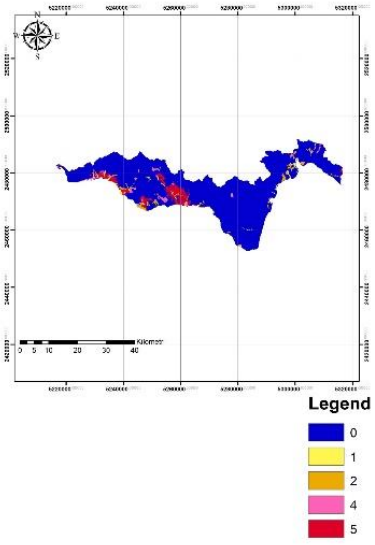

Figure 5. The potential of „Porțile de Fier” Natural Park ecosystems for production/crops (ArcMap 10.4)

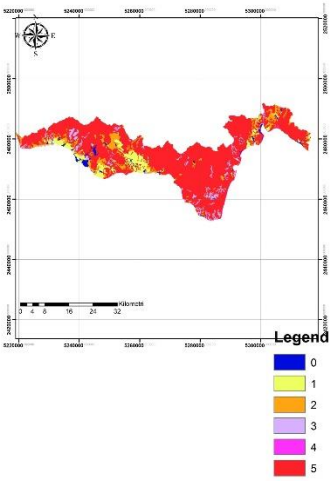

Figure 6. The potential of „Porțile de Fier" Natural Park ecosystems for recreation and tourism (ArcMap 10.4)

CONCLUSIONS

GIS analysis can be a particularly valuable tool in highlighting and quantitatively assessing the services provided by ecosystems. Based on GIS analysis and the ecosystem services classification methodology, „Porțile de Fier" Natural Park has a high potential for a series of services related to climate regulation, water purification and recreation, and less for production. This study highlights and provide a framework for obtaining a rapid assessment of ecosystem services at the level of a protected area, the analyses being able to be complexified for more detailed analyses.

REFERENCES

Boerema A., Rebelo A.J., Bodi M.B., Esler K.J., Meire P. 2017. Are ecosystem services adequately quantified? Journal of Applied Ecology 54, 358–370.

Bouma J.A., van Beukering P.J.H. (Eds). 2015. Ecosystem Services: From Concept to Practice. Cambridge University Press.

Burkhard B., Kandziora M., Hou Y., Muller F. 2014. Ecosystem Service Potentials, Flows and Demands - Concepts for Spatial Localisation, Indication and Quantification Landscape Online 34: 1-32.

Burkhard B., Kroll F., Nedkov S., Muller F. 2012. Mapping supply, demand and budgets of Ecosystem Services. Ecological Indicators 21: 17-29.

Burkhard, B. & Maes, J. 2017. Mapping Ecosystem Services. Pensoft.

Kareiva P., Tallis H., Ricketts T.H., Daily G.C., Polasky S. 2011. Natural Capital: Theory and Practice of Mapping Ecosystem Services. Oxford University Press, Oxford.

Martnez-Harms M.J., Balvanera P. 2012. Methods for mapping ecosystem service supply: A review. International Journal of Biodiversity Science, Ecosystems Services and Management 8: 17-25.