THE GEOECOLOGICAL STRUCTURE TYPICAL FOR THE DEPRESSION BASIN OF THE BĂILE HERCULANE RESORT, ROMANIA

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Abstract

The “geosystem” and “geoecology” concepts have evolved over time, as they have been continuously analysed and developed by the various geography schools (Russian, French, Slovak, Anglo-Saxon, German, Romanian). The most widely-agreed upon view on the geosystem is the one brought forward by the French geographer Georges Bertrand, which shows that this system is the result of the interaction between the ecological potential (or the abiotic component), biologic exploitation (or the biotic component) and anthropogenic actions (human activity). In this paper, the geoecological analysis of the Băile Herculane resort depression basin is carried out while considering these three main components. The dynamic geosystem characterization - the paper aim - is conducted in this investigation by means of the biorhexistasy theory of H. Erhart, which divides geosystems into three different classes: biostasy, rhexistasy and parastasy. In conclusion, it can be stated that landscapes in the Băile Herculane spa area, known since ancient times for their beauty and flora and fauna richness, point to a geosystem in the biostasis phase, with a stabilized ecological potential which is currently balanced vis-à-vis the ongoing biological exploitation. However, due to certain anthropogenic impacts, the partial modification of the ecological potential or of the biological exploitation in certain areas has led to the occurrence of subsystems (ecosystems) in a rhexistasis phase. Apart from the aforementioned, the Cerna Valley geosystem has a natural geoecologic potential evolution, in which changes occur at a slow rate, with minimal modifications, favoured by the still low anthropogenic pressure on the environment.

Keywords: geosystem, geoecology, Baile Herculane, biorhexistasy theory, geoecological analysis.

1. INTRODUCTION

The “geosystem” and “geoecology” concepts have evolved over time, as they have been continuously analysed and developed by the various geography schools (Russian, French, Slovak, Anglo-Saxon, German, and Romanian). (Manoiu, 2005, p 4-14; Manoiu, 2014, p 11-20) All schools accept the idea that man and his actions are an integral part of the geosystem, alongside biotic and abiotic elements, and that the relationships between these geosystem constituents represent geoecology's object of study (Huggett, 1995, cited by Manoiu, 2005, p. 6-7 and Manoiu, 2014, p. 13-14).

The most widely-agreed upon view on the geosystem is the one brought forward by the French geographer Georges Bertrand (Cruz, 2004, p 141-152), which shows that this system is the result of the interaction between the ecological potential (or the abiotic component), biologic exploitation (or the biotic component) and anthropogenic actions (human activity). In this paper, the geoecological analysis of the Băile Herculane resort depression basin is carried out while considering these three main components. It must be mentioned that the following abiotic components are comprised within the ecological potential: landforms, climate, hydrography and soils.

The dynamic geosystem characterization is conducted in this investigation by means of the biorhexistasy theory of H. Erhart (Tudoran, 1976, cited by Manoiu, 2005, p. 8-10 and Manoiu, 2014, p. 15-16), which divides geosystems into three different classes: biostasy, rhexistasy and parastasy.

1). Biostasy geosystems are the ones in which the ecological potential is generally stable and in balance with the biological exploitation, a state which can be easily restored, even in the event of an anthropogenic intervention.

2). Rhexistasy geosystems are the ones in which the balance between components is heavily disturbed due to massive ecological potential-related changes, of natural or anthropogenic origin, followed by changes of the biological exploitation. These systems' global dynamics are dominated by geomorphological processes.

3). Parastasy geosystems are the urban systems having reached an irreversible state – as long as the anthropogenic pressure remains constant – relative to natural conditions. In the case of human settlements and urban agglomerations, the laws of nature have been replaced by social laws. Parastasy geosystems have been created on a natural infrastructure, under the pressure and direct control of a social-economic superstructure. Their ecological potential is profoundly modified, and consists of "anthropogenic" landforms and hydrography, altered climate ("urban topoclimate"), soils that are misused or destroyed by sealing etc. Biological exploitation is absent or highly reduced and artificial; in return, the anthropic action resulting from overpopulation is dominant.

According to our view, the geoecological analysis investigates the relationships between the geosystem's abiotic, biotic and anthropogenic components, which constitute geoecological structures, and shows the anthropogenic component's impact on the ecological potential and biological exploitation, providing solutions in order to counter the negative effects of human activities.

2. ANALYSING ABIOTIC AND BIOTIC GEOECOLOGICAL ELEMENTS OF THE DEPRESSION BASIN

2.1. Ecological Potential

The Băile Herculane resort is located in the country's south-western extremity, in a depression basin in the Cernei Valley, at a mean altitude of 160 m, and is bordered by the Mehedinţi Mountains in the south-east, and by the Cernei Mountains in the north-west.

We consider the ***defining elements of its ecological potential*** to be ***the Cerna River – the hydrografic element***, and the ***valley*** created by Cerna – ***landform element***, more specifically ***the sector crossing the resort's depression basin which leaves its mark on the entire geosystem.*** The entire Cernei valley ***represents a unique geosystem***, with a certain specificity in terms of its abiotic and biotic components.

Cerna, called Tierna and then Dierna by the Romans, has given shape to one of the most picturesque and interesting valleys in the Romanian Carpathians, a huge gorge that runs for about 40 km (Grigore, 1989, cited by Manoiu, 2005, p. 123). Cerna totals a small catchment of only 555 km^2. It is approximately 60 km long; it is narrow and has a northeast – southwest orientation. It is highly asymmetric, as most of its tributaries are located on the right side: Măneasa, Iovanu, Balmez, Olan, Belareca etc.

Cerna's source is located on the south-eastern slope of the Godeanu Mountains. Almost throughout its entire 84 km-long course, it presents the characteristics of a mountain river – a steep valley carved in hard rocks, with numerous gorge sectors and basins (Badea et al., 1981, cited by Manoiu, 2005, p. 123). Cerna's course follows a northeast-southwest oriented longitudinal fault line system, flanked by the Vâlcan and Mehedinţi Mountains on the left, and by the Godeanu and Cernei Mountains on the right.

Cerna River flows into the Danube, forming a wide bay upon contact with the Orşova municipality accumulation lake.

With regard to the mineral springs of Cerna Valley, they originate from seepage water circulating in the fracture zones, down to a depth of 1200 m, where they are heated and mineralized. They surface in Cerna's banks, along fault lines, as ascending thermal mineral springs.

Băile Herculane sources are of vadose origin and have an artesian regime generated by the level difference between the water's infiltration and emergence points. This level difference reaches about 1200 m (considering the altitude of Cerna's tributaries and springs at 1800 m, and that of the resort of 160 m). Southern resort springs have an artesian pressure which can project water up to 50 m above ground level.

Since Roman times, the flow constancy, the mineralization of 3-6 g of dissolved substances/l and temperatures of 40-60^{0}C have resulted in the establishment of the renowned Băile Herculane resort. In terms of mineralization, thermal springs contain sodium chloride (1.7-3.5 g/l), hydrogen sulphide, sodium hyposulphite and sulphydrate, which account for the water's salty and sulphurous character. The local mineral waters include the following thermal water types: a). sulphurous, sodium chloride-rich, calcium-rich hypotonic; b). sodium chloride-rich, calcium-rich; c). sulphurous, oligomineral-rich, and d). radioactive oligomineral-rich.

Currently, in the surroundings of Băile Herculane resort, there are 16 natural thermal water springs, covering almost 4 km of Cerna's course, of which 9 are being used for spa treatments, at a rate of 25.75 l/s, while the others flow freely into Cerna. The resort's current thermal water reserve is 4000 m^3 in 24 hours, and it provides – due to its physical and chemical properties – a wide range of spa treatment options.

Cerna Gorge starts upstream, and extends from the Gârdoman Peak (1700 m) down to the confluence with Belareca. Between Băile Herculane and the confluence with the Belareca brook, Cerna Valley widens and resembles an elongated depression (Grigore, 1989, cited by Manoiu, 2005, p. 124)

The ***gorge sector*** located between the confluences of the Olanu and Belareca brooks – in which Băile Herculane resort is located, and which defines its landform setting as an essential geo-ecological element – features a predominantly calcareous, steep and heavily fissured left side slope (Mesozoic limestone), with horns, ridges, based on accumulations of blocks (from the Mehedinţi Mountains), and right side slope consisting of crystalline schists and old sedimentary formations (ridges of Cerna Mountains).

In other words, the resort's surroundings are dominated by two mountain massifs: to the west, Cerna Mountains, and to the east, Mehedinţi Mountains (Fig. 1). Cerna Mountains consist in a series of parallel ridges perpendicular to the axis of Cerna Valley. They start off from a single ridge that descends from the Godeanu Mountains to south of the resort. These ridges are separated by Cerna's tributary brooks.

The water has carved various types of exposed karsts (exokarst) and deep-seated karsts (endokarst) in the limestone of the Cerna Mountains. The exokarstic forms include: narrow and barren ridges, fragmented slopes, limestone cliffs, gorges, clints, waterfalls, screes etc. The endokarstic forms consist in caves and precipices, some of which are unique countrywide –"The steam grotto", "Cleft" and "Hercules" caves, and "Adam's pit". There are hot caves in which an original (endemic) cave fauna, as well as numerous morphological and mineralogical curiosities have developed. In the resort's immediate vicinity there are sites such as "The thieves' cave" or "The hajduk grotto", of great archaeological significance, inhabited since the Stone Age.

The second mountain chain framing the Cerna Valley to the east is called Mehedinţi, and it accompanies Cerna all the way to its confluence with the Danube. They consist of a single massive ridge that dominates the Cerna Valley. The Mehedinţi Mountains, less well covered than the Cerna Mountains, are mainly composed of limestone, and feature a wide range of karstic forms.

The exokarstic elements found in the Mehedinţi Mountains include: steep slopes and rocky cliffs that reach impressive heights ranging from 500 to 800 m, dry valleys, karst depressions at altitudes of about 1000 m, narrow gorges with rapids and waterfalls, such as Romnuţelor (Râmnuţelor), Ţesnei, Feregari, Jelerău etc., sinkholes and micro-depressions in which rivers disappear in the limestone cover, only to reappear after many kilometres of underground circulation and result in karst springs, dolines and limestone pavement (Badea et al., 1981, cited by Manoiu, 2005, p. 131).

The endokarstic forms are caves and precipices, renowned for their size, beauty and scientific value. Such sites include the Soronişte Large Cave, Domogled Cave, “Gaura Ungurului” of Cheile Pecinişca, Peştera dintre Pietre, Ponorul Pecinişca Cave, Şerban's Cave etc.

Granite, although less frequent, also results in outstanding landforms such as sphinxes.

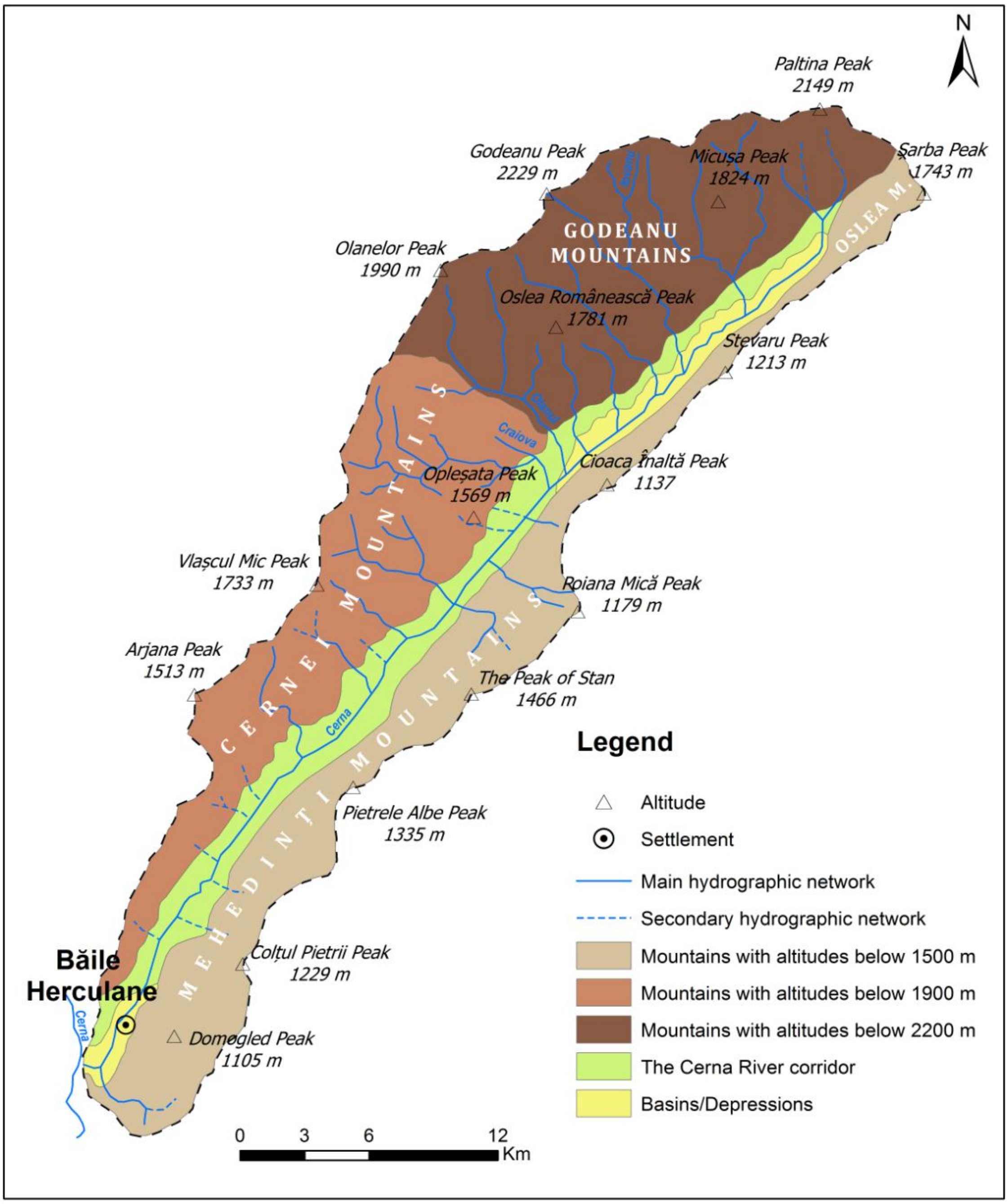

Fig.1. Landforms of Cerna Valley – fundamental component of the ecological potential – and their altitude distribution

Several peaks of the Mehedinţi Mountains stand out: Piatra Mare a Cloşanilor (1421 m), Stan's Peak (1466 m), Şuşcu (1192 m), Inălăţu Mare (1301 m), Inălăţu Mic (1146 m), Hurcu (1088 m), Domogledul Mare (1105 m) and Domogledul Mic (1100 m) (L. Badea et al., 1981, cited by Manoiu, 2005, p. 131). Domogled Mountain is particularly impressive due to its steep rocky cliffs, on which only pines are resilient enough to grow.

The climate of Băile Herculane – ***highly important geosystem element*** – corresponds to the mountain depression type, with sub-Mediterranean influences. The mountains surrounding the resort soften the temperate-continental climate influences, and protect it against strong winds.

The average annual temperature is of 10.5 ^{0}C, while the average temperature in July is of 20.4-20. 5 ^{0}C, and in January of – 0,3 ^{0}C …– 0,4 ^{0}C. The lowest temperatures are recorded in January and February, since that is when the Siberian anticyclone builds up.

Following the general orientation in relation to the dominant circulation, a downward displacement of air can be noticed on the western slopes of the Cerna Valley, i.e. a foehn-type process that results in cloud system dissipation.

The average annual number of sunny days, at the resort, is of 152, while the number of overcast days reaches 110. Most sunny days are recorded in July and August, and the least between November and February. Maximum cloudiness occurs in the cold weather, while blue skies are recorded on average 20-23 days per month during the summer.

In Cerna Valley the shift process winter to spring starts early. At Băile Herculane, it may start as early as the beginning of February.

The average annual rainfall amounts total 760 mm at Băile Herculane, while the most abundant rain is recorded in May and June (first peak), due to the influence of the Azores High, and in November and December (second peak), due to the Mediterranean cyclones.

Most precipitation takes the form of rain. Snow layer thickness is low due to recurring melting during winter. Atmospheric calm days are common, and peak in July (28%). Sunshine duration totals an average annual number of 1900 hours.

It is known that, in south-eastern Romania, at high altitudes, in a clear atmosphere, the predominant air mass movement is the western one. However, in Cerna's catchment, the landform configuration generates an air channelling phenomenon. Thus, at Băile Herculane, the highest wind frequency has the directions S = 18.8% and N = 15.4%, i.e. the ones corresponding to the direction of the respective portion of the valley. At Băile Herculane, wind speed is low, with an annual value of 1.8 m/s (Badea et al., 1981, cited by Manoiu, 2005, p. 135).

Surveys on air ionization in the resort showed a total number of positive and negative ions ranging from 1295 to 1445 ions/cm^3 of air (depending on the location in which the measurements were made), with a predominance of negative ionization (655-830 +ions/cm^3) over positive ionization (640-680 -ions/cm^3). The area is considered to have an optimum air ionization level, both quantitatively and qualitatively (Teodoreanu E., 2010, p. 86-90). This is largely due to the presence of radioactive elements in rocks and in the resort's rich thermal water supply.

For the Băile Herculane resort and its surroundings, the following types of ***soil*** – ***the depression basin's last ecological potential element*** – are characteristic (Badea et al., 1981, cited by Manoiu, 2005, p. 135):

a). rendzinas (black and brown), brown soils and exposed rock, formed on limestone in the lower sector, especially on Cerna's left bank, but also in the middle – exposed rock is encountered very frequently – and upper sectors – narrow limestone ridges, precipices or scree formations.

b). rendzinas and brown soils, formed on the carbonate substrate, mainly consisting of marly limestone, conglomerate, clay and sandstone sedimentary rocks, which are found in the basin's lower section.

c). alluvial deposits and alluvial soils, present on meadow strips.

2.2. Biological Exploitation

The fauna and flora specificity of Băile Herculane and its surroundings is given by the strong ingress of ***southern phyto- and zoogeographical elements***, against the central-European background: *Tilia tomentosa* (silver lime), *Fraxinus ornus* (South European flowering ash), *Carpinus orientalis* (Oriental Hornbeam), *Corylus colurna* (Turkish hazel), *Syringa vulgaris* (lilac), *Cotinus coggygria* (Eurasian smoketree), *Quercus pubescens* (downy oak), *Quercus cerris* (Turkey oak), *Castanea sativa* (sweet chestnut), *Ruscus aculeatus* (butcher's-broom), ***for the plants*** and *Euscorpius carpathicus* (Scorpiones), *Neobisium erithrodactylus* (Pseudoscorpiones), *Coelotes falciger* (Aranea), *Phloeosinus aubei*, *Ontholestes haroldi*, *Morimus funereus* (Coleoptera), *Cicada orni*, *Tibicina haematodes*, *Lyristes plebejus*, *Agallia laevis* (Homoptera), *Barbitistes ocskayi*, *Metrioptera domogledi*, *Isophya speciosa hirticornis* (Orthoptera), *Mantispa perla* (Neuroptera), *Cyllenia maculata* (Diptera), *Eucera clypeata* (Hymenoptera), *Orchesella balcanica* (Collembola), *Helicodonta triaria* (Gasteropoda), *Pararge roxelana*, *Crambus pauperellus*, *Eutelia adulatrix*, *Polyploca ruficollis*, *Pieris ergane*, *Herculia fulvocilialis*, *Ocneria rubea*, *Gramodes algira* (Lepidoptera), *Vipera ammodytes*, *Testudo hermanni* (Reptilia), ***for animals***.

There are numerous ***rare and endemic flora and fauna elements***, of which the following are particularly noteworthy: ***faunal endemisms*** *Athethmia rufa*, *Bucculatrix mehadiensis*, *Obesoceras confusellum orientale* (Lepidoptera), *Lytopelte herculana*, *Vitrea jetschini* (Gasteropode), *Insigniporus acunaeli* (Chilopoda), *Tracheoniscus trilobatus* (Isopoda), *Allothrombium angulatum* (Tromboidea), *Smittia antelobata* (Diptera), *Troglohyphantes herculeanus* (Aranea); ***pre-glacier circum-Mediterranean relics*** *Hipparchia statilinus*, *Coenonympha leander* (Lepidoptera), *Metareticulata mengei* (Aranea), as well as ***the great floristic rarities*** *Genista radiata*, *Primula auricula ssp. serratifolia*, *Athamantha hungarica*, *Delphinium fissum* (Badea et al., 1981, cited by Manoiu, 2005, p. 146).

In Cerna's basin there are ***two vegetation layers***, each consisting of ***two sub-layers***, namely:

- alpine layer with alpine and sub-alpine sub-layers

- nemoral layer with beech forest and sessile oak forest sub-layers.

The lower sector of Cerna Valley, where the Băile Herculane spa is located, is covered with oak species which make up the ***sessile oak forest sub-layer***. In these forests, the most common species is *Quercus petraea* (sessile oak), mixed with *Q. dalechampii*, *Q. polycarpa*, *Q. frainetto*, *Q. cerris*, *Q. pubescens*, *Tilia platyphylos*, *Acer platanoides*, *A. campestre*, *Ulmus foliacea*, *Carpinus betulus*, *Corylus avellana*, *Prunus spinosa*, *Crataegus monogyna*, *Cornus sanguinea*, *Rosa canina*, *Sambucus nigra*, *Ligustrum vulgare*, *Sorbus torminalis*.

At Băile Herculane there are also protected specimens of European yew (*Taxus baccata*), a conifer which used to be much more common in Romanian forests. Within the resort's Central Park, ***Romania's most beautiful mammoth tree specimen (Sequoia gigantea)*** is protected (Fig.2). This giant tree is native to Central California and the Sierra Nevada Mountains in North America, where it can reach 100 m in height and a diameter of 15 m.

In the sessile oak forests, due to the vegetation's abundance and variety, as well as to the mild climate conditions, wildlife is also well represented: *Cochlodina laminata*, *Limax maximus* (Gasteropoda), *Lymantria dispar*, *Saturnia pyri* (Lepidoptera), *Balaninus glandium* (Coleoptera), *Emberiza citrinella* (yellowhammer), *Jynx torquilla* (Eurasian wryneck), *Falco tinnunculus* (common kestrel), *F. peregrinus* (peregrine falcon), *Coracias garrulus* (European roller) (Aves), *Apodemus sylvaticus* (wood mouse), *Felis silvestris* (wildcat), *Capreolus capreolus* (European roe deer) (Mammalia).

The ***Black pine*** (*Pinus nigra ssp. banatica*), which is ***an endemic species***, grows on the local limestone slopes and shallow soil screes.

Alders and willows can be found in Cerna's meadow, on alluvial soils. Willows include *Salix alba*, *S. fragilis*, *S. purpurea*, *Populus nigra*, *Alnus glutinosa*, *Cornus sanguinea*, *Rubus procerus* etc. The alders growing in the vicinity of the Băile Herculane spa include *Alnus glutinosa* (black alder), *Salix alba*, *S. fragilis*, *S. purpurea*, *Cornus sanguinea*, *Acer tataricus*, *Rubus procerus*, *Platanus acerifolia*.

On Cerna River certain differences in environmental conditions were noticed, with consequences in the distribution of life. In the upper half, the river bed is relatively narrow, the current is strong, the benthic facies is made up of stone blocks, gravel and sand, and the water is clear and transparent.

In the lower half, although the riverbed widens, there are numerous rapids sections; in the banks' vicinity, the sandy-muddy facies is dominant, the water becomes less clear and the flow rate decreases. According to these features, in Cerna two major biotopes can be identified: the lotic biotope in the upper sector, and the lentic biotope in the lower sector.

With regard to invertebrates in the lower sector, most common are oligochaetes (*Limnodrilus udekemianus*, *Nais pardalis*, *N. simplex*, *N. pseudoptusa*), Diptera (*Simulium columbaczense*, *S. banaticus*, *Prosimulium hirtipes*), the gasteropod *Ancylus fluviatilis*.

In terms of vertebrates, while in Cerna's upper sector there are species such as: trout (*Salmo trutta fario*), grayling (*Thymallus thymallus*), yellow-bellied toad (*Bombina variegata*), alpine newt (*Triturus alpestris*), in the lower sector more common are: the nase (*Chondrostoma nasus*), European fire-bellied toad (*Bombina bombina*), agile frog (*Rana dalmatina*) (Badea şi col., 1981, cited by Manoiu, 2005, p. 151).

The flora and fauna of Cerna have undergone qualitative and quantitative changes, starting with the second half of the eighteenth century, especially in the lower river sector, at the same time as the Herculane spa resort was being developed. The discharge of wastewater and sulphurous water into Cerna resulted in water chemistry changes, i.e. the increase of organic matter and salts, and the decrease of oxygen concentration (Manoiu, 2005, p. 151-152; Manoiu, 2014, p. 68-70).

The beauty of the landscape, alongside the scientific importance of numerous local flora and fauna species, led to the creation of the Domogled-Cerna Valley Natural Park, which totals 60,100 hectares.

Domogled Mountain, located in the immediate vicinity of the Băile Herculane spa, was established as a nature reserve in 1932, by an order of the Council of Ministers (no. 1149), which referred to an area of 900 ha, bordered by "the state forest, Prolaz, Pteş and Pâţa creeks, the railway track and by the steep cliffs."

Fig. 2. Romania's most beautiful mammoth tree specimen (Sequoia gigantea) in Băile Herculane's Central Park

The flora on Domogled, which is a limestone mountain with steep slopes and valleys, is highly well-known. More than 20 Romanian and foreign botanists have been conducting studies in this area for almost three centuries. The best known work, which made this place famous throughout Europe, was published by Degen (1901), and lists 705 species. Subsequently, Pax (1909), according to whom this mountain has the most interesting flora in Europe, mentions 42 additional species, bringing the final figure up to 747. Gh. Bujorean and P.C. Popescu, having considered all of Domogled's peaks, thus expanding the research area, estimated in 1966 that there were over 1000 species in Herculane (Manoiu, 2005, p.153).

On Domogled there are numerous plant and animal species from ***southern regions*** (East Balkan, Balkan-Illyrian, Mediterranean), and this mountain is considered to have the highest number of plant species in Europe.

In the forest, in addition to the common species of Austrian oak (*Quercus cerris*), sessile oak (*Quercus petraea*), European beech (*Fagus sylvatica*), etc., there are numerous species of trees and shrubs of southern origin such as: *Carpinus orientalis* (Oriental Hornbeam), *Sorbus torminalis*, *Sorbus cretica*, *S. aucuparia*, *Fraxinus ornus* (South European flowering ash), *Juglans regia* (Persian walnut), *Padus mahaleb* (mahaleb cherry), *Cotinus coggygria* (Eurasian smoketree), *Rosa spinosissima*, *R. pendulina*, *Corylus colurna* (Turkish filbert), etc. On steep rocky cliffs the umbrella-shaped crown pine (*Pinus nigra ssp. banatica*) can be found (Fig. 3) – rare, endemic species –, while the lilac (*Syringa vulgaris*) can be seen growing on rocks. The rare, protected coniferous yew tree (*Taxus baccata*) can also be found here.

Out of the herbaceous plants, the most interesting are: *Primula auricula ssp. serratifolia* (mountain cowslip species – endemic), *Campanula crassipes* (endemic), *Edraianthus kitaibelii*, *Ferula heuffelii*, *Minuartia cataractarum*, *Minuartia graminifolia ssp. hungarica*, *Saponaria bellidifolia var. hirticaulis*, *Athamanta turbith ssp. hungarica* (floristic rarity), *Delphinium fissum* (floristic rarity), *Thlaspi dacicum, Genista triangularis*, *G. radiata* (floristic rarity), *Colchicum haynaldi* (floristic rarity), *Dianthus domogledi* (endemic), *D. spiculifolius*, *D. kitaibelii* (floristic rarity), *D. trifasciculatus*, *Agropyron panormitanum*, *Ruscus aculeatus* (butcher's-broom), *R. hypoglossum*.

Fig. 3. The black pine (Pinus nigra ssp. banatica), an endemic species, in Domogled-Cerna Valley Natural Park

On Domogled's meadows the following species can be seen: *Centaurea laevigata*, *C. degeniana*, *C. triniaefolia* (floristic rarity), *Scabiosa banatica*, *Galium purpureum*, *Festuca panciciana*, *Iris reichenbachii* (floristic rarity), as well as other rare and endemic species such as: *Hypericum rochelii*, *Linum uninerve*, *Seseli rigidum*, *Cerastium banaticum* and a vetch species (*Vicia truncatula*) which cannot be found in any other resort in the country.

Among the ***faunal elements***, the following stand out: Carpathian scorpion (*Euscorpius carpathicus*), horned viper (*Vipera ammodites*) and over 1300 Lepidoptera species characteristic to various geographic areas (alpine, Pontic, Balkan, Mediterranean).

3. ANTHROPOGENIC INTERFERENCES IN THE DEPRESSION LANDSCAPE OF THE BĂILE HERCULANE RESORT; POSSIBLE EVOLUTIONARY STATE OF THE LOCAL GEOECOLOGIC POTENTIAL

The Cerna Basin, as it is bordered by two mountain ridges with steep slopes and is not easily accessible, was subjected to anthropogenic changes to a lesser extent, despite the fact that it has been inhabited since ancient times. Human actions have not had major effects on the geosystem.

Therefore, in this picturesque area, with a pleasant climate, diverse karstic phenomena and unusual charm, the Romans, who valued the therapeutic effect of thermal waters, established a resort known as "Ad aquas Herculi sacres." Starting with the years 105-107, the town began developing, and went through an era of prosperity that lasted over 170 years. Once the Roman administration was no longer in place, it is unknown what happened to the resort. Later on, after 15 centuries (around 1728), during the Austrian occupation, the spa activity was resumed and Băile Herculane became well-known all over Europe. But the recently-revived resort was again seriously affected by the Austro-Russo-Turkish wars. However, the local waters' therapeutic effectiveness ensured the resort's restoration.

It was rebuilt gradually, for the most part in the form that can be seen today, through the effective contribution of the Romanian rural population. Up to 1913, facilities were put into place and buildings were constructed, and the small resort, hidden under the great Domogled Mountain, became international. In the 60s, 70s and 80s, several hotels, restaurants and treatment spas were built.

There is no doubt that the anthropogenic changes, implemented since ancient times, have not been limited to the documented archaeological sites which are related to thermal water use. The changes caused by agricultural and pastoral activities were equally important, but they cannot be considered as human intervention with significant consequences, but rather as strictly local changes that were to be perpetuated in the following centuries, and that eventually resulted in numerous clearings and meadows (pastures and hayfields).

Băile Herculane, with a total of 6,000 inhabitants, thoroughly illustrates the tourist potential of the Cerna Valley. Romania's oldest resort, and also one of Europe's most famous spa establishments, celebrated in 2013 its 1860th documented year of existence.

A little-known fact is the close connection between the name of the resort and ***Empress Elisabeth of Austria*** (1837-1898), also known as Sisi. ***Empress Elizabeth*** was passionate about the beauty of nature, rest and treatment establishments, and journeys, and she travelled throughout Europe. Sisi loved the Băile Herculane spa, and she visited it in ***1884, 1887, 1890, 1892 and 1896***. In 1896, together with her husband, ***Emperor Franz Joseph*** (1830-1916), she met with Alexander I of Serbia and Carol I of Romania in this "paradise", at the inauguration of navigable channel Iron Gates (Cristescu, 1996).

In the Cerna basin, the complex economic activities, especially industrial ones, occurred very late, similarly to environmental changes triggered by the anthropogenic impact.

Since ancient times until the start of the first forest exploitation activities (1951), anthropogenic interference produced no environmental degradation. Although pastoral and agricultural activities have exerted constant pressure on the forest, as the forest floor was reduced in order to make room for meadows and grasslands used for grazing and hayfields, the pressure has been moderate and relatively limited, and it has not caused geo-ecological imbalances and ensured a normal ecosystem development. During this time, forest exploitation was limited to meeting the needs of local temporary and permanent residents (firewood, construction of houses and huts etc.), and the basin's forests remained untouched.

In the eighteenth century, the downstream section of the valley became industrially active after the establishment of a chalk factory and a limestone quarry (next to the Ferigari Valley). But despite the continuous development process of this period, the valley's anthropogenic transformation was low. Although circulation increased, especially in southern Cerna Valley (around Băile Herculane), the built area expanded and the landscape changed, as human influence became increasingly noticeable, the anthropization process remained slow and spatially limited.

In 1951, the first forest exploitation activities begin in a few small areas in the Şaua Padină Valley, in the immediate vicinity of Băile Herculane, but they were abandoned in 1957 due to difficulties related to log transportation. Throughout the basin, upstream of Băile Herculane, the landscape remained almost unchanged, as the only activities were the pastoral and agricultural exploitation of clearings and meadows. However, downstream of the resort, limestone exploitation intensifies in order to ensure the demand of the chalk factory, which led to a considerable expansion of the quarry along the left keys of the Ferigari stream. This is when the first anthropogenic landscape degradation effects can be seen.

While the actions taken during the period 1951-1964 did not lead to major changes, they were not limited only to slow changes in vegetation cover (which can regenerate naturally), but also involved the substrate, the modification of which lasts for long periods of time.

After 1964, traditional pastoral-agricultural activities diminish, as the population is increasingly attracted to new industrial activities (such as hydraulic structures, road construction along Cerna). Essential landscape changes occur rapidly and trigger irreversible degradation.

The lush ancient forests start being exploited systematically in 1964. The operations consisted of clear-cutting and combined cutting, and were always accompanied by conifer replanting. As a result, most slopes and high altitude surfaces became once more covered by various tree species and, consequently, erosion processes were slowed down, and in some places they were virtually non-existent. There were however certain exceptions, such as the secondary valleys and forest roads located on strongly inclined slopes used for transporting timber, where the erosion is high and reaches the bedrock (Badea et al., 1981, cited by Manoiu, 2005, p. 160-161). In these areas fast-growing shrub species must be replanted in order to prevent soil washing and erosion.

The implementation of the hydraulic system projects at Iovanu and Şapte Izvoare Reci springs led to changes in water quality as a result of discharging in Cerna massive amounts of earth, rock, plant debris, oil products (engine lubricants and fuels), detergents, metal scraps. This changed the water's chemical composition and physical characteristics, as well as the biotopes. The aquatic flora and fauna have undergone qualitative and quantitative changes. Very low species diversity was found in reservoir zooplankton. Only the groups cladocera and copepods were present; the former was dominant and all development stages of the *Daphnia longispina* species were found. These zooplankton components reflect environmental conditions in mountain reservoirs and show that, while it represents an important nutrition source for juvenile lake ichtyofauna elements, it is however insufficient for sustaining the development of a diverse fish fauna.

CONCLUSIONS

In conclusion, it can be stated that landscapes in the Băile Herculane spa area, known since ancient times for their beauty and flora and fauna richness, point to a ***geosystem in the biostasis phase***, with a ***stabilized ecological potential which is currently balanced vis-à-vis the ongoing biological exploitation***. ***Biostasis landscapes*** cover forests, clearings and meadows in the depression basin. The local fauna can find appropriate conditions and its relation with the vegetal biomass proves the existence of normal trophic conditions and a stable equilibrium between geosystem components.

However, due to certain anthropogenic impacts, the partial modification of the ecological potential or of the biological exploitation in certain areas has led to the occurrence of subsystems (ecosystems) in a **rhexistasis** phase. **Rhexistasis landscapes** cover hydropower exploitation areas. They have a fragile balance which evolves regressively and irreversibly in relation to their initial state. Measures that regulate human interventions therefore become essential and must be fully consistent with geo-ecological specificities.

The construction of dams for the reservoirs at Valea lui Iovan and Şapte Izvoare Reci has brought the local geoecologic subsystem in an advanced rhexistasis state, as its balance was significantly disturbed.

Apart from the aforementioned, the Cerna Valley geosystem has a natural geoecologic potential evolution, in which changes occur at a slow rate, with minimal modifications, favoured by the still low anthropogenic pressure on the environment.

REFERENCE LIST

1. Badea L. şi col. (1981). Valea Cernei – Studiu de geografie. Editura Academiei. Bucureşti.
2. Cristescu I. (1996). Miracolele Cernei. Herculane – Model turistic. Editura Hercules Friends. Drobeta Turnu Severin.
3. Cruz O. (2004). Paisagem e geografia física global. Esboço metodológico. R. RA´E GA. Curitiba, n. 8, p. 141-152. Editora UFPR. Brasil.

4. Grigore M. (1989). Defileuri, chei şi văi de tip canion în România. Editura Ştiinţifică şi Enciclopedică. Bucureşti.
5. Huggett R.J. (1995). Geoecology – an Evolutionary Approach. Routledge – London and New York.
6. Mănoiu V.-M. (2005). Structuri geoecologice specifice în depresiuni şi culoare de văi din Carpaţii Meridionali şi Subcarpaţii Getici. Interpretări comparative. Editura Printech. Bucureşti.
7. Mănoiu V.-M. (2014). Structuri geoecologice specifice în depresiuni şi culoare de văi din Carpaţii Meridionali şi Subcarpaţii Getici. Interpretări comparative – pentru studenţi -. Editura Nouă. Bucureşti.
8. Teodoreanu E. (2010). Air and Water, Basic Factors in Romania's Spa Resorts. Aerul si Apa. Componente ale Mediului: 86-90
9. Tudoran P. (1976). Peisajul geografic – sinteză a mediului înconjurător. Buletinul Societăţii de Ştiinţe Geografice din România, vol. IV. Bucureşti.