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# LEVELS OF BIOLOGICAL DIVERSITY: A SPATIAL APPROACH TO ASSESSMENT METHODS

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**ABSTRACT -** Biological diversity, interpreted as a variety of natural and man-dominated biological and ecological systems, plays an important role in assuring their stability and can be interpreted at different spatial scales, based on the hierarchical level of the system (biocoenose/ ecosystem, biome/complex of ecosystem, biosphere/ecosphere). Literature distinguishes six levels of biodiversity, namely alpha, beta, gamma, delta, epsilon, and omega. The current paper lists methodologies appropriate for assessing diversity at each of these levels, with a particular focus on regional diversity (gamma, delta, and epsilon diversities), i.e. CORINE land cover classification and the biogeographical regions of the European Union.

**Keywords:** α/ β/ γ/ δ/ ε/ ω diversity, ecological systems, CORINE, biogeographical region, region of development

## 1. Systemic organization of the environment

Ecology, inter and trans-disciplinary science, "*assures the theoretical fundament for perceiving and interpreting the «environment», including both natural (physical and biological) environment and the environment transformed by the human species, as a hierarchy of organized and dynamic units with identifiable and quantifiable structural and functional properties*" (Vădineanu, 1998). These units, named generically ***ecological systems***, consist of a lifeless (*abiotic*) component and a living (*biotic*) component, among which interconnections form and make the two components act as a unitary whole. Based on the time and space scales, ecological systems differ by the biotic and abiotic components. Therefore, *ecosystems* consist of a *biotope*, e.g. a certain forest, versant, portion of a river, and a *biocoenose*, i.e. all vegetal and animal species populating the biotope. *Complexes of ecosystems* consist of an *abiotic component* represented by a hydrographic basin of a creek or river, a sea, an ocean, a geographic region, generally named *landscape* in English, *landschaft* in German, populated by a *biome*. The *ecosphere* (all ecological systems on Terra) is formed by an *abiotic component* represented by all *geo-spheres* – lithosphere, atmosphere, hydrosphere, and a *biotic component*, namely the *biosphere* (*Figure 1*).

## 2. Biodiversity: relationship with stability and levels based on the spatial scale

***Biodiversity*** is defined by **Law no. 58 of 13 July 1994 on the ratification of the Convention on biological diversity, signed at Rio de Janeiro on 5 June 1992** as "*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*". In this regard, biodiversity includes:

– Ecological diversity, at different levels: complexes of ecosystems, species and ecological niches (assembly of all conditions needed for a species to exist), diversity of organisms – diversity of taxonomical hierarchy and genetic diversity – genotypes and their frequency in populations, components managed by the United Nations Environment Programme (UNEP), and

– Ethno-cultural diversity – interaction of man at all levels, traditional lifestyles.

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Based on energy consumption, biotic components of ecological systems evolve against entropy. More precisely, the complexity degree of inner structural and functional organization (inner diversity) increases, and the system acquires more stability, understood as a certain regularity or periodicity of the variation of factors, determining a regime character of the variation. Ecology had initially admitted the hypothesis according to which stability is directly (linearly) dependent of diversity (i.e., more diversity = more stability), but later on researchers found out that the relationship is more complex. There is an optimal diversity corresponding to a maximum stability, realized by the association of stably related species, and the excess or deficit in diversity disestablishes the system, determining its reposition on a different evolutional trajectory (Tomescu and Savu, 2002).

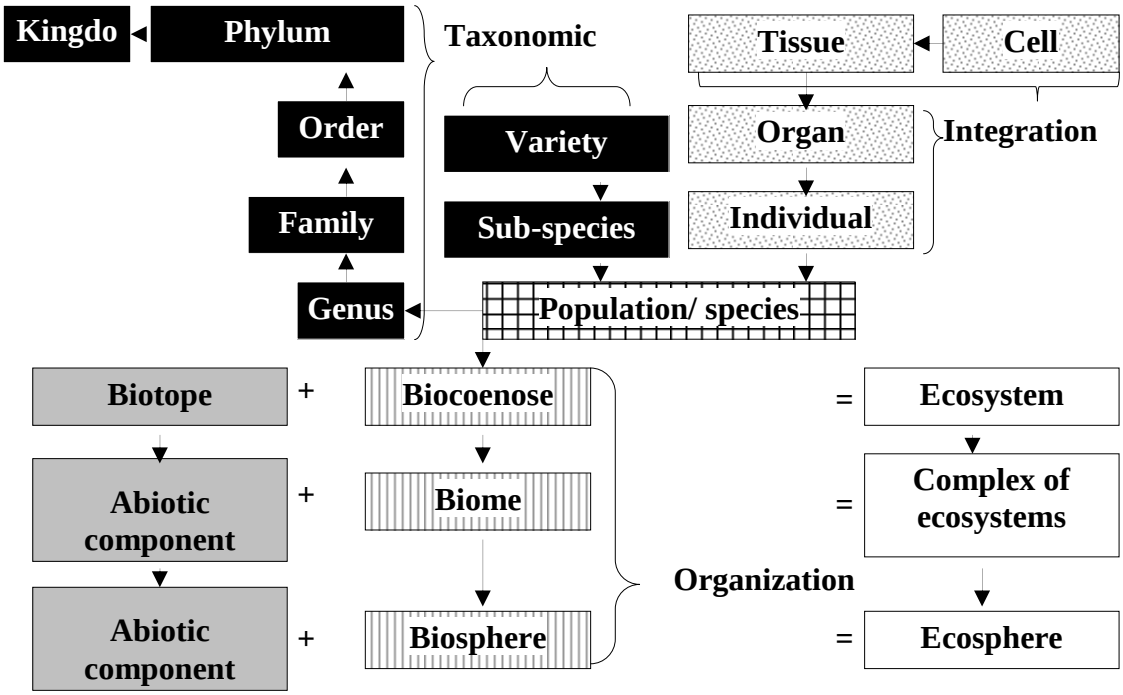



**Figure 1.** *Hierarchy of biological and ecological systems and the taxonomic hierarchy* (Petrișor, 2007)

Stability of ecological systems can be interpreted based on four concepts (Vădineanu, 1998):

- ***Resilience*** – the speed of the return of state variables to equilibrium conditions after the action of a command factor (greater for stable systems);
- ***Persistence*** – conservatorium of the system to the pressure of command factors – measured by the duration of the equilibrium state while command factors act against the system (greater for stable systems);
- ***Resistance*** – amplitude of changes of state variables when command factors act (smaller for stable systems);
- ***Variability***– frequency of modifications of state variables (smaller for stable systems).

From a spatial planning perspective, administrative-territorial units of European countries have been classified by the Statistical Office of the European Communities (EUROSTAT) based on a unitary system named Nomenclature of Territorial Units Statistics (NUTS). Romania has three types of NUTS units: regiuni de dezvoltare (regions of development) - NUTS level 2, județe (counties),

including Bucharest - NUTS level 3, and comune/ municipii/ oraşe (communes/ municipalities/ cities) - NUTS level 5 (Pascariu, 2002).

Based on the spatial scale, Magurran (1998) and Pusceddu (2008) distinguish the following levels of diversity:

- Alpha (α) diversity – diversity of an ecosystem, community, taxonomic or functional group or biocoenose;
- Beta (β) diversity – diversity of ecosystems within a complex of ecosystems, diversity of habitats or diversity along gradients;
- Gamma (γ) diversity – diversity of a regional complex of ecosystems, a large area, e.g. biogeographical regions within continents, presented below;
- Delta (δ) diversity – diversity of higher rank (macro-regional) complexes of ecosystems, e.g. global biogeographical regions, presented below;
- Epsilon (ε) diversity – diversity of life environments (oceanic, terrestrial);
- Omega (ω) diversity – philogenetic diversity / diversity of the global taxonomical hierarchy.

α diversity is also called specific diversity, measured by the *species richness*, i.e. either the total number of species or the number of species within a certain systematic or functional group, or the value of a certain index of diversity, in a more elaborate form. Most diversity indices are built starting from the number of species and number of individuals of each species, and a certain mathematical model of diversity, based on informational entropy, geometry, frequency distributions, etc. (Magurran, 1998).

With respect to the diversity of ecosystems within a complex of ecosystems (β diversity), Vădineanu (1998) distinguishes the following types:

- Man-dominated ecosystems (human socio-economic system): Rural, agro-industrial ecosystem, transport nets; Agro-ecosystems; Urban ecosystems;
- Maritime ecosystems and complexes of ecosystems: Open ocean; Littoral waters (continental plateau); Upwelling; Abyssal zones; Coastal ecosystems – estuaries, lagoons;
- Continental aquatic ecosystems and complexes of ecosystems: Lentic ecosystems – lakes, ponds; Lotic ecosystems – creeks, rivers; Wetlands – deltas, flood areas;
- Terrestrial ecosystems and complexes of ecosystems: Arctic and alpine ecosystems; Coniferous forests; Broad-leaved forests; Temperate climate pastures; Tropical pastures and savannas; Areas with winter precipitations and summer droughts; Desert: grass and brushes; Tropical forests (rainy and draughty seasons); Wet tropical forests.

The diversity of the types of ecosystems (β diversity) is also reflected by the diversity of habitats corresponding to biotopes and evaluated by land cover. The European Union uses the CORINE (Coordinated Information on the European Environment) classification, used initially for biotopes and applied today to land parcels to reflect their ***cover*** and ***use***, presented in *Table 1* (Commission of the European Communities, 1995, pp. 21; de Lima, 2005). ***Land use*** shows how man uses land; ***land cover*** indicates what lies on that surface, from a biophysical viewpoint (Jensen, 2000, pp. 413). E.g. in a mountain area the land could be covered by conifers, but the parcel could be a park or a natural forest; in a field, land could be covered by herbaceous vegetation, but used in agriculture (as a pasture or cropland), as a park (if it lies within a city), or could be a natural pasture.

Natural and seminatural ecosystems represent some 47% of the total surface in Romania. As a consequence of CORINE Biotopes Program, 783 types of habitats were identified and characterized in 261 areas analyzed all over the national territory: 13 coastal habitats, 89 wetland habitats, 196 pasture habitats, 206 forest habitats, 54 marsh habitats, 90 rock/sand habitats and 135 agricultural habitats (Guvernul României, 2001).

The utility of CORINE classification scheme is illustrated in *Figure 2* by the example of Bucharest, based on 2000 data (de Lima, 2005). The diversity of CORINE categories corresponding to the regions of development (presented in *Figure 2 b*) is displayed in *Figure 2 a* and summarized in *Table 2*, also referring to their biogeographical situation.

**Table 1.** *CORINE land cover classification scheme.*

| Level 1 | Level 2 | Level 3 |
|---|---|---|
| 1. Artificial surfaces | 1.1 Urban fabric | 1.1.1 Continuous urban fabric |
| | | 1.1.2 Discontinuous urban fabric |
| | 1.2 Industrial, commercial and transport units | 1.2.1 Industrial or commercial units |
| | | 1.2.2 Road and rail networks and associated land |
| | | 1.2.3 Port areas |
| | | 1.2.4 Airports |
| | 1.3 Mine, dump and construction sites | 1.3.1 Mineral extraction sites |
| | | 1.3.2 Dump sites |
| | | 1.3.3 Construction sites |
| | 1.4 Artificial, non-agricultural vegetated areas | 1.4.1 Green urban areas |
| | | 1.4.2 Sport and leisure facilities |
| 2. Agricultural areas | 2.1 Arable land | 2.1.1 Non-irrigated arable land |
| | | 2.1.2 Permanently irrigated land |
| | | 2.1.3 Rice fields |
| | 2.2 Permanent crops | 2.2.1 Vineyards |
| | | 2.2.2 Fruit trees and berry plantations |
| | | 2.2.3 Olive groves |
| | 2.3 Pastures | 2.3.1 Pastures |
| | 2.4 Heterogeneous agricultural areas | 2.4.1 Annual crops associated with permanent crops |
| | | 2.4.2 Complex cultivation patterns |
| | | 2.4.3 Land principally occupied by agriculture, with |
| | | 2.4.4 Agro-forestry areas |
| 3. Forest and seminatural areas | 3.1 Forests | 3.1.1 Broad-leaved forest |
| | | 3.1.2 Coniferous forest |
| | | 3.1.3 Mixed forest |
| | 3.2 Scrub and/or herbaceous vegetation associations | 3.2.1 Natural grasslands |
| | | 3.2.2 Moors and heathland |
| | | 3.2.3 Sclerophyllous vegetation |
| | | 3.2.4 Transitional woodland-shrub |
| | 3.3 Open spaces with little or no vegetation | 3.3.1 Beaches, dunes, sands |
| | | 3.3.2 Bare rocks |
| | | 3.3.3 Sparsely vegetated areas |
| | | 3.3.4 Burnt areas |
| | | 3.3.5 Glaciers and perpetual snow |
| 4. Wet-lands | 4.1 Inland wetlands | 4.1.1 Inland marshes |
| | | 4.1.2 Peat bogs |
| | 4.2 Maritime wetlands | 4.2.1 Salt marshes |
| | | 4.2.2 Salines |
| | | 4.2.3 Intertidal flats |
| 5. Water bodies | 5.1 Inland waters | 5.1.1 Water courses |
| | | 5.1.2 Water bodies |
| | 5.2 Marine waters | 5.2.1 Coastal lagoons |
| | | 5.2.2 Estuaries |
| | | 5.2.3 Sea and ocean |

Diversity of biogeographical regions (γ, δ or ε diversity): Global diversity (ε diversity) is based on Pielou's classification (1979), presented in *Figure 3a*. European biogeographical regions (γ or δ diversity) were identified by the programs Emerald and Natura 2000 (European Topic Centre on Biological Diversity, 2006). The European Environment Agency (EEA) presents, within the European Environment Information and Observation Network (EIONET), a classification of European biogeographical regions (*Figure 3b*). *Figure 3c* details the situation in Romania, for comparative purposes, using the same classification scheme. The analysis of aforementioned data indicates that Romania contains five of the eleven biogeographical regions identified in Europe. Biogeographical diversity offers Romania a special environmental asset (in comparison, Hungary, the United Kingdom, Lithuania, Latvia, Estonia or the Netherlands are uniform from the viewpoint of biogeography, and larger countries – Germany or Poland – present only two biogeographical regions.

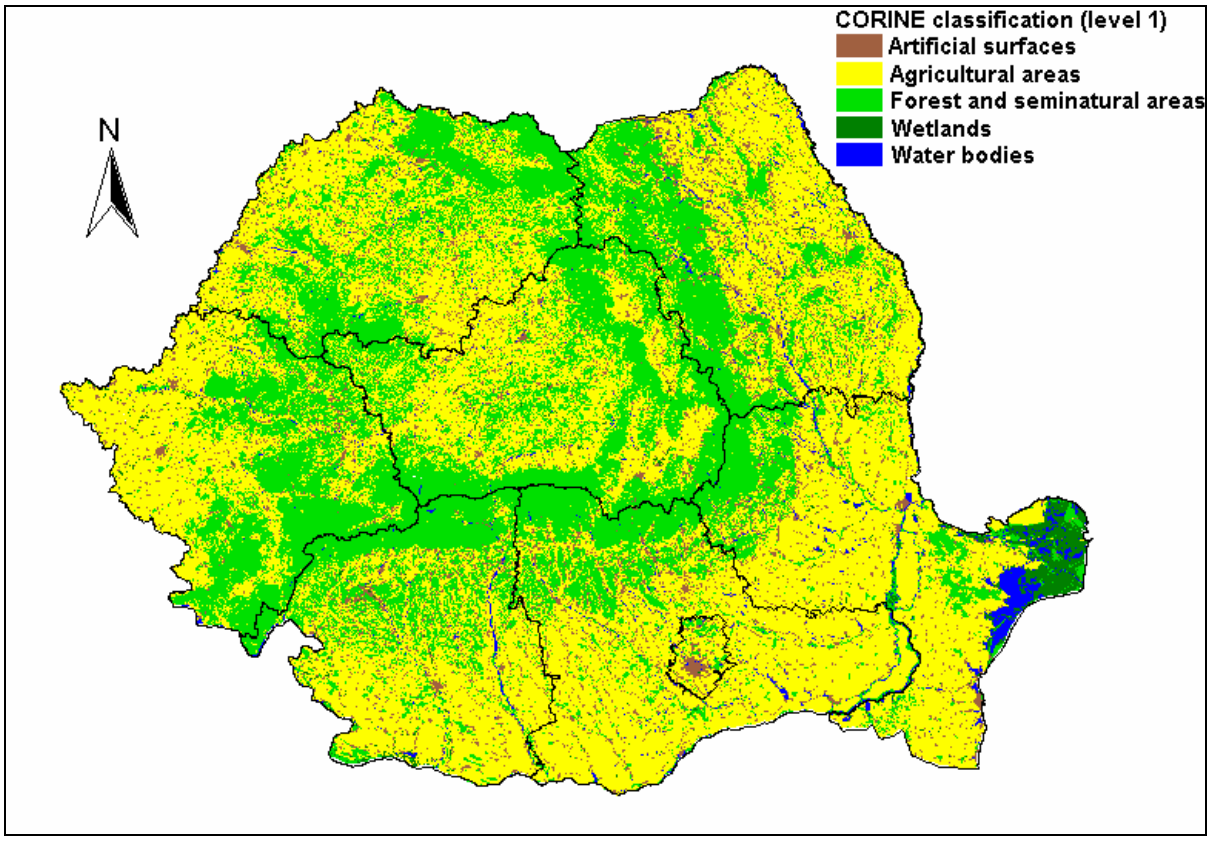



**Figure 2a.** *Biotopes characteristic to the regions of development*.
CORINE classification – 2000 data

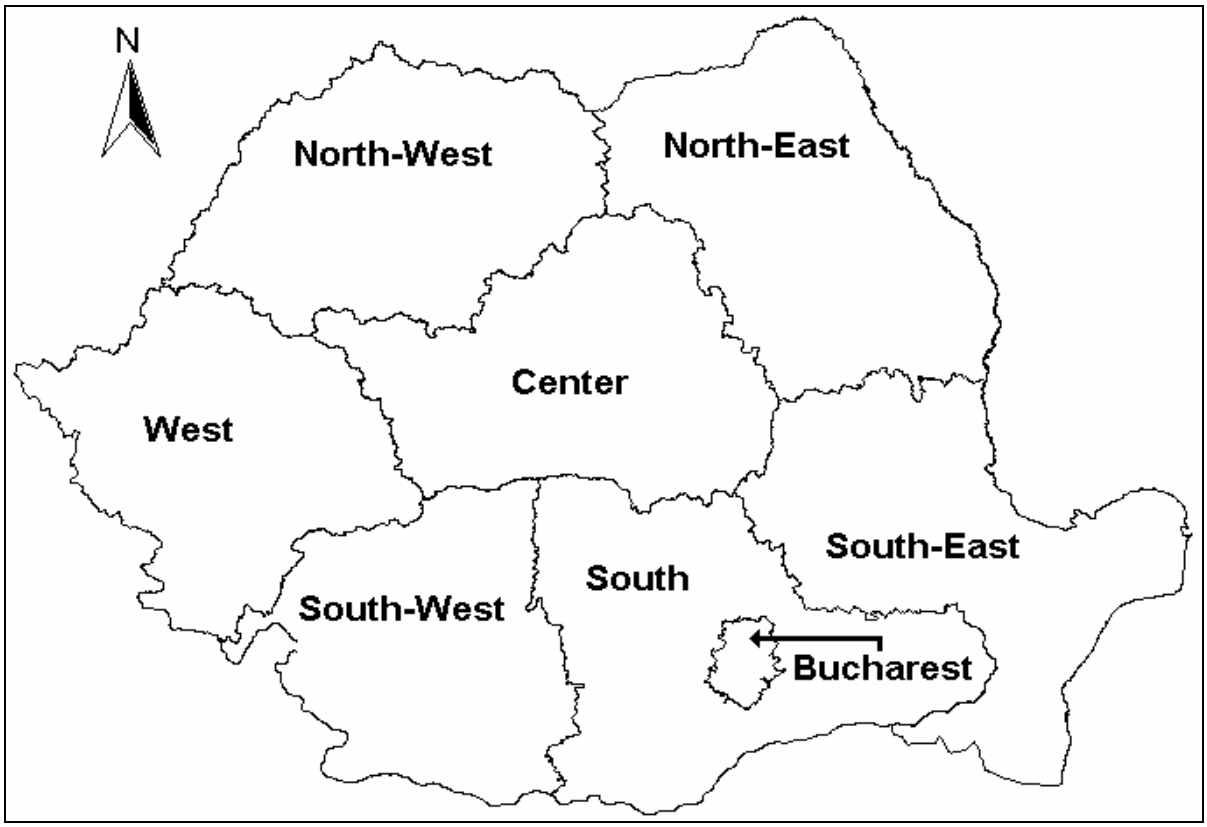



**Figure 2b.** *The Romanian regions of development.*

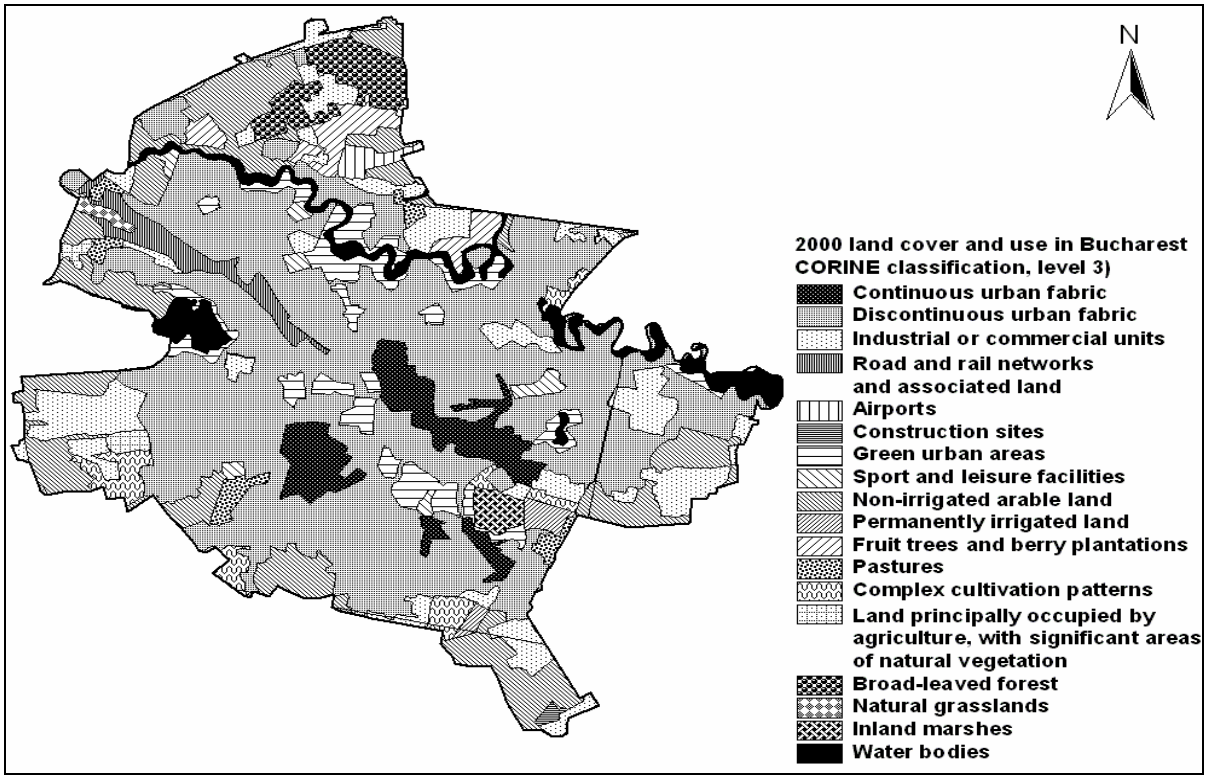
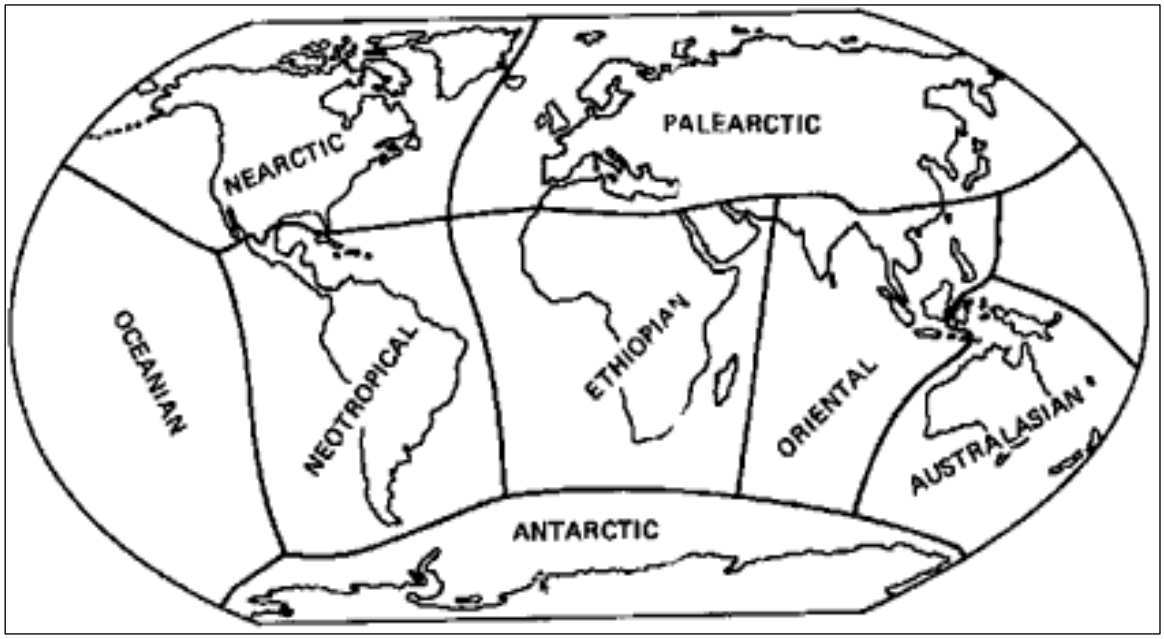
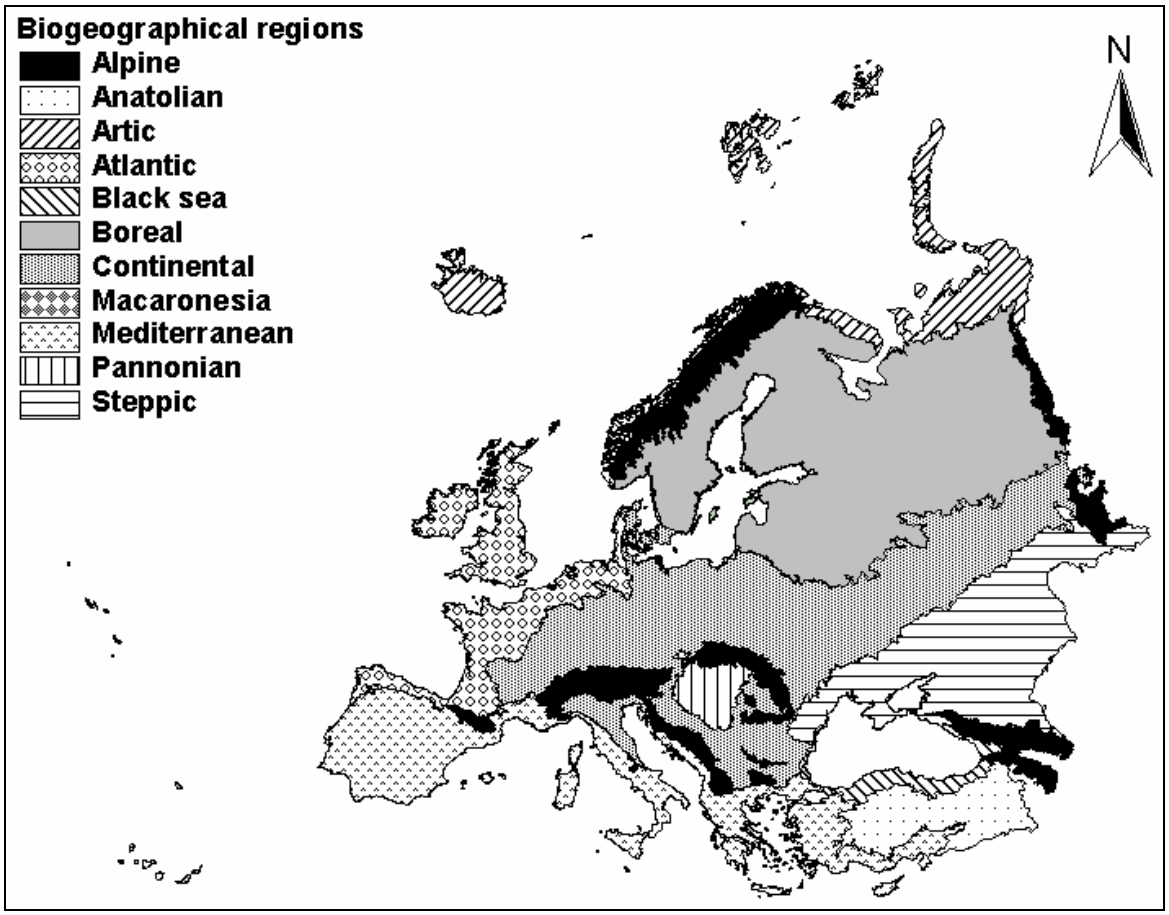



**Figure 2c.** *Biotopes characteristic to Bucharest, CORINE classification – 2000 data.*

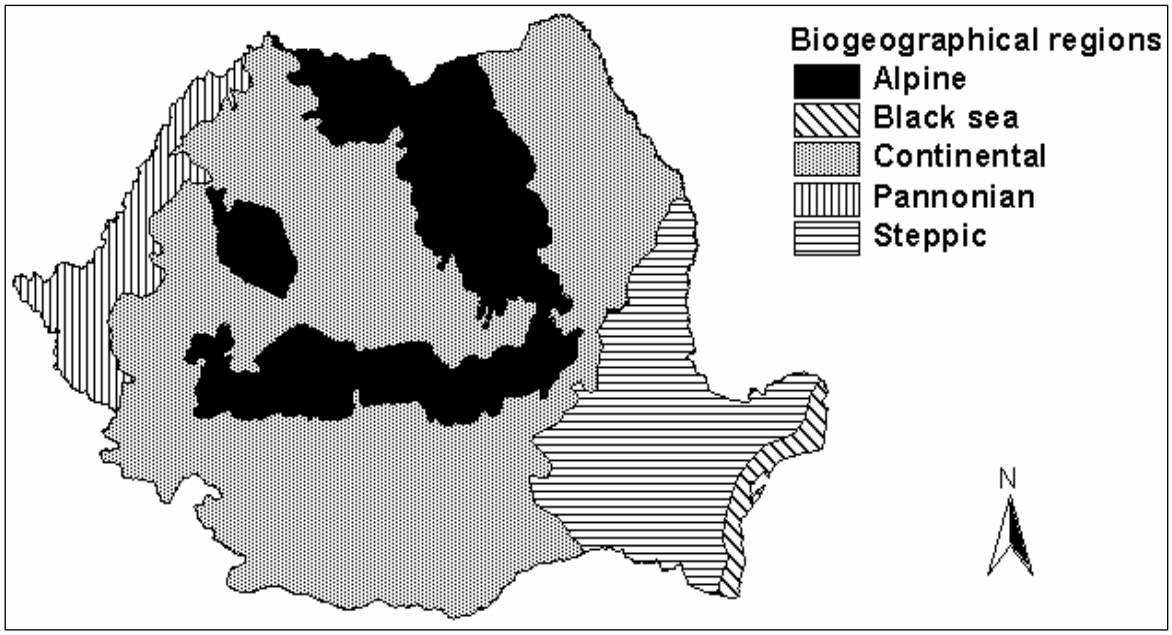
a


NEARCTIC
PALEARCTIC
OCEANIAN
NEOTROPICAL
ETHIOPIAN
ORIENTAL
AUSTRALASIAN
ANTARCTIC

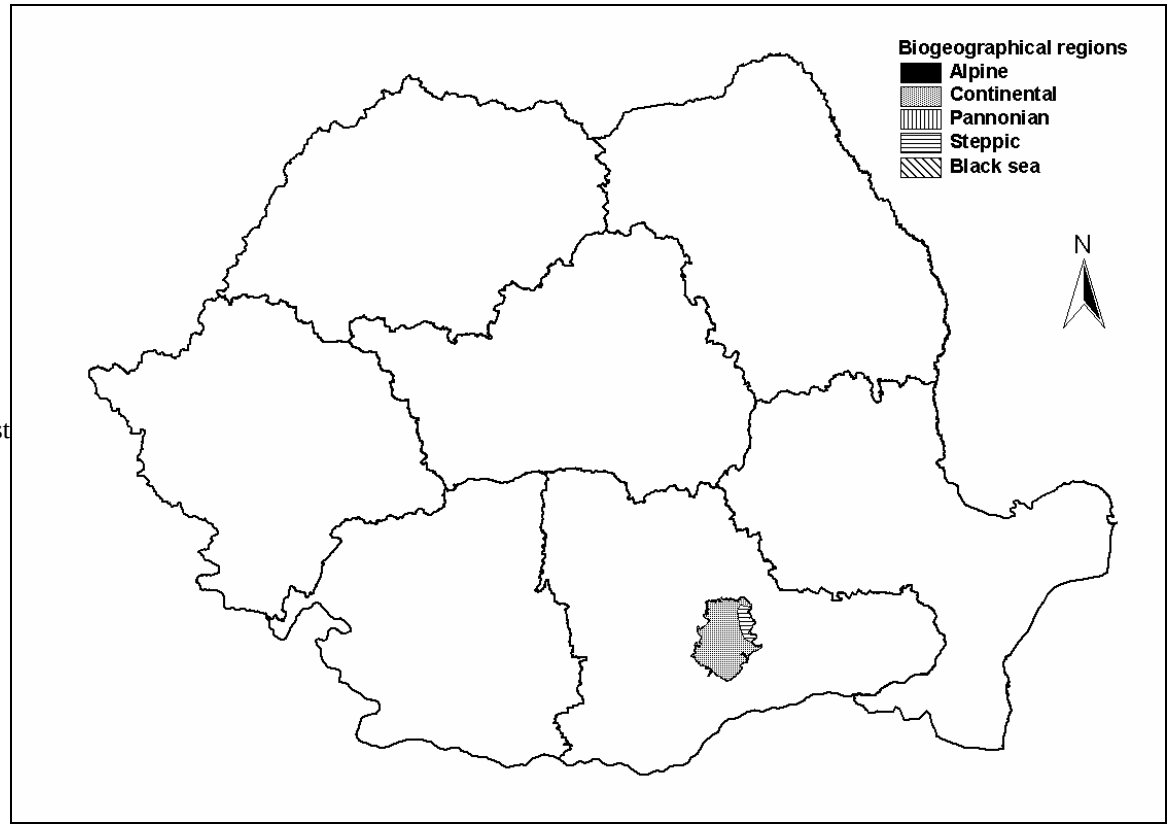
b


Biogeographical regions
Alpine
Anatolian
Artic
Atlantic
Black sea
Boreal
Continental
Macaronesia
Mediterranean
Pannonian
Steppic
N

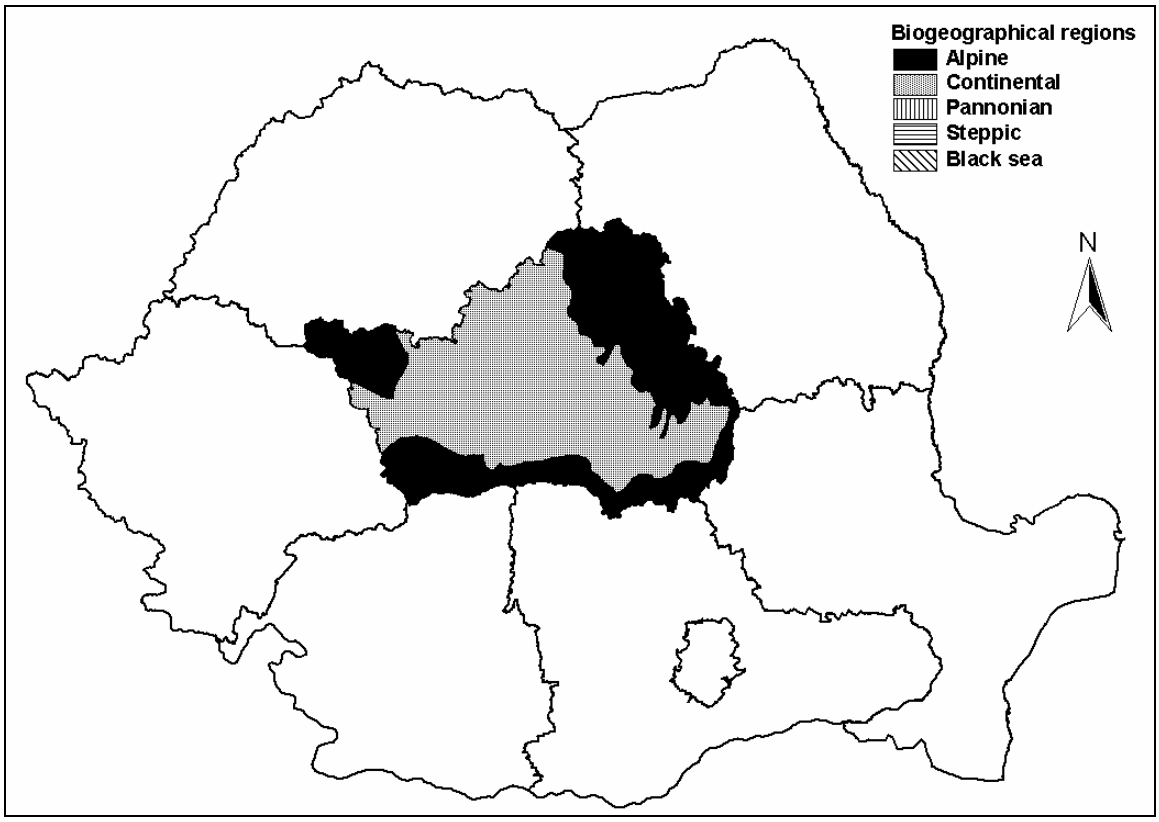
c



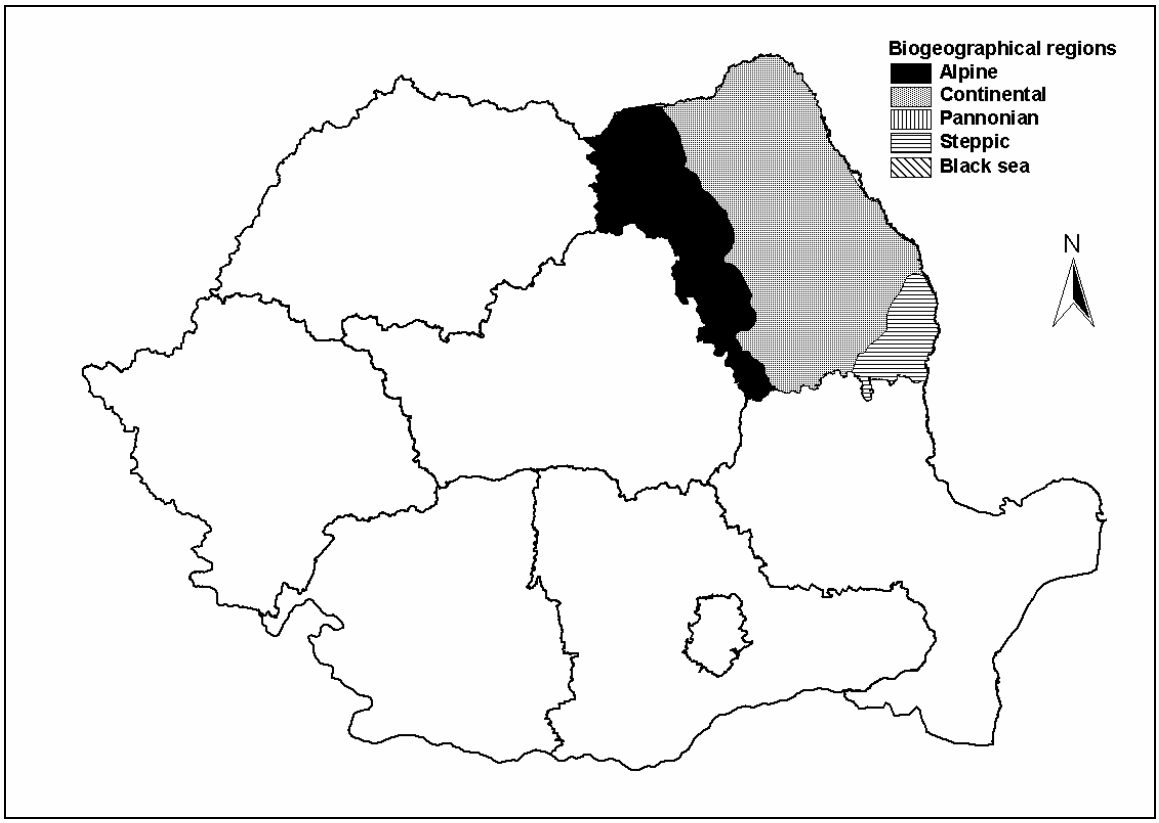

d - i - Bucharest



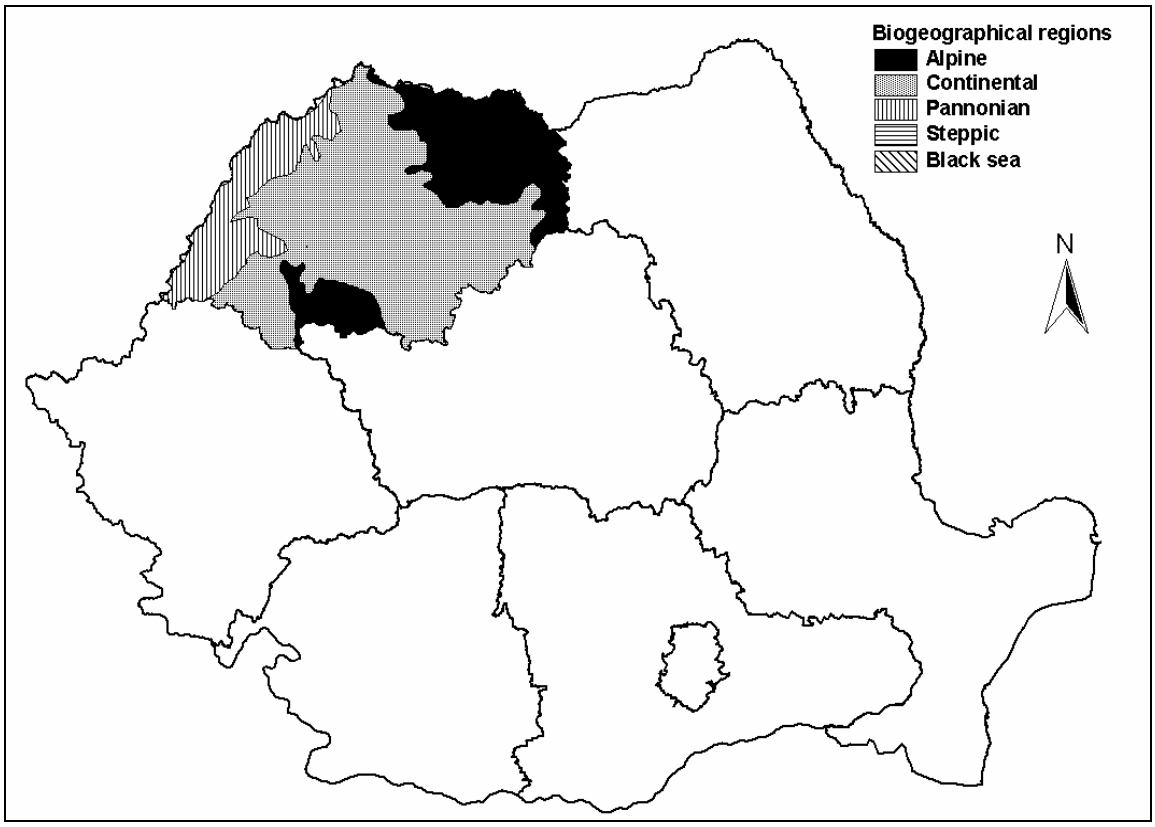
d - ii - Centre



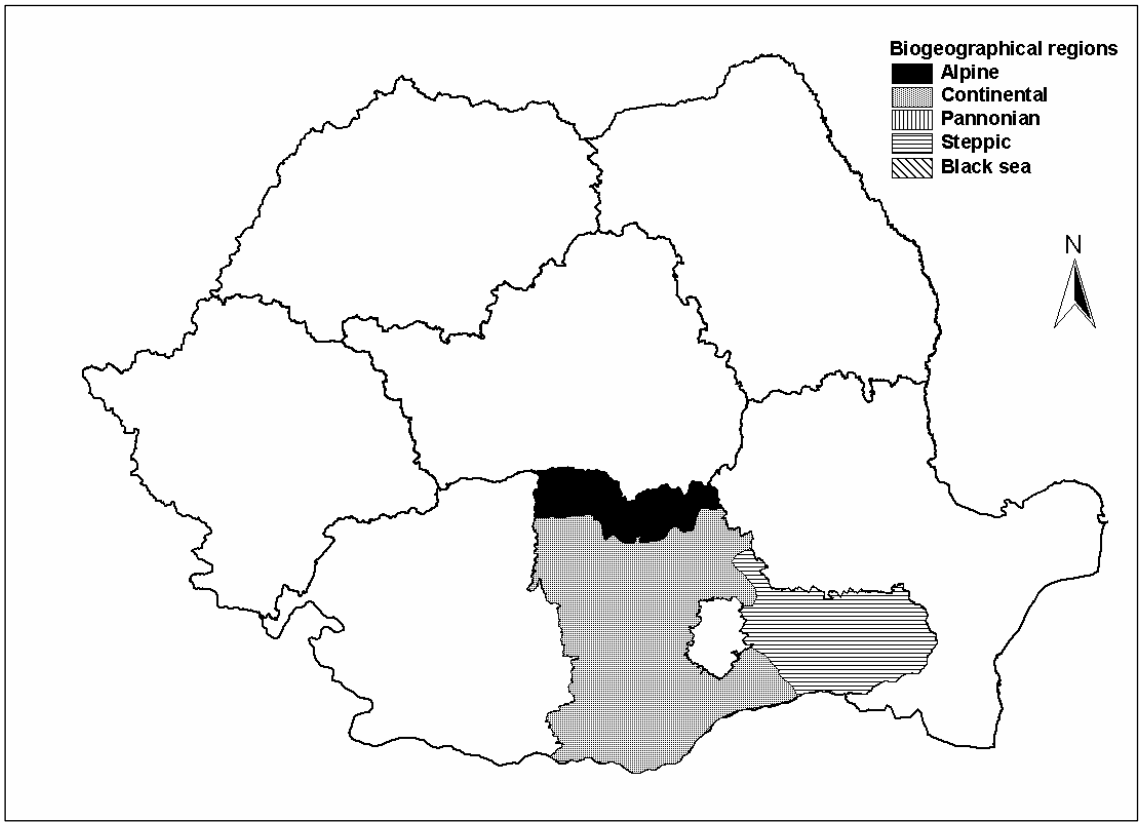

d - iii - North-East



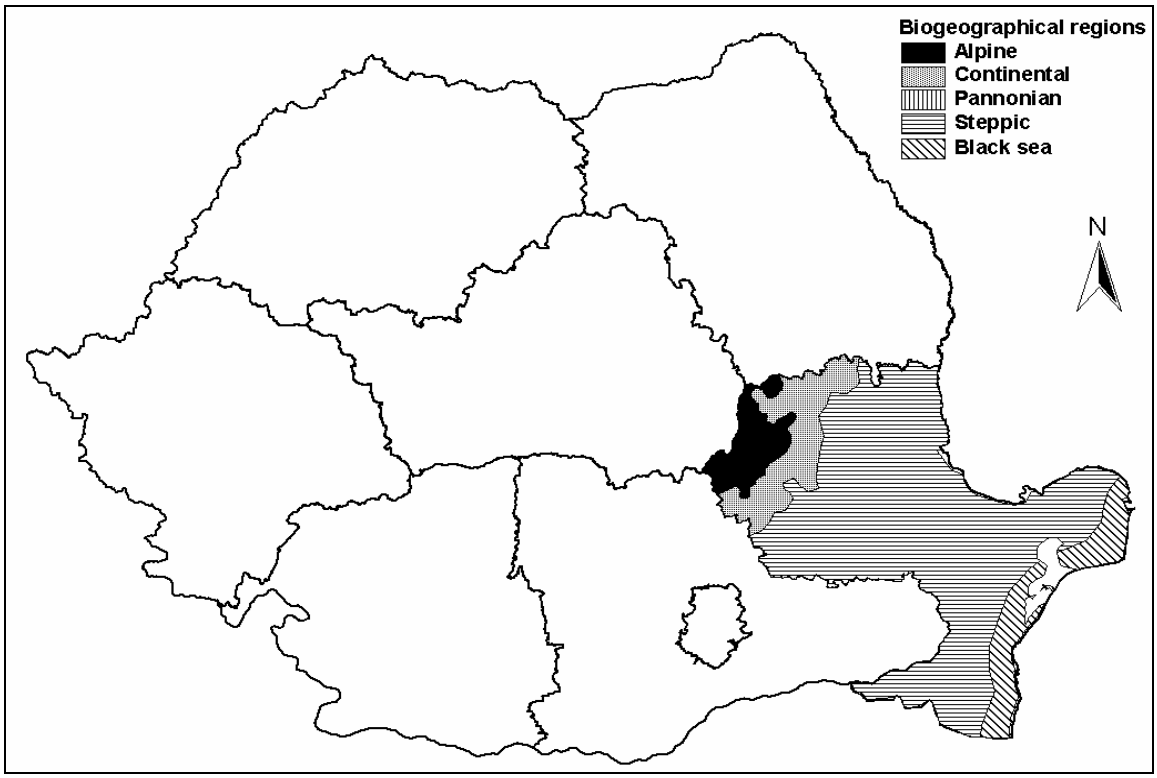
d - iv - North-West



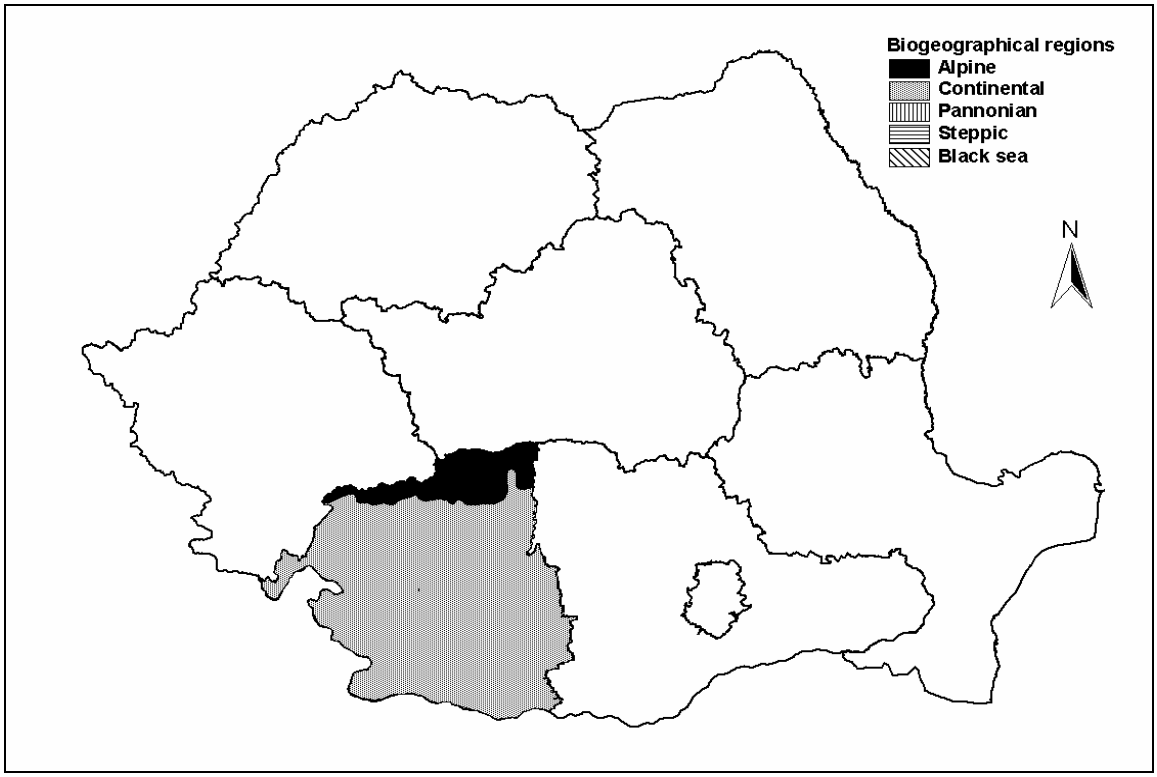

d - v - South



d - vi - South-East




d - vii - South-West



d - viii - West

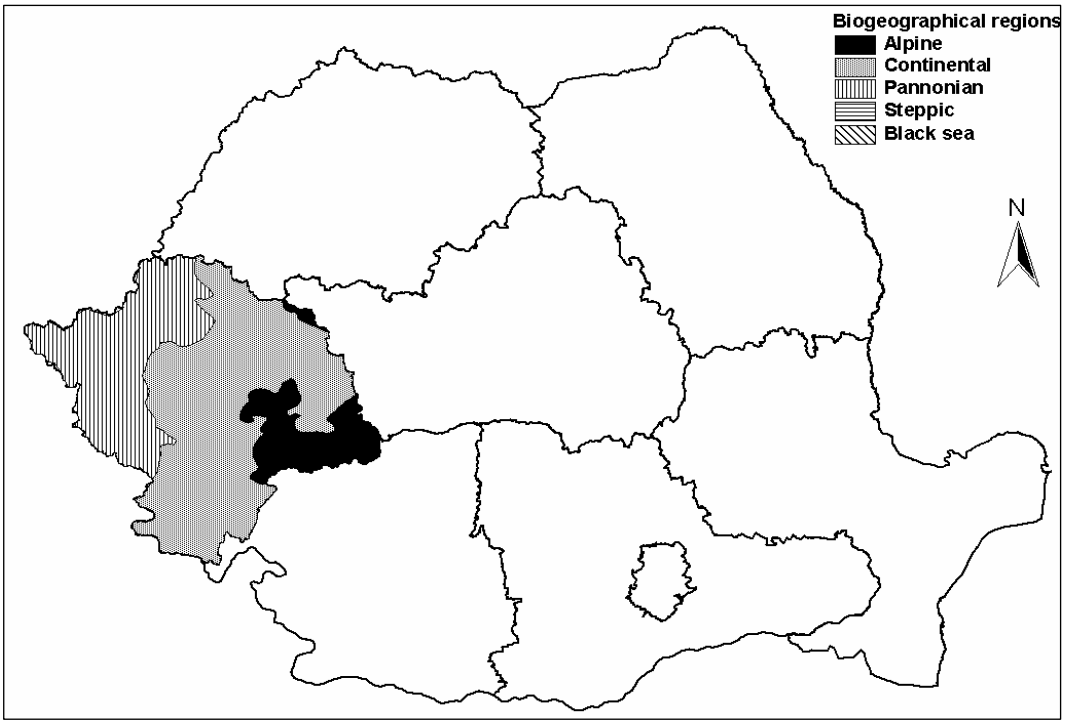



**Figure 3.** *Biogeographical regions (a) global (Pielou, 1979), (b) European (Commission of the European Communities, 1995), (c) Romanian - national and (d) Romanian, corresponding to the regions of development* (Commission of the European Communities, 1995)

**Table 2.** *Characterization of ecosystems within the regions of development.*

| | **Biogeographical** | **Land use/cover** |
|---|---|---|
| Bucharest | Steppic and continental. High diversity despite of reduced surface. | Highest percentage of built areas. Other than these, agricultural land and very little forested land. |
| Centre | Alpine and continental (in the centre). | Agricultural areas surrounded by forests. Few urban areas visibly defined. |
| North-East | Alpine and continental (predominant). | Forested areas (West) and agricultural lands in the East (predominant). Scattered built areas, looking like elongated regions along the main valleys. |
| North-West | Alpine, continental (predominant, situated in the centre) and pannonian (West). High diversity. | Forested areas (North and South) and agricultural lands (predominant in all other areas). Few urban areas in North, South and West. |
| South | Alpine (North), continental (predominant, South) and steppic (East). High diversity. | Forests in the North. Agricultural lands (predominant). Urban areas well defined. Waters easily noticeable. |
| South-East | Alpine, continental, steppic and Black Sea, disposed in this order as parallel bands from NE to SW. Highest diversity. | Forests in the South-West. Agricultural lands (predominant). The Danube Delta can be seen in the East; due to it, this region has the largest percentage of waters and wetlands. Few urban centres noticeable as well. |
| South-West | Alpine (North, poorly represented), continental (predominant, in the South). High diversity. | Forests in the North. Agricultural lands (predominant). Urban areas visible along the main valleys. Waters visible too. |
| West | Alpine, continental and pannonian, disposed in this order as parallel bands, relatively equal, from NE to SW. High diversity. | Agricultural and forested areas with approximately equal percentages, intermingled, even though agricultural areas are predominant in the West. Few urban centres visible. |

### 3. Diversity of the European continent

The evaluation of European biodiversity is the output of successive studies, concluded with presentations delivered at Dobris (1995), Aarhus (1998), Kiev (2003) and Belgrade (2007), and published by the European Environment Agency. The information used in these assessments is derived from satellite imagery or received from specialized agencies (European Environment Agency, 2007; Nunes de Lima, 2005).

The diversity of biogeographical regions corresponding to the regions of development is displayed in *Figure 3 d-i* (Bucharest), *ii* (Centre), *iii* (North-East), *iv* (North-West), *v* (South), *vi* (South-East), *vii* (South-West) and *viii* (West). The analysis of these maps leads to the same conclusion on the high diversity of biogeographical regions in Romania. Even smaller regions of development include at least two biogeographical regions and the largest ones, four (South-East). Their complete characterization is summarized in *Table 2*.

A different method to analyze anthropic impact on the complexes of ecosystems is to compute the ***ecological footprint***, measuring anthropic pressure on natural ecological ecosystems by estimating the amount of biologically productive land and sea area needed to regenerate (if possible) the resources a human population consumes and to absorb and render harmless the corresponding waste, given prevailing technology and current understanding (Wikipedia, 2007). In other words, the ecological footprint measures the natural surface needed to support humanity if everybody lived a given lifestyle (Wikipedia, 2007) through three methods used to estimate (Chambers *et al*., 2000; BBC News, 2007):

- The (vegetated) surface that could absorb the carbon dioxide resulted from burning fossil fuels and unabsorbed by the oceans;
- The cultivated surface that would produce the amount of alcohol equivalent to burnt fossil fuels;
- The (vegetated) surface that would have been needed in the geological past to form fossil fuels (e.g., forests that generated coals in the Carboniferous).

In this respect, *Table 3* presents the European situation in 2001 and 2003, while *Figure 4*, the international one.

The assessments of European environmental quality have led to the identification of several causes of the decline of biodiversity, summarized in *Table 4* (European Environment Agency, 2007, pp. 186). Many of these are quantifiable at the spatial scale of complexes of ecosystems and important for forecasting the evolution of environmental quality of the regions of development.

A EEA report shows that urban sprawl and expansion of transport infrastructure lead to the overexploitation of natural resources, pollution of atmosphere, water and soil, loss of biodiversity, and desertification (European Environment Agency, 2006, pp. 28-37). Urban sprawl can be used looking at land use maps, as it has been shown previously. EEA has analyzed these changes in Romania, showing that forested and heterogeneous agricultural lands have increased their surface, whilst shrubberies and permanent croplands reduced their surface. As the situation of the regions of development could differ from the national one, it is important to assess it based on more recent data. The utility of such assessments results from analyses of particular sub-regional areas, where the magnitude of changes increases and makes them easier to notice. *Figure 4* presents the situation of the counties Gorj and Vâlcea from the South-West region of development where some built surfaces were returned to agriculture (less) or forested (more) and buildings were raised on former agricultural or deforested lands. The amplitude of such phenomena is higher around the cities Motru and Rovinari (Gorj county) and Berbeşti (Vâlcea county). *Figure 5* presents the situation of the region of development Bucharest-Ilfov, where the most important phenomenon is represented by the development of constructions on former agricultural lands, especially in the sector situated N-NE-E of Bucharest, immediately close to it (commune Voluntari, Ilfov county).

**Table 3.** *Ecological footprint in Europe*

| | 2001 population (million) | 2001 (ha/person) | 2003 (ha/person) | Change (%) |
|---|---|---|---|---|
| **Global** | **6,301.5** | **2.2** | | |
| **Developed countries** | **955.6** | **6.4** | | |
| **Developing countries** | **3,011.7** | **1.9** | | |
| **Undeveloped countries** | **2,303.1** | **0.8** | | |
| Albania | 3.2 | 1.46 | 1.43 | -2 |
| Austria | 8.1 | 4.80 | 4.94 | 3 |
| Belarus | 9.9 | 3.07 | 3.32 | 8 |
| Belgium and Luxemburg | 10.8 | 5.28 | 5.61 | 6 |
| Bosnia and Herzegovina | 4.2 | 1.99 | 2.33 | 17 |
| Bulgaria | 7.9 | 2.99 | 3.11 | 4 |
| Croatia | 4.4 | 2.57 | 2.94 | 14 |
| Check Republic | 10.2 | 4.65 | 4.91 | 6 |
| Denmark | 5.4 | 7.02 | 5.75 | -18 |
| Estonia | 1.3 | 5.26 | 6.47 | 23 |
| Finland | 5.2 | 6.63 | 7.64 | 15 |
| France | 60.1 | 5.61 | 5.63 | 0 |
| Germany | 82.5 | 4.44 | 4.55 | 2 |
| Greece | 11.0 | 5.11 | 5.00 | -2 |
| Hungary | 9.9 | 3.51 | 3.50 | 0 |
| Ireland | 4.0 | 5.04 | 4.95 | -2 |
| Italy | 57.4 | 3.87 | 4.15 | 7 |
| Latvia | 2.3 | 2.81 | 2.59 | -8 |
| Lithuania | 3.4 | 4.05 | 4.44 | 10 |
| Macedonia | 2.1 | 2.00 | 2.32 | 16 |
| Moldova | 4.3 | 1.29 | 1.27 | -2 |
| The Netherlands | 16.1 | 4.66 | 4.39 | -6 |
| Norway | 4.5 | 6.06 | 5.85 | -4 |
| Poland | 38.6 | 3.37 | 3.29 | -3 |
| Portugal | 10.1 | 4.20 | 4.19 | 0 |
| Romania | 22.3 | 2.18 | 2.35 | 8 |
| Russia | 143.2 | 4.32 | 4.41 | 2 |
| Serbia and Montenegro | 10.5 | 2.31 | 2.28 | -1 |
| Slovakia | 5.4 | 3.79 | 3.23 | -15 |
| Slovenia | 2.0 | 3.31 | 3.42 | 3 |
| Spain | 41.1 | 4.52 | 5.36 | 18 |
| Sweden | 8.9 | 5.64 | 6.07 | 8 |
| Switzerland | 7.2 | 4.99 | 5.15 | 3 |
| UK | 59.5 | 5.58 | 5.59 | 0 |
| Ukraine | 2.62 | 3.19 | 0.57 | 2.62 |

### 4. Protection of biodiversity: NATURA 2000 ecological network

*"The EU's policy on nature conservation within its territory is essentially made up of two pieces of legislation: Council Directive 79/409/EEC on the protection of wild birds (known as the '**Birds Directive**') which was adopted in April 1979 and Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (known as the '**Habitats Directive**') which was adopted in May 1992. Together, they establish a legislative framework for protecting and conserving Europe's wildlife and habitats.*

*At the centre of this policy is the creation of a coherent ecological network of protected areas across the EU - known as NATURA 2000. This will be made up of:*

- ***Special Protection Areas (SPAs)** to conserve the 182 bird species and sub-species listed in Annex I of the Birds Directive as well as migratory birds and*
- ***Special Areas of Conservation (SACs)** to conserve the 253 habitat types, 200 animal and 434 plant species listed under the Habitats Directive* (European Commission DG XI, 1996).

In the European Union, NATURA 2000 is closely related to the biogeographical regions, as each of them hosts characteristic species and habitats. In line with the principles outlined by the Rio Declaration and Convention, sustainable development implies the preservation of biodiversity for the next generations, by instituting natural protected areas including elements representative for all types of habitats and all species within a given zone; therefore, each site should reflect the biodiversity of the region where it lies. The administrative goal is to create sites conserving habitats and species characteristic to each biogeographical region.

**Table 4.** *Main threatens against biodiversity*
(number indicates the importance of a cause in a given area)

| Threat | Central and Western Europe | Caucasus | Central Asia | Eastern Europe | Southeastern Europe |
|---|---|---|---|---|---|
| Climate change | 2 | 3 | 3 | 2 | 2 |
| Urbanization/ infrastructure | 3 | 1 | 1 | 2 | 2 |
| Agricultural intensification | 2 | 1 | 2 | 2 | 2 |
| Land abandonment | 2 | 0 | 1 | 2 | 3 |
| Desertification | 1 | 2 | 3 | 1 | 2 |
| Acidification | 1 | 0 | 0 | 3 | 1 |
| Eutrophication | 3 | 1 | 1 | 2 | 2 |
| Radioactive contamination | 0 | 0 | 0 | 2 | 0 |
| Forest fires | 1 | 0 | 0 | 2 | 2 |
| Illegal logging | 0 | 2 | 1 | 2 | 3 |
| Illegal hunting/ wildlife trade | 0 | 3 | 3 | 1 | 0 |
| Invasive alien species | 2 | 1 | 1 | 2 | 2 |

Several studies have analyzed the relationship between NATURA 2000 sites and the protection of coastal areas, either by looking at the number of NATURA 2000 sites in the coastal areas (*Figure 7*) within the framework of assessing European biodiversity (European Environment Agency, 2007), or by looking at urban pressure on such sites in pilot regions (*Figure 8*) in the framework of increasing awareness of urban sprawl (European Environment Agency, 2006).

Based on the data delivered by the Romanian Ministry of the Environment and Sustainable Development free of charge via the Internet, the map presented in *Figure 9* displays the main categories of protected areas based on the biogeographical region where they are situated. Moreover,

*Figure 10* places these areas in their corresponding relief units. Most of these areas are in mountain areas and in floodable plains (the Danube Delta).

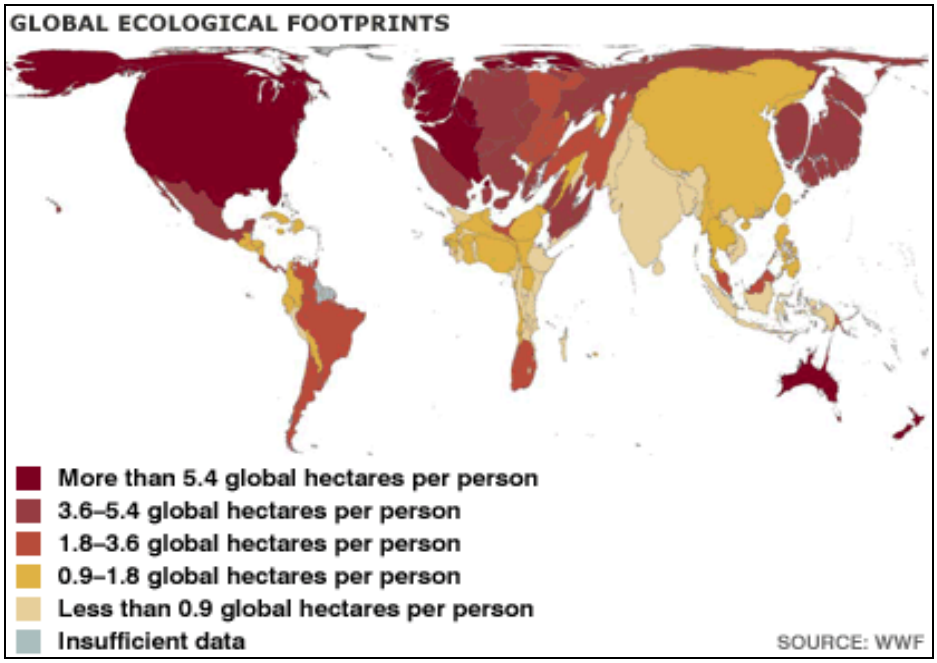



**Figure 4.** *Global ecological footprint (BBC News, 2007). Darker colours indicate elevated values.*

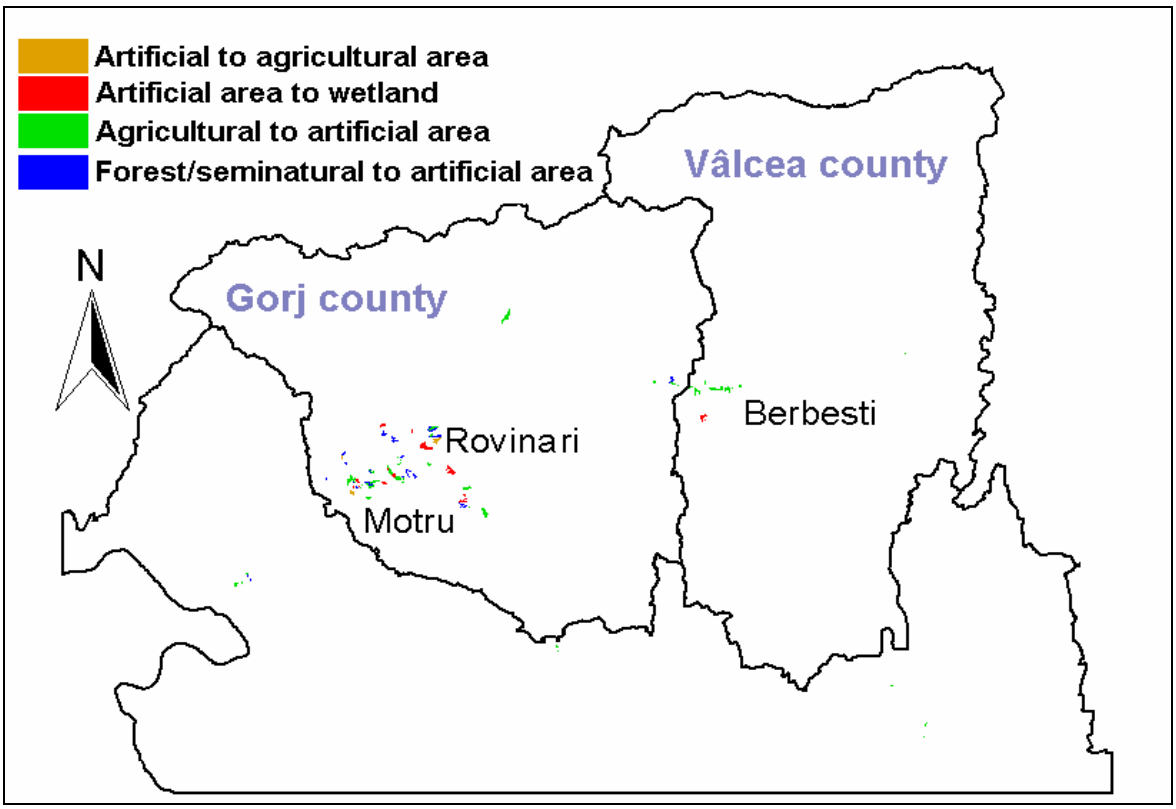



**Figure 5.** *Land use changes during 1990-2000 in the counties Gorj and Vâlcea (region of development South-West).*

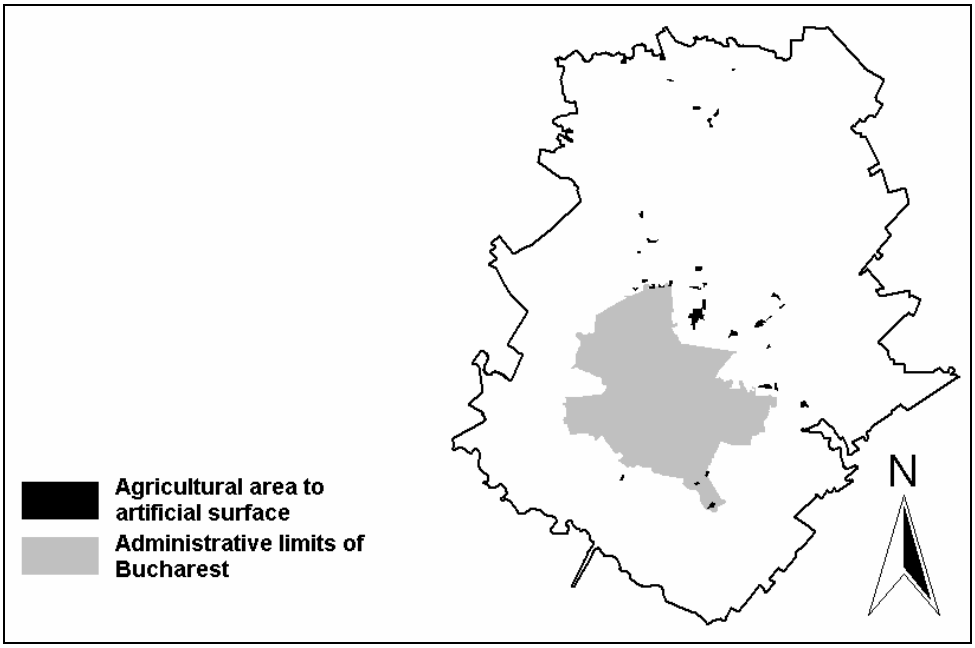



**Figure 6.** *Land use changes in the region of development Bucharest between 1990-2000.*

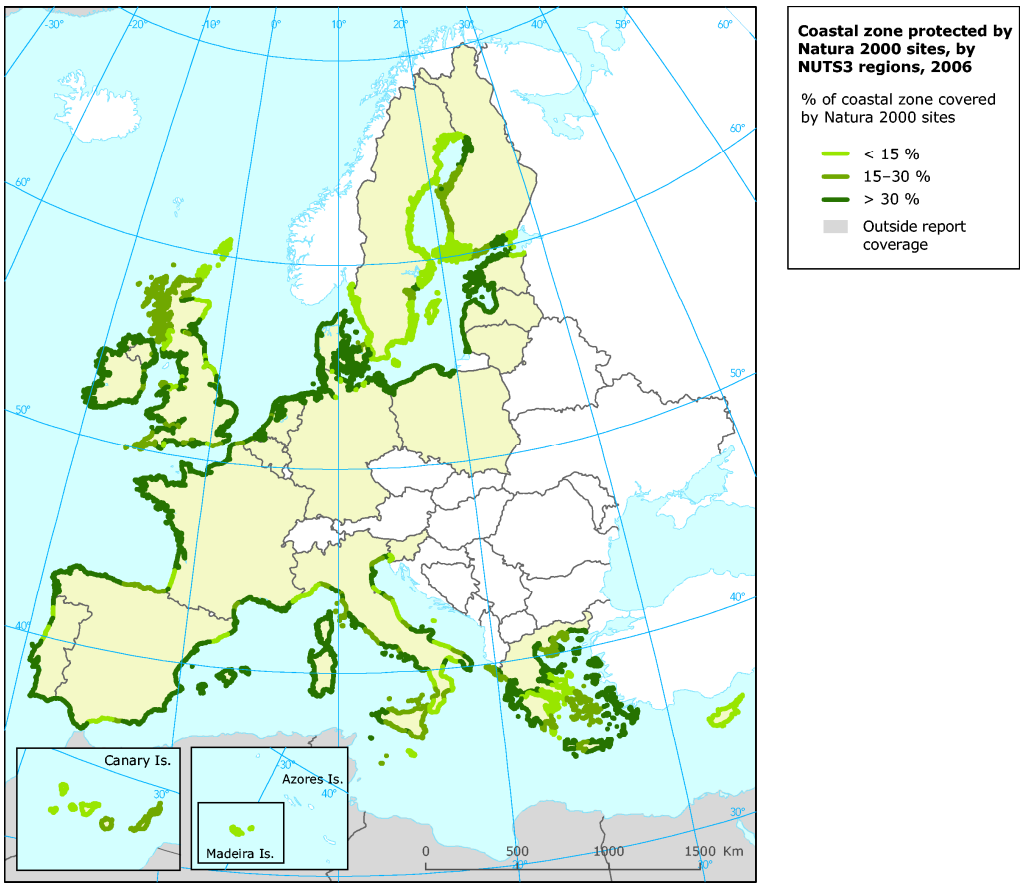
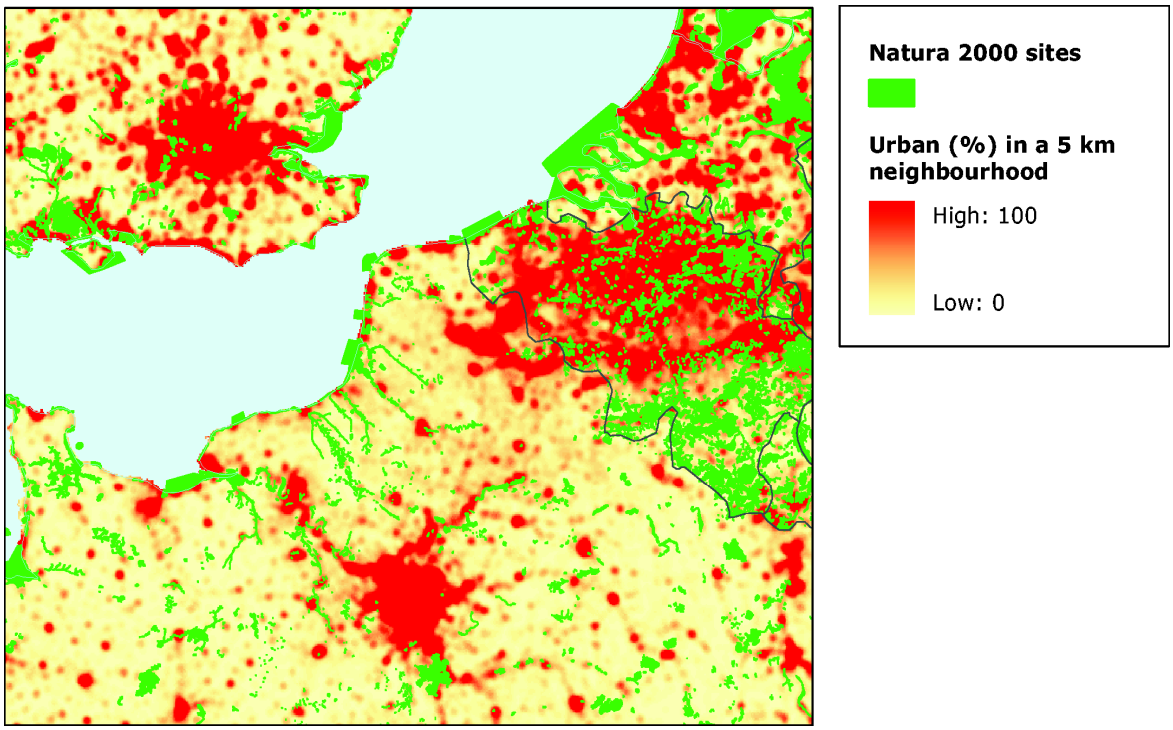



**Figure 7.** *NATURA 2000 sites in coastal areas.*

a




b

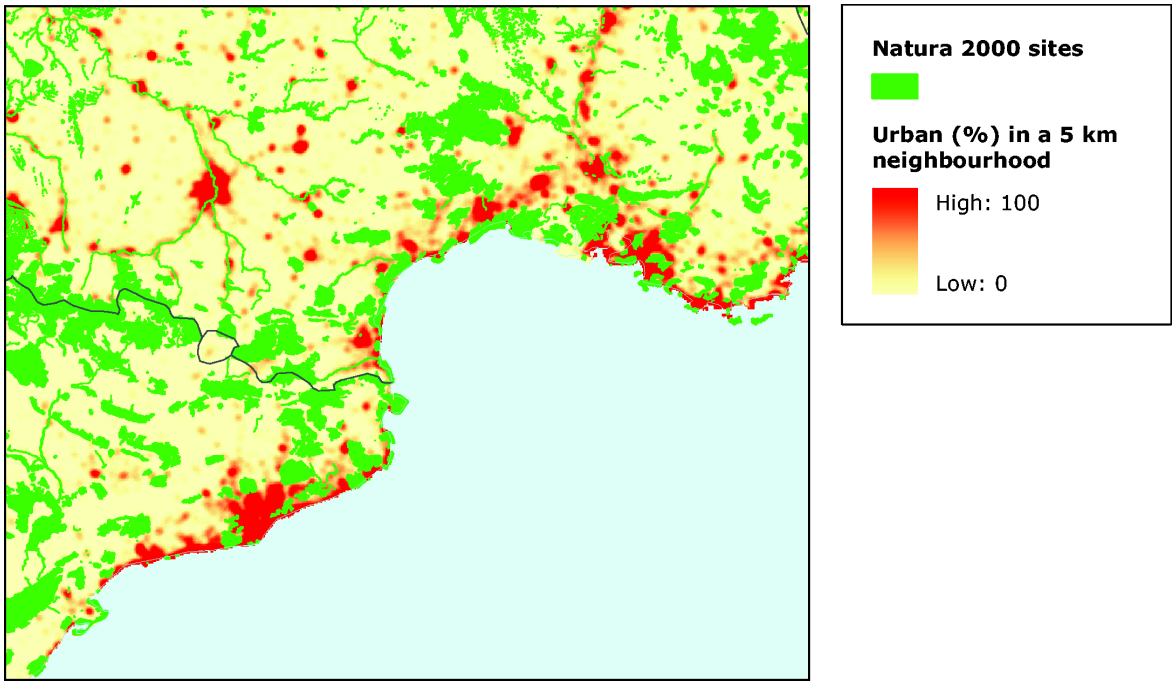



**Figure 8.** *Urban pressure on Natura 2000 sites in coastal areas of the English Channel (a) and western Mediterranean (b).*

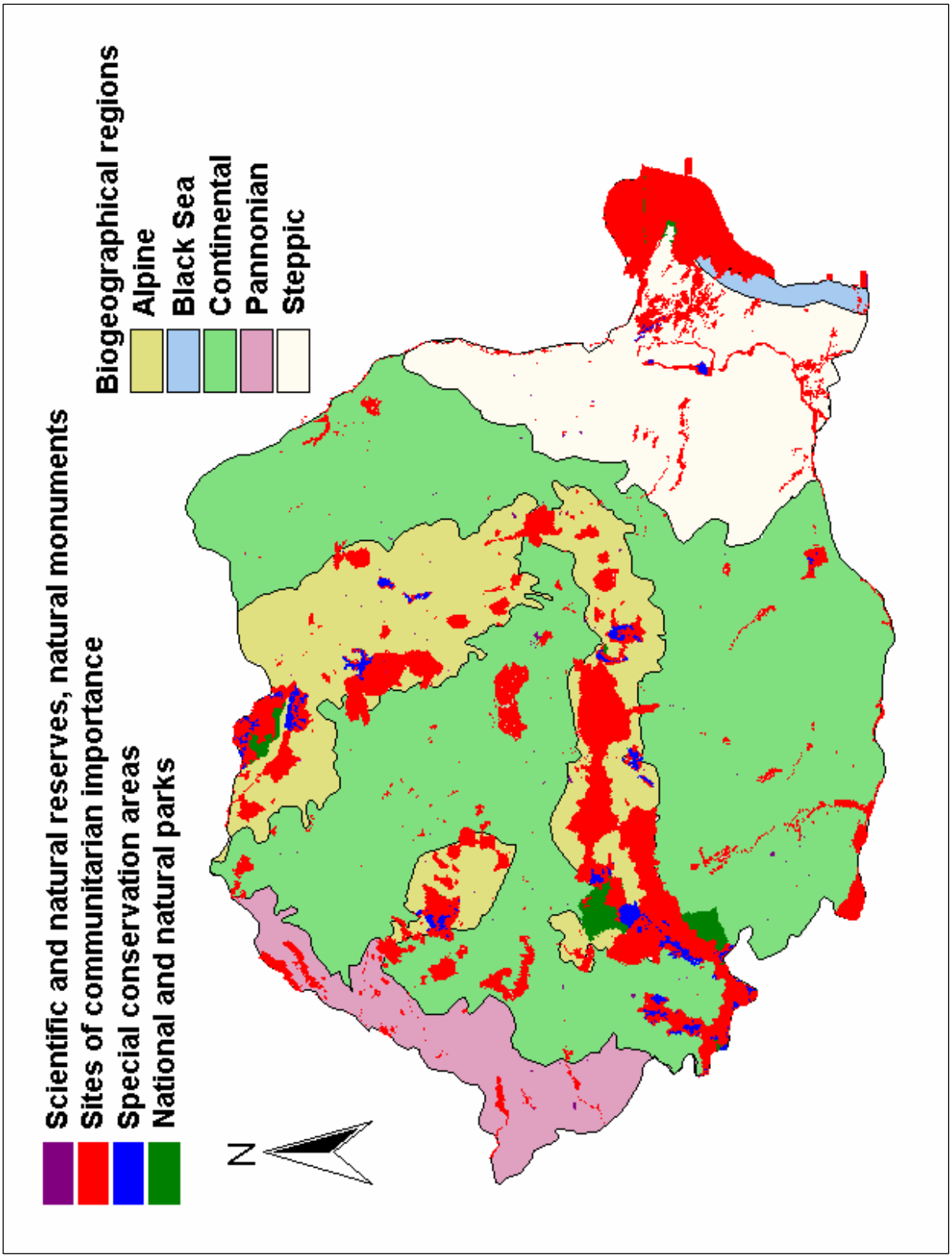



**Figure 9.** *Protected areas, including NATURA 2000 sites in Romania, based on the biogeographical region. Romanian biogeographical region are presented in* **Figure 3 c.**

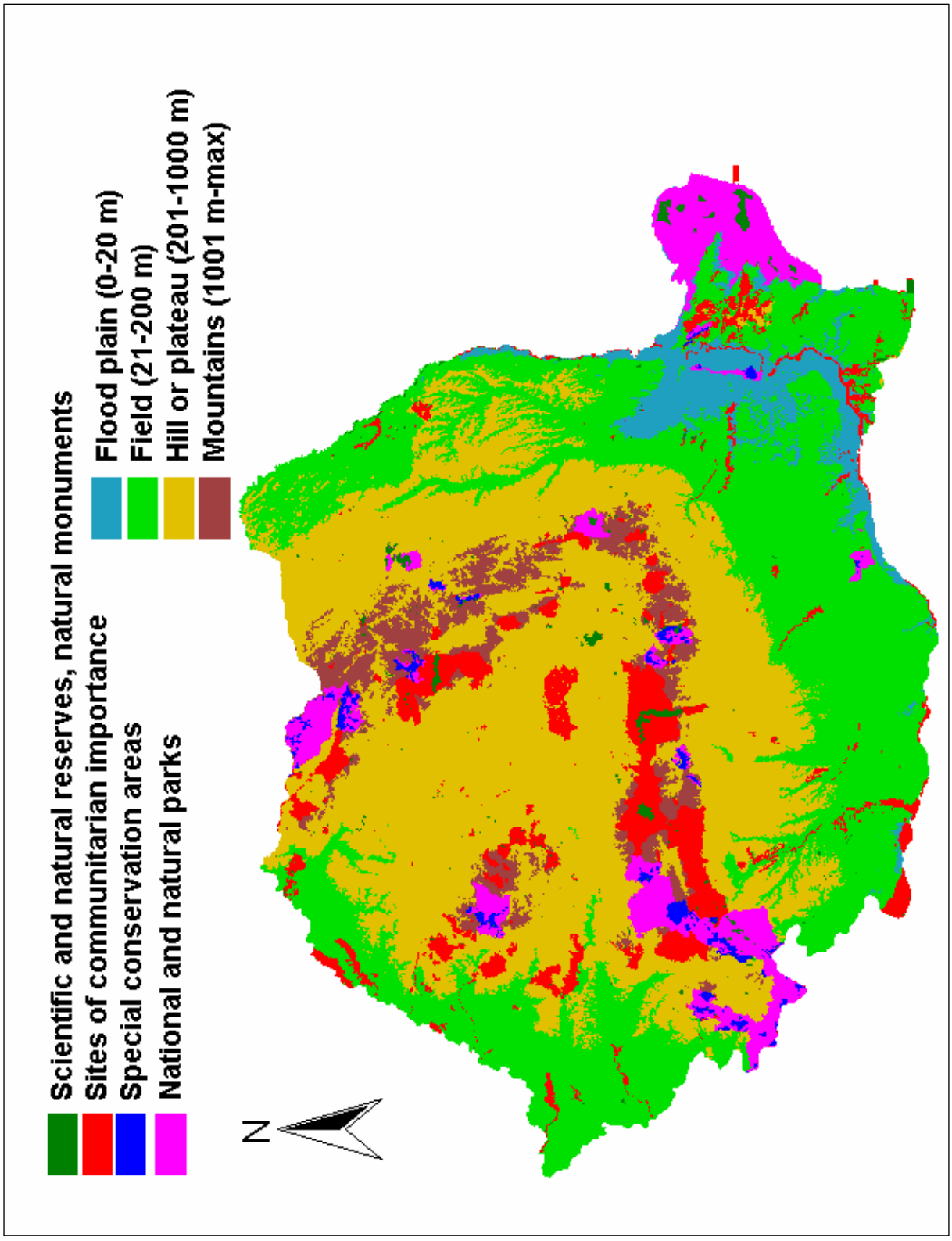



**Figure 10.** *Protected areas, including NATURA 2000 sites in Romania, based on the relief.*

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