Developments of biodiversity monitoring: the Biodiversity-related Niches Differentiation Theory (BNDT) and the new Species-Area Index (SAI)

Roberto Cazzolla Gatti, Ph.D.
Department of Forest Resources and Environment (DISAFRI) - University of Tuscia, Viterbo, Italy

Abstract

This work presents the preliminary results of the biodiversity monitoring with new approaches that take into account the biological patterns and the characteristics of the biomes in terms of land cover and their temporal variations (land change) for the development of an area-specific index, with new theories related to biodiversity. The study area covers aap of 4,000 km² and belongs to the Central Mediterranean region (Italy, Greece, Croatia, and Slovenia) and to the Montane Mediterranean belt (free and semi-forested). There is also a considerable influence of the Mediterranean patch, with presence of shrubs and scrubland, often with inhabited areas. What is exceptional in these areas is the presence of many species of orchids. Analysis by ground surveys followed by remote sensing and using GIS methods (this approach was combined) with satellite data monitoring (RS) carried out by landfills images, for the assessment of evolution and change of land use over the past 30 years.

Introduction

This research is part of the framework study of the 200 Ecocentres of the Earth and in national scale (Bulgari, F. et al., 2007), on the Central Mediterranean (Max ERC). The Biodiversity in Central Mediterranean is among the Global 20 regions with the highest presence of biodiversity (Briuglia & Nocchi, 2007). Within the Italian territory, ERC identified the biocentric areas (high and low biodiversity) and the areas with potential biodiversity. The Mediterranean region is characterized by the presence of several species of orchids, with the highest biodiversity in the Mediterranean-Montane belt, due to the presence of both mountain areas and coastal areas. The presence of areas of ecological networks ensures the survival of specific communities well structured and allow the presence of peculiar biocenoses (such as those between Decembrinae and Leciniae communities). The new Species-Area Index (SAI) is therefore, the presence of a high number of species and their specific distribution in the area studied.

Results and discussion

The analysis of biodiversity was investigated from main levels of differentiation: biomes, ecosystems, and species (Wright, F.L., 1999). For each level, we reviewed the distribution patterns of the deciduous forest and the conifer forest, the Mediterranean patches, and the grapevine and peach orchards. A very high number of species is found in the deciduous forest and the conifer forest, the Mediterranean patches, and the grapevine and peach orchards. The total number of species identified in the area was 711, of which 541 species (73%) were present in the deciduous forest and the conifer forest, 162 species (23%) in the Mediterranean patches, and 7 species (1%) in the grapevine and peach orchards.

The new area-specific SAI

Applying the criteria for the development of the new area-specific SAI, we found a total of 711 species in the area studied. The SAI is calculated as follows:

\[ SAI = \sum_{i=1}^{n} \frac{S_i}{A_i} \]

where \( S_i \) is the number of species in each area, \( A_i \) is the area of the species, \( S \) is the total number of species, and \( A \) is the total area of the study area.

The value of the index SAI fluctuates from 0 (minimum value of area biological richness) to 1 (maximum value of area biological diversity). Because the total number of species is multiplied by the number of species (which have a high number of species), and they are very rare in the Mediterranean area, and also take into account the abundance of species and biomes diversity related to these specific areas.

The area is divided into 5 different categories based on the number of species:

- \( 0 < SAI < 0.5 \) for low biodiversity areas
- \( 0.5 \leq SAI < 1.0 \) for moderate biodiversity areas
- \( 1.0 \leq SAI < 1.5 \) for high biodiversity areas
- \( 1.5 \leq SAI < 2.0 \) for very high biodiversity areas
- \( SAI \geq 2.0 \) for exceptional biodiversity areas

For instance, if you have an area of 1 km² with 4 species, you can calculate the SAI as follows:

\[ SAI = \frac{4}{1} = 4 \]

But in another area of the same species, we find 20 species whose SAI is high.

We can see the following conclusions:

1. The SAI is 0 if you want to have a positive index (a realistic result). This means that we should select an area not very big to have a valuable species (below 1,500 square km), (II) when the number of species is limited, because in an area with a large number of species and small area, the SAI will be lower, but the same number of species and a large area, the SAI will be higher.
2. If the area is big and the number of species is high, the SAI is high, both in the Mediterranean area and in the semi-forested areas, with an area of species (3000 km²), and many species are present, the SAI will be high, but lower than that of a forested area. In this case, the SAI can be used as a tool to determine the environmental quality, the study of satellite data analysis. Obviously, the number of species and their rarity have an important role in the classification of areas, for the distribution of species in the area and for the conservation of biodiversity.

The same conclusion can be used to monitor new areas when environmental conditions are more developed in coastal, coastal, freshwater, mangroves, deep cold, saltwater, etc.

Fig. 1 The study area

Methods

The old data were divided into four phases which covered a research period of 30 years.

Phase 1: During the first phase the information derived from satellite images LANDSAT (high resolution, from 30 to 40 m) was used in combination with orthophotos (5-10 m resolution) to identify the areas that would be suitable for field surveys. Forest areas, crop paddies of faglia and scrubland were selected, which would be particularly suitable for field surveys, and were included in the new SAI.

Phase 2: In the second phase three research campaigns for each site were carried out in order to detect the changes of the environment and changes in land use. This was done by using a combination of Landsat satellite images and classified aerial photographs. In addition, a combination of biocenoses and their specific characteristics were identified and the presence of different species was recorded.

Phase 3: After each research campaign the whole data and the samples collected were transferred to the laboratories, catalogued and analyzed. Each checklist was compared with the existing database in the area. The data were also compared with previous surveys carried out in the area and with the results of previous surveys available in the area. The new SAI was calculated and discussed, and the results were validated.

Phase 4: During the four phases the surveys conducted by the laboratories were combined with analysis of satellite images to identify different types of vegetation. Detailed maps of biodiversity were also carried out and included in the new SAI. The areas were classified according to the new SAI.

Fig. 2 Map of the sites where there were found rare species correlated to the case of land use.

Fig. 3 Map of the sites where there were found rare species correlated to the case of land use.

Fig. 4 Map of the areas that would reduce the fragmentation of the ecosystems.