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COST 341

Habitat Fragmentation due to Transportation Infrastructure

ROMANIAN STATE OF THE ART REPORT

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Contribution to the elaboration of National Report, which belongs to COST 341 action.

INCERTRANS Bucharest working group is the main author of this National Report, that is an integrating part of COST 341 action.

The team led by Eng. Razvan Novaseliv, the national repporteur and 341 COST Management Committee Member and also Head of Department Facilities Equipment and Geodetical-Topographical Studies, is made up of staff qualified in the field of road and railwaz traffic, environment protection and ecology, geodetical and topographical measurements and the related fields, with a rich experience in transport research.

In order to work out this State-of-the Art Report, referring to habitat fragmentation, due to transport infrastructure , there were engaged many other institutions and personalities mentioned in the reference list. The significant contribution they had is reflected both in the complexity of the elaborated work, and in the various points of view this topic is approached.

Another institution, which is very important at national level, namely: National Road Administration is concerned and registers great achievements in performing road pavements, bridges, viaducts, etc., and it is involved in conceiving this National Report, having a particular contribution on the behalf of its experts.

There are also high skilled professionals, who greatly participated in the working out of this national Report. They devoted a great deal of energy on this very special paper.

As regards our acknowledgement, we take this opportunity to express our gratitude for their assistance in elaborating the Romanian Report.

In our opinion the Report statements give a true and fair view of INCERTRANS position in compliance with the new requirements at world level.

We conducted our Report as close as possible to the European standards generally accepted , and we believe our paper provides a reasonable basis for future studies, concerning the approached field.

1. INTRODUCTION

Romania is a country of average dimension located in the Southeast of Europe. **(fig.1)** Out of 238,390 km^2 total surface, 62% represents the agricultural surface (arable lands, pastures, hayfields, orchards, vineyards and viticulture, fruit growing seed beds), 27% forests, 3-7% water, non-productive grounds 2% and built surfaces 2.64%. The surface occupied by roads and railways represent 1.65% (internal road network is under 1%), which is very little as compared to most European countries. **(fig.2)**

Romania's relief and climate conditions created and preserved a natural characteristic of flora and fauna. Danube's Delta, plains with forest steppe character, hills, mountains and Alpine gaps have as much biotopes where in a perfect natural equilibrium, there were developed rare or unique relief forms in Europe.

The intensive industrialization, without protective measures against notions elements issued by technological processes, equipment which are often outdated, notions emissions, the road network and its accessories for maintaining it (plants for asphalt mixture preparation, quarries, pit ballast) have affected the health of natural environment. To this action it is also added the deliberate will of man to distruct environment. Waters, rivers or lakes, ground water, the sea of Romanian seaside shows (preserves) the mark of lack of preventive measures in order to damage them from ecological point of view.

One of the undermining forms of human existence basis is the laying out of communication ways by exclusive subordination to economic criteria. Being aware of the necessity to develop some national research programs of infrastructure effects upon bio-diversity and of results implementation in order to minimize the impact, may lead to adaptation of present transport means to ecological requirements and to integration of this subject into the planning procedures of new infrastructure. ***IENE*** experts underlined the necessity to co-operate and the information exchange in the field habitat fragmentation at European level. This co-operation led to the occurrence of ***COST 341*** program.

In compliance with the first report, ***COST*** member countries are organized in 5 groups with common features as regards the reports between habitat and transport infrastructure. Romania belongs to the group of "Central and East European Countries".

Poland and Romania represent the countries with the greatest territorial extension, which are introduced in ***COST 341***; as a result, the findings obtained,

involve significant territories of the Center and East of Europe. Romania, by its position in this area is integrated, both historically and from the point of view of contemporary evolution, into 3 great transport axes:

- The axis that crosses Europe from North to South; The axis that links Western Europe to Russia; The axis which links Europe to the Black Sea – Balkans and Asia.**(fig.3)**

The achievement of a sustainable equilibrium between human activities in process of development and environment protection imposes an assignment of responsibilities, which should be fair and well defined. In this respect, preoccupations concerning environment should be integrated into the definition and putting into operation of economic and sectorial policies, into decisions of public administration, into production processes as well as into the entire individual behavior and selections.

As regards Romania, the world strategy of environment protection is well expressed in the "National Action Program for Environment Protection", worked out by the Ministry of Forests, Waters and Environment Protection, which is at the same time a materialization of government policy for which environment protection and "durable development" represent objectives of national priority.

Within this context after 1989 in Romania it was achieved a national research program aiming at "delimitation and description of Eco-regions from our country". In the research program there were taken into consideration just the 3 main components: geographical frame, ecosystems resources (bio-diversity) and the extent of human intervention. Eco-regions determination allowed the knowledge of main landscape types of Romania based on ecological grounds. After 1990 in has begun the greatest technical and scientifical territory arrangement at national level. We speak about P.A.T.N. = The Plan of National Territory Arrangement. Obviously, in this work of great dimensions, of national value – and for parks – of international value, there are also concentrated the date regarding the habitats that must be considered for their possible fragmentation (defragmentation). By legislation the two sections of the plan for national territory arrangement, in Romania there are concentrated the information that allows the correlation of the 2 partners – ***Habitat and Infrastructure.*** Starting with 1991, there were achieved great synthesis works of numerous specialized researches already existent. Moreover, it was passed on to the inventory of flora and fauna bio-diversity of Romania, elements that are absolutely necessary in ***COST 341*** study. Out of 3.800 species of plants that existed in Romania a few decades ago, some of them are declared "Monuments of nature", 290 are vulnerable species, 185 are threatened with disappearance, and 17 have already disappeared. As regards animal species, non-vertebrates that would represent the objective of total protection, due to the very great number (around 33.085 species) are appreciated to be in danger only 11. Out of 700 of vertebrate species, 26 are in danger and 5 have disappeared.

There have been recognized 36 “naturally protected areas”. The National Network of protected areas contains 586 objectives, occupying 4.8% of Romania’s territory and it is made up of 122 botanical, 15 zoological, 65 geological, 58 speological, 52 paleontological, 51 forest, 151 mixed and 8 landscape areas.**(fig4)**

At the present we can mention as biosphere reservations of Romania: Danube’s Delta, Apuseni Mountains, Aninei Mountains, Valea Cernei, Cheile Bicazului, Portile de Fier.

Another type of protected areas is a national park: Retezat, Rodna, Ceahlau, Piatra Craiului, Cozia, Caliman.**(fig.5)**

The ecologization process of human sciences and technical activities represent the object of COST 341 program. “To ecologize a human action means not only to see only immediate positive results. It means at the same time the possibility to have negative retroactions (eco-feedbacks) – fragment. In direct relationship, infrastructure achieved in transports may represent – at a certain moment – human society engaging in non-ecological or even anti-ecological actions. These 2 concepts “habitat” and “infrastructure” in transports, are the 2 component of environment, which COST 341 aims at changing from “aggressed” and “aggressor” to “partners”. The surface occupied by communication ways is not alarmingly great related to the country’s surface, as compared with other Europe’s countries. The routes of communication ways are established for years – if changes were registered, these have as an objective: maintenance, modernization or rehabilitation – absolutely new routes are not significant as regards length.

Finally, we must specify that in Romania, there is on one hand a ***strong nature feeling*** and – on the other hand – well developed branches of nature sciences with an emphasis on nature protection and ecology (Prof. Dr. Viorel Soran and dr. Borcea, 1981).

2. KEY ECOLOGICAL CONCEPTS

Introduction

Territory arrangement and ***transport*** are 2 main elements which, sustaining one another, participated in the appearance (creation) of a more dispersed and mobile society. While traffic increase should be restrained in order to observe ecological objectives, it seems that modern models of territory arrangement make out of automobile and truck use, a necessity and not a selection, the developing model influencing the mobility requirement.

Durable development is the development by which present necessities are satisfied without compromising the possibilities to satisfy future generation.

Durable regional development is focused on ***flows equilibrium*** out and in the region. Bioregional forecasting adapt the functional relationship between food and consumption production and thus the landscape will be redirected towards a productive use and this achieves a rehabilitation tendency.

The Eco-system is a system made up of total living beings and of their life environment. The equilibrium of an eco-system is ensured by the fact that each change acts as a new function of the system.

The so called 'n' functions act towards maintaining the present condition of a system, while dysfunction's push towards a changing corresponding to a condition with increased stability. The Eco-system is therefore a flexible system, due to the multitude of its stability conditions that allow a positive action of 'n' functions and its high entropy characterizes it. Development in ecological sense means the biotic adaptation of community to medium by functional differentiation and external changes. We must remind, Romanian research contribution regarding "Key ecological concepts", which were confirmed in specialty international congress:

A. Basic change of the way the human society actions are understood within the complex and continuous process of ***INFRASTRUCTURE*** complex achievement. From the well-known philosophy, completely wrong, concerning nature domination, society understood that it is obliged to behave with natural environment like in front of a PARTNER, which is not only worth respecting but also fearful. As a result, numerous fields of human activities are analyzed again and subject to an ***ECOLOGIZATION PROCESS***.

B. Man's possibility not only to avoid his mistakes but to pass on to a higher step of the way he can "repair" what he has damaged. In scientific research this field is known under the name of ***"ECOLOGICAL RECONTRUCTION",*** in the sense of deepening the possibility to recreate some ecological systems that should observe – partially, at least – the initial biological processes of Eco-systems functioning.

2.1. Landscape ecology

We may encounter 3 approaches of landscape study in Romania's research.

A.The most known is ***GEOGRAPHICAL*** approach. It is mainly based on physical landscape components, forms of relief and on water presence, and was each geographical form is expressed by its specific space. This way of approach was enriched by "geosystem" concept (Suceava 1963). Its definition gets us closer to a correct understanding of landscape structure: "An open system, made

up of correlated elements of nature, subject to nature law and acting within geographical cover".

B. A second type of approach is ***"LANDSCAPE – ARCHITECTURAL"*** approach (dr. architect V. Mitrea 2000), where there are prevailing the urbanism architect's and landscape painter's and means of action. The major objective is to conceive design and achieve park, garden and square structure in urban and suburban landscape that are considered closed. Also in this case the green space network in human settlements was studied as a system (Berindan 1968, 1975), in order to use them as a major protection, rest and recovering factor of human communities.

C. The third approach is the ***ECOLOGICAL*** one achieved still since 1977 (A. Rosu – Irina Ungureanu) and being based on G. Bertnand's paper (1968).Thus, we quote: "landscape is the result of 3 main components: ecological potential (ecological support – subsoil and neutral elements), the community of living organisms (biological exploitation – vegetation and fauna) and human actions (built areas – s.n.").

The landscape forms an independent entity where complex phenomena contribute together to assembly working

Agriculture and traditional pastoral activities have managed for centuries semi-natural habitats and their abandonment led to general poverty of bio-diversity and to landscape variety. Road network becomes ever denser, the loss rate is already very high: one km^2 of terrain (ground) is generally crossed by several km of modernized highways and country roads. In their immediate neighborhood, the microclimate and the structure of limitrophe flora and fauna are modified. Most frequently, one km of road with intense traffic strongly influences a surface more than 40 hectares. The existence of high-class roads incurs the barrier effect, landscape's pollution and changing.

Roads of reduced importance, besides having a poor technical endowment, actively contribute to a negative impact upon life quality in natural environment by favoring the deep penetration of human activities – tourism invasion, illegal exploitation, recent non-regenerated clearing. Destroying flora and fauna diversity by infrastructure over development, endangers the health of community, which is at the same time subject to risks generated by possible transports of noxious or chemical substances made without precaution.

Due to economic situation in Romania the road network developed at the level of those from West or Central Europe and implicitly the problems of impact upon environment are not situated at the same level.

So that, in most regions of our country, the landscape is characterized by the abundance of natural structures or with natural aspect that make possible the development of abundant spontaneous vegetation, which in its turn makes possible the existence of a rich fauna.

New and ‘improved’ roads threatens many protected areas, river sewerage may endanger riparian wet lands, and the routes chosen for high-speed railways. Also sea transport, of some goods often dangerous, may affect coastal zones.

2.2. Landscape characteristics

Environment is everything around the place occupied by dwelling as geo-bioclimate nature, social conditions and all buildings and objects built.

The value of natural or artificial landscape structures is given by their extent of impact on the behalf of human activity and it greatly depends on the biological diversity, developed in their Eco-system as well as on the sheltering possibilities they ensure. According to the importance they have in the existence and development of sheltered population there are: natural or ***artificial Eco-systems but with natural aspect*** (forest skirt; lakes shores and the river banks; hedges and trees alignments; foundations and hillocks of geological origin) and ***artificial structure*** (railway embankments; road embankments; borders of cultivated fields; forest or agricultural roads; store walls). **(fig. 6, fig. 7, fig. 8)**

The characteristics of Romanian's morphology - corridor sectors - represent territories of energetic concentration, pointed out by adding the hydrographic network and by laying out some important transport networks, automotive and railway.

In these units one may distinguish 2 mayor types of natural barrier: orographic (communication ways) and hydrographic (water courses and commutations), along with human concentration and elements characteristic to the activity of landscape affected by human constructions (waste, polluted areas). Not achieving or hindering certain minimum communication (natural, artificial) corridors between natural geo-systems may lead to their function blockage and it amplifies the phenomena of natural risk. Human settlements of type and the communication ways make so that the landscape should under-grows important changes and it should favor the speed up of morph-dynamic processes. In our country there is a criminal lack of responsibility for land use and green spaces management. The last 10 years are characterized by unprecedented aggression and with difficult to appreciate consequences, of all that means natural environment, irrespective of location. In rural localities and in pre-urban area there are found out wild and irrational clearing, invasion of green areas by tourist constructions or dwellings, located more or less illegally, tourist invasion of protected areas, setting up of new access roads and traffic amplification on the existent areas, wild exploitation of some resources (for example quarries). At the same time many of agricultural surfaces are not exploited. These actions lead to the restriction of habitats, modification of lands function and of living standard with negative effects both upon fauna and flora.

2.3 Habitat fragmentation

Every zone may be defined as a land unit for which functional relationship are almost absolutely internal, fact pointed out by landscape diversity and by progressive fragmentation of habitats. Assessment of ecological potential, of potential offered by isolated landscape structures in each ecological sector, really puts together the 3 basic factors, namely: quality, capacity and habitats' functions existing in the sectors concerned. Dramatically affected by human activity, natural habitats linked by characteristic landscape structures, that offer guidance and protection and where there were maintained natural elements, have allowed over time, due to the existence of enough members of the species, the survival of a sure diversity of flora and fauna.

The basic requirement in order to preserve biological diversity is "in situ" preservation of natural Eco-systems and habitats, keeping and recovering of living species in their natural environment. In this context fragmentation with obstacles never to be overcome, is a phenomenon not to be neglected and led to the definition of the term :"ecological sequence" that defines the functional ecological entity, delimited by a number of natural and artificial obstacles, for which functional relationship are almost absolutely internal, as a result of partly or total restriction.

Land fragmentation is particularly materialized by disturbing the ecological equilibrium, especially in case of forested areas and it affects not only animals' life that move above soil, but also the life of creatures that move in water or air. Roads and urban agglomerations reduce original biotopes of wild fauna or divides them by isolating populations. Roads size, traffic density and slopes arrangement affects the species' passing; the circulation path may absolutely isolate a population or it may represent just an obstacle for certain animals.

For numerous animals, the fact that roads are closer does not constitute a place to stay fully acceptable due to toxicity. But also changing related to devastation may have a negative effect upon land.

Roads' effects do not confine themselves only to the proper highways, in their immediate vicinity, but also microclimate and the structure of limitroph flora and fauna is changed.

Most frequently, one road km with busy traffic strongly influences a surface more than 40 hectares. The negative impact of road transport upon community is generated by a busy traffic, noise, bad smell, dust and dirt, and the affected area extends sometimes up to 100 m on each side of the road.**(fig.9)**

Romania's surface is 237,500 km^2 and is made up of around 31% mountain relief, 36% hills and tablelands and 33% plains. Forest surfaces represent about 27% and those for agricultural use around 59% and according to the data at our disposal we estimate that there are surfaces that remained not-fragmented 10-100 km^2 . The surface occupied by communication ways (less

than 1%) is not so alarmingly great, as compared to other countries of Europe. Density is about 0.38% km/ km^2 , the distance between linear infrastructure in the plain area is 3 - 12 km and greater in the mountain area : 15 - 40 km. Density of district roads, that contribute to the mobility necessary to small industry and agricultural enterprises, is three time smaller than that of Germany or Poland. The routes of communication ways are established years ago, and if changed were registered, these had as objective : maintenance, modernization or rehabilitation. Absolutely new routes are not significant in length. The increase of percentage for space use will be made, taking into account the proper roads, link roads and other facilities (gas stations, parks, restaurants and motels). Increase of automobile number of Romania will require a space more and more assigned to parks, for example a town like Bucharest, which has a population of about 2.4 million of inhabitants, will require almost 10 km^2 of land (almost 5% of total space) only for parking. **(fig.10)**

2.4 Metapopulations, sinks and sources

In studies of impact upon environment, together with the real density of fauna, there should be taken into account habitat conditions (surface size, biotopes diversity, habitat quality, isolation, existent roads and traffic density), present and perspective fauna situation, as well as the general potential of region ecological development.

Each population is naturally subject to variations, a region where fauna density is at present lower than the average, is at risk to be underestimated and possibly degraded.

Every animal species has a ***specific organization***, which is genetically established and against which they cannot deviate but in a limited manner.

The extension of the field necessary to each species determines if a natural surface that remained is enough in order to keep an animal population and if the habitat of the respective species is too small in relation to the specific one, its disappearance from this place is just a matter of time. In a population, various animals have regular or random contacts.

If these contacts between various parts of population of different animal species are interrupted, these are divided into smaller populations or sub-populations, which have a relationship with other populations. From time to time, some animals leave their usual environment, they rove and meet by chance, local populations that join. If not, they are looking for a non-occupied habitat where they settle. Spontaneous movements (migration, expansion) determine an exchange of genetic material between local populations and increase of genetic characteristics variety and thus uninhabited (desert) areas may be re-populated.

At the same time, important losses registered in a given region (caused for example by diseases) may be compensated by animal migration coming from limitroph areas.

Small habitat islands separated from great distances, become improper for animal life, because the energy necessary to find food and accident risks are too great.

The smaller these surfaces are, the more necessary the possibilities of migration and change are. ***Animals*** that live on little islands have almost no or at all genetic changes with other populations. The more isolated an area is, the more is the risk of local population not to maintain itself.

The smaller a population is, the more it contains hereditary diseases. If the new combinations of genetic material are limited to a few individuals, there is the risk of totally eliminating the others during a few generations.

Composition of hereditary luggage is modified and genetically diversity is reduced leading to the occurrence of ***genetic drift*** phenomenon. Decreasing of biotin surface ***also changes species variety***. Those which have few needs and adapt themselves easily, may stand out because they are less sensitive to human activities and to structure changes they involve. More sensitive species, which are at origin, diminish or completely disappear.

If the area affected by the cumulated traffic impact and road infrastructure, vulnerable species (which are usually the rare ones) tend to disappear, thus remaining the common ones. Therefor, roads may deteriorate an environment without directly destroying it, because they are structures that isolates animals and separates them from certain areas and important resources. Animals with long mileage of migration suffer enormously due to the blocking of their passages. The road capacity to act as an ecological barrier tends to pauperize fauna, fact which is more destructive than the role of psychological and thermal barrier, since at last it hinders the landscape from fulfilling its role of living environment.

2.5. Movement of animals and ecological networks

Connectivity is the characteristics of landscapes to ensure the functional link between various points/zones of various wild species habitats, this being essential for their movement. In every ecological sector we distinguish entities characterized by the development potential offered by landscape structures, to which animal populations had to adapt.

The primary living space_for fauna is the one that includes all natural areas, created by man with natural aspect and various areas of agricultural cultures from the inside of areas with animal's normal activity ***(complementary living space)***, is the one that includes areas which present a little interest for terrestrial fauna, but however, it offers possibilities of evolution and

development in the near future. ***Spaces that are inadequate to be used by fauna***, include built areas and strongly affected areas by human activities.

The use of space by animals has also imposed various movement types: quick movement in open field, on the most direct route, from a hospitable environment to another one and slow movement, by stages, along or under the vegetal structures, which offer food or shelter in case of danger movement method is used by most animals. This movement method requires the presence of vegetal structures adequate to species and the existence of certain links between various landscape structures.

Associated with the type of animal movement, the term of "corridor" defines a concept that is deduced from the remark that animals moves repeatedly and in a great number along some routes frequently used, each species has its particular movement modalities and moreover the type of movement depends on its motivation. The study of ecological network leads to the possibility to identify 2 types of corridors: ***primary biological corridors***, which are found in all biotopes and hospitable landscape structures, where pre-existent links create a coherent corridor network on large scale (inter-regional networks) and ***secondary biological corridors*** which are located in the biotopes and hospitable landscape structures, but where preciously existent links ensure only limited networks (local network). The most corridors identified go through the biotopes and forest skirts already included in the life space of fauna. There are also spaces such as links which cross the lands of farms with artificial structures, lands with constructions and road infrastructure not included in the current life space, which have a vital role in the coherence of the entire system. The link between habitats is ensured by corridors, that from such an ecological network. In fragmented landscapes, the interconnecting characteristic disappears fact that leads to the risk of losing natural habitats aimed at.

At intersection points between road traffic network and biological network there are registered the greatest values of the risk of collision between fauna and vehicles. These conflict points are generally well-known, but their effect and the changes they produce in nature, more often give the impression that they are unpredictable and at the same time uncontrollable.

As an unhappy consequence of road traffic is also accident, sometimes with fatal results, of very many mammals, birds, amphibians and invertebrates caught unawares on the road.

For example, in April 1993 on DJ 222A road, on a length of 2 km of non-modernized road and with very reduced traffic, there were found 135 adult toads (Bufo bufo) crushed (Cogalniceanu D., Venezel M. - "Considerations regarding protection and preservation of amphibian and reptile population"). This accident led to the conclusion that the road separated 2 vital points of amphibians habitat and interrupted their movement.

It's always to be preferred to try preserve and improve the routes which animals already use. Anyway, it's not sure they will exist for ever and then other

roads will have to be found. Within the plan of land using it must be ensured the presence of these corridors. They are defined as biological corridors meant for non-intensive agriculture or for maintaining the natural aspect where constructions are not authorized.

Very few species have the tendency to cross the communication ways, and when they do it, they do it by accident, occasionally, without a permanent motivation. Up to the present in our country there were not registered routes of season migration with great animals, routes that intersect the communication ways. Some species are not afraid to get closer to inhabited areas (fox, wild boar, deer, roebuck, rabbit and wolf). Nevertheless, the number of accidents produced by collision with field animals is so small that is not registered at the level of Forest Directorates Hunting.

2.6. Scale and hierarchy

Fragmentation scaling as well as the hierarchization of its effects, at the scale of whole country, may lead to adopting some scientific criteria, which might be able to generate economical criteria of assessment and application of the solution for prevention, reduction and compensation of fragmentation effects, with in the context of durable development of transport systems.

After 1889 in Romania it was achieved a national research program aiming at "delimitation and description of Eco-regions (ecological regions) of our country". In the research program there were taken into account just the 3 main components specified above: geographic framework, ecosystems resources (bio-diversity) and the dimensions of human (anthropoid) intervention". Determination of Eco-regions allowed us to know – on ecological bases – the main types of Romania′s landscapes. The results published in 1992 (A. Vădineanu and collaborators) delimited 22 eco-regions that may be assimilated with landscape types. There are: 1.Oriental Carpathians; 2.Meridians Carpathians; 3.Banat Mountains; 4.Apuseni Mountains; 5.Transilvania′s tableland; 6.Getical Sub-Carpathians; 7.Curve Sub-Carpathians; 8.Suceava′s tableland. 20 Danube meadow, etc.

At the level of entire country′s territory it stands out the. The Network of Natural Zones that should be protected.

The protection levels are complex, from Biosphere Reservations (Danube Delta), National or Natural Park (Domogled – Valea Cernei, Retezat, Iron Gates, Cheile Nerei, etc.) up to habitats of flora or fauna some species with special protection conditions.

To there are added a number of 827 Protected Natural Zones of surlier sizes than parks. They are related to administrative units of national territory.

Terrestrial species which from the hunting background and are noticed in relation to the risk of intersecting the traffic routes are: Carpathian deer – Cervus eluphus (the Red Deer) **(fig.11)**; The Roe Deer – Capreolus capreolus **(fig.12),**

The Fellow Deer – Dama dama; the Mouflon – Ovis musimon, the Chamois – Rupicapra **(fig.13);** Wild Boar Sus scrofa **(fig.14);** the Brown Bear – Ursus arctos **(fig.15);** the Lynx – Lynx lynx; the Martens – Martes species; the Wild cat – Felix siluestris **(fig.16);** the Badger – Meles meles; the Fox – Vulpes vulpes **(fig.17),** the Hare – Lepus Europeus **(fig.18);** the Wolf – Canis lupus **(fig.19);** the Jackal – Canis aureus; Racoon dog – Ricterentes procyonoides.

The living area of there species is generally situated in affronted mountain massifs and in hill area. The habitats of various species were re-dimensioned and consolidated. Generally, the dispersion of animal population is denser towards the center of habitats, in specific living areas (affronted, with possibility to find a shelter and hiding-place, situated at as long as possible distances from populated, polluted, aggressive areas. Animals movements (of the type: day or season moving, dispersion or migration) along corridors or transversally on them, are reduced enough in relation with important traffic routes. Amore intense activity may be noticed on public roads routes of low category, non – aggressive exploitation roads (forest roads, agricultural, etc.). Due to the small number of events in which with animals should be involved, there is not available a statistics of collisions between animals and traffic means.

2.7. Indispensable model (abstract)

Environment is all that there is around the place occupied by dwelling as a geo – bio-climate nature, social conditions and buildings and objects built. The present society understood that it is obliged to essentially modify the way in which it acts, passing from the known philosophy, to dominate nature, to a ***PARTNERSHIP*** with natural environment. Within this context, in the sense of deepening the possibility to recreate certain ecological system that should observe – at least partially – initial biological processes of ecosystems functioning, there are registered "Key ecological concepts which refer to ***ECOLOGIZATION PROCESSES*** and to ***ECOLOGICAL RECONSTRUCTION*** that constitute contributions of Romanian research.

The value of natural or artificial landscape structures is given by their degree of being affected by human activity and it greatly depends on the biological diversity, developed in their eco-system, as well as on the possibilities of sheltering that they ensure.

Assessment of ecological potential, the potential offered by isolated landscape structures in every ecological sector, really puts together the 3 basic factors, ramely: quality, capacity and functions of habitats present in sectors of concern. The 3 approaches of landscape investigation encountered in Romanian studies, ***GEOGRAPHIC, LANDSCAPE PAINTIN – ARCHITECTURAL*** and ***ECOLOGICAL*** approaches may lead to a correct understanding of landscape atructure.

Besides the barriers of communication type (roads, railway), the natural ones (water courses with great flow, mountain massifs) also constitute green corridors along which a normal fauna life may develop, provided that its "wilderness should be protected; the presence of man should be as redeced as possible.

Characteristic to Romania′s morphology, corridors sectors represent territories of energetic concentration, pointed out by adding hydrographic network and changing of tree graph, with the role of energetic transfer and exploited by "laying out some important transport network", automotive and railway.

Due to Romania′s economic situation, the road network is not developed at the level of those from West and Central Europe and implicitly the problems of impact upon environment are not placed at the same level.

So that in most regions of our country, the landscape is characterized by the abundance of natural structures or with natural aspect that enable the development of an abundant spontaneous vegetation, which in its turn enables the existence of a rich fauna.

The surface occupied by communication ways in Romania (less that 1 %), is not alarmingly great in relation to country′s surface, as compared to other Europe′s countries.

The routes of communication ways are established many years ago, there aimend at mentioning, modernizing or rehabilitation - absolutely new routes are not significant in length.

The density of district roads, which contributes to the mobility necessary to small industry and agricultural enterprises, is 3 times swatter than that of Germany or Polond. The increase of space use percentage will be made taking into account the proper roads, link roads and other facilities (gas stations, parkings, restaurants and motels).

The area of wild species life is generally located in affronted mountain massifs and in the hill area. The habitats of various species were dimensioned again and consolidated.

Animal's movements (of the type: day or season shift, dispersion or migration) along corridors or transversal to them are quite reduced in relation to important traffic routes.

3. INFRASTRUCTURE EFFECTS UPON NATURE

Introduction

The relationship between land use and transport has a considerable meaning for environment. Transport systems require movement space and exerts major effects upon habitats and landscape; their interaction with the way of land use is often subtle and on long term. Transport represents an important factor in the development of human settlements; in its turn the development model influences the demand for mobility.

3.1. Direct effects – Overview

Crucial factors that contribute to land fragmentation are road network expansion, evermore confinements and increasing number of vehicles that get outside the carriage way. In the neighborhood of forests and agriculture areas, traffic is the greatest threat for bio-diversity.

The impact upon biotope may be very evident close to roads, where due to accumulation of multiple effects of road traffic, the effective degradation covers much more surfaces than road width.

The accumulated impact of traffic in the neighborhood of road strongly affects environment fact that renders inhospitable living environment. Various noxious factors (salt, herbicides, heavy metals), light, noise, oil residues and toxic gases, render inhospitable the living environment. **(fig.20)**

The main pollutant agents which must be taken into account when estimating the effects upon vegetation are:

- Nitrogen oxide NO_X, that produce soil and water ***acidity (acidifiere)***
- Particles, smokes that are not assimilated but in reduced proportion
- Ozone made up of other pollutants interaction which is a risk factor and it may affect plant roots, leaves and may be the cause of low crops.
- Various hydrocarbons (HC, VOC, methane, etc) which are accumulated in soil and than being encountered in food by means of consumption plants.

Along with these emissions an overwhelming effect have the so-called "green house gases" out which the most important and quantitatively the most polluting is carbon dioxide.

Another factor that generates pollution and leads to fragmentation due to constructions is also urban sewerage, that serves many towns (in the last decade) the population of which has considerably increase and represents the main cause of dead waters.

Danube Delta is slowly infected by Danube's polluted waters, fact that affected population of fish that were considered in the past the food of the poor people in our country and today they become a luxury. **(fig.21)**

3.1.1. Habitat loss and transformation

In Romania roads represent a small percentage of space occupied (less than 1%). In other parts of Europe this percentage is much greater. However, road construction in Romania is a process under development.

The World Bank and other international financial institutions (The European Bank for Reconstruction and Development and the European Bank for Investments) take into account proposals for modernization and constructions of new roads and the European Union has in view a program for building a Trans-European networks of motorways that should cross Romania too.

These new plans will lead to the increase of percentage for space utilization, taking into account the proper roads, the link roads and other facilities.

The space occupied and the changed due to infrastructure, which is estimated of statistics calculation at the and of 1998 is presented according to the following table:

Total surface		**23839,1 (thousand hectares)**
Agriculture surface		14801,7
Of which:		
Arable land		9350,8
Pastures		3402,7
Meadows		1503,4
Vineyards and vine nurseries		281,8
Orchards and nurseries		263,0
Forests and other lands with forests vegetation		6672,3
of which forests		6227,4
Buildings		630,5
Roads and railways		395,7
Waters and ponds		880,4
Other surfaces		458,5
Protected areas	No.	Assigned surface
Biosphere Reservations	3	583,6
National Parks	14	376423
Scientific Reservations	40	2712
Nature Monuments	180	2712
Reservations of Nature Preservation	573	118161

3.1.2. Corridor function

Nature corridors must ensure links between similar origins. Besides the barriers of communication way types (roads, railway) the natural ones (water

courses with great flow, mountain massifs) also represent green corridors along which it may be developed fauna normal life, provided its "wilderness" is protected and human presence should as reduced as possible. In case of great road axes such as motorways, this objective will be only partially reached.

Most of local populations, sub-populations or other populations are in a permanent relationship. From time to time some animals leave their usual environment, rove and meet other populations, which they join. If not, they look for non-occupied habitat where they establish themselves.

Spontaneous movements (migration, expansion) determine exchanges of genetic material between local populations and also lead to an increase of genetic characteristics variety.

Thus, deserted areas may be repopulated and the important losses registered in a given region (caused by, for example diseases) may be compensated by animal migration coming from limitrophe area. One biotope, which is isolated among roads, railway, or urban agglomeration, is difficult to be accessed by a great number of animals.

3.1.3. Disturbance

Road technologies and respectively equipment may produce a chemical pollution (heavy metals – released for example by tire friction, oil residues and toxic gases), physical pollution with noise, light and vibrations as well as affects upon soil and hydrological equilibrium by rain water that "washes" the road, as well as draining works and winter time maintenance (salt use on roads – sodium chloride, herbicides). Great concentrations of sodium and chlorine in pins needles indicate the fact that salt plays a decisive role in their effect upon vegetation.

Surface water drives the salt more than 100 m of road and it affects both plants and small animals. Measurements carried out when brooks are thawing near roads have pointed out salt concentrations that have a destructive effect for many organisms of fresh water.

Absorption at upper level plays a more important role than the absorption by root.

Factors that contribute to impact upon vegetation in this way are: great salt quantity applied on roads during winter, unusual meteorological conditions from the period of blooming, vegetation degree of getting near traffic.

The effect is also reflected upon underground waters and soils that will show an increase of salt concentration.

There are found out saturations that are limitrophe zones to terrestrial communication ways and an impact upon ground water even in acute cases of macro-pollution such as lakes acidifying and forests destruction.

The atmosphere is washed by rain so that air pollutants are transferred to other environment factors (surface and underground water, soil, vegetation, fauna), there take place vegetation destruction, acidifying of water, soils and their introduction into noxious components (example: nitrates, sulfates, oil products, heavy metals such as lead etc) and finally, by trophic chain, they reach to affect by food and environment sanitation, directly man's health.

Another example is when hydrological change caused by road structure leads to drying of plants habitat and thus to flora changes. Vehicles exhaust gases change air composition and contribute to modification of precipitation quantity, which affects by a secondary effect soil and water acidifying, that in its turn affects flora and fauna.

As compared to other noxious substances such as nitrogen oxide and sulfur, toxic heavy metals like lead, cadmium and nickel are not important, but exceeding the admissible concentration in adjacent soils they infest both plants and animals of areas limitrophe to road network. It was found out that the most strongly affected surface is a lane that may reach up to 10 meters width outside the safe area provided from the road axle. Near motorway there are living creatures surely affected by heavy metals. Since in nature, small species are food for great species, infestation appears also with animals, which do not directly contact the polluting source. It was found out that animals living on road edges, have within their body a lead level that reached values 14 times greater than normal ones. Today the problem of lead content is decreasing since the gas consumed is greatly without lead.

Traffic noise is also a factor that influences fauna. It is known for sure that birds avoid a relatively large area along roads. Search for food is much more reduced near roads than at a certain distance from them. Birds avoid a relatively large zone along roads and this distance may reach for some more sensitive species, up to 1000 m as against it. Most of birds are very few near roads. The effect is more intense in case of roads run by 20–30 vehicles/day than in case of those with a traffic density of 1 vehicle/day.

Life space damage is determined also by the frequency of signaling and by loss of vegetation with which animals are normally feeding. In this area vulnerable species (which are usually the rare ones, tend to disappear and remain only the common ones.

Thus road capacity to act as an ecological barrier tends to impoverish fauna, which is much more destructive than the role of physical and thermal barrier, finally hindering the landscape to fulfill its role of living environment.

The size of affected area mainly depends on the land morphology and traffic intensity; the effects are extended on an area much greater than the effected widths of road, sometimes up to 100 m of its each side.

3.1.4. Fauna victims

Besides those mentioned we remind that million people are wounded or killed in car accidents every year and a great part of population, particularly that of urban areas are affected by the noise produced by automotive traffic. Air pollution and noise, stress and social separation caused by traffic have negative effects upon human health.

The conflict between fauna and traffic may be summed up in 3 situations:

Reduced traffic (under 1000 vehicles/day) – only the small terrestrial fauna will be seriously embarrassed in its movement, but many animals of various sizes will be killed as a result of collisions, so that in dangerous points measures must be taken to improve visibility both for driver and for animals and in case of amphibians is necessary to provide special crossing passages.

Average traffic density (between 1000 and 10000 vehicles/day) – animals are aware of the danger and some of them avoid the road and the surrounding areas. However, the number of animals killed in great collisions is great, but it is possible to cross the road under certain conditions. When the vehicles number is between 4000 and 10000 vehicles/day the affected area increases. The number of animals is small and mortality decreases.

Busy traffic (10000 vehicles/day) – very busy traffic has almost entirely a deteriorating effect. Only animals that resist under stress or are overexcited try to cross the road. The affected area along road is equivalent with at least twice its opening. The number of animals killed is however small, but the barrier effect is complete from biological point of view.

Accidents caused by great mammals are rare on surrounded roads, but this function as barriers for animals that cross the road. Without specific constructions that should allow fauna to pass, animals frequently reach the road (access ways in motorways, breaks of surrounding fences (hedges)) and become prisoners.

Then there are produced spectacular accidents. In case of small animals is more difficult to stop their crossing. The martens cross without problems all surroundings, foxes slips under surroundings at the smallest part of rugged land and badgers dig passes under the surrounding fences (hedges) that are not buried in soil.

3.1.5. The barrier effect

Fauna freedom (of development and movement) is ever more reduced. One of the most visible consequences is disappearance of many mammals, birds and invertebrates, killed when they were trying to cross the roads. Infrastructures in particularly motorways due to constructive conditions are obstacles considered impossible to surpass for most of species, leading up to ceasing or even stopping the migration.

Roads barrier effect has been studied for various animals species. Studies show that a road of 3 m width hinders land use by field mice. It was proved that

beetles do not cross at all a stationing loop of 5 m width used only by 50 vehicles/day. A species of locusts has not yet populated the inside of a road node after 20 years since its construction. The hare reduces its speed at a simple country road crossing visible on intact snow layer that hides it. Instead, roe bucks may integrate secondary roads within the habitat, but they are completely inhibited by very frequented and important roads. They do not cross unless under the effect of being disturbed or when they are afraid. Animals that migrate, for example young deer are always an exception from this rule.

Our present condition without bushes, water meadows, thickets and with devastated places, the large agriculture space without shelter and possibility to find food became less and less adequate not only to life but also to survival of many wild species. At the same time with these facts there also decrease specific predators with fur and feathers during the day and at night. Therefore, it is found out an unprecedented poverty of wild fauna diversity, as an obvious consequence of flora bio-diversity poverty.

Roads and their auxiliary installations are obstacles for animal movement on land and are at the same time "psychical barriers". Road surfaces are hot in summer time thus creating "thermal barriers" that cannot be surpassed, because animals (amphibians, insects) are dehydrated or exhausted after such an effort.

Rivers and canals are also psychical barriers due to too steep slopes that are traps for animals that jumped into the water and then they are unable to climb back thus dying by drowning. This impact is translated by the ***barrier effect***. It depends on roadsides (constructive structure and road width – ***effect of rejecting***), on traffic volume, morphology of crossed land, soil type and of course animal species that occupy this land as well as the number of animal mortality due to collisions with vehicles. Traffic amplifies the barrier effect of roads by: psychical disorder caused by noise, light, vehicles movement, chemical disturbances produced by gas and dust pollution, due to wear and deterioration of road surface and vehicles.

Accidents caused by great mammals are rare on surrounded roads, but these works as barriers for animals crossing the road. Barriers should be placed only where collisions are a problem (traffic safety, destruction of wild animals).

Also obstacle constructions only on one side of the road are not recommended because if animals stay captive on the carriage way also accident risk by collision with vehicles increases quickly. Surroundings alone do not guarantee a total security. For example wild boars that cover the surrounding until they find a passage.

3.1.6. Effects upon vegetation

Until 1998 Romania had the greatest lead quantity of gasoline from Europe (0.5 g/l), and this diminished during the same year at 0.32 g/l,

which represents more than the double level admissible in European Union (0.15 g/l).

Romanian diesel oil contains 10 times sulfur than that of European Union (0.5% as compared to 0.45% in EU), although the limit was reduced in 1998 at 0.35% and government expressed its intention to align these limits to those of European Union in due time. It is recommended to be used the gasoline without lead.

Although lead toxicity is well known for plants, data are not relevant and not enough. Al. Ionescu admits that lead plays a role in producing some injures of plants aerial parts. Further we will present some researchers opinions as regards plants resistance to the unfavorable action of lead.

Species resistant to lead pollution (according to silviculturists and biologists from Institute of Essen – Germany quoted by G. Smejkal, 1982).

Very sensitive species:

Species resistant to lead pollution	**District**	**Locality**
Robinia pseudacacia	Alba	Zlatna
	Argeş	Piteşti
	Braşov	Făgăraş
	Constanţa	Medgidia, Năvodari
	Hunedoara	Călan, Chişcădaga
	Mureş	Adămuş, Dâmbau
Robinia pseudacacia	Sibiu	Copşa Mică, Mediaş, Micăcasa, Târnăvioara
Syringa vulgaris	Alba	Zlatna
	Arad	Vladimirescu
	Braşov	Codlea
	Cluj	Câmpia Turzii, Turda
	Gorj	Bârseşti, Târgu-Jiu
Juglans regia	Alba	Zlatna
	Bacău	Bacău
	Constanţa	Medgidia, Năvodari
	Caraş-Severin	Reşita
	Gorj	Bârseşti, Târgu-Jiu
	Hunedoara	Călan, Crişcior, Luna Păuliş, Hunedoara
Prunus armeniaca	Bacău	Gura Văii
	Hunedoara	Călan, Hunedoara
	Sibiu	Mediaş, Micăcasa
	Gorj	Bârseşti
	Prahova	Teleajen, Valea Călugărească

As regards nitrogen oxides the researches undertook by Al. Ionescu (1982) and G. Smejkal (1982) point out that at concentrations of 4-8 ppm, on about 5% of leaves surfaces there appear necroses and at concentration greater than 25 ppm, leaves are faded away and fall prematurely.

Another important pollutant is sulfur dioxide. The photo-oxidization phenomenon of sulfur dioxide from atmosphere plays a particular role. Researches shown that its rate of formation hardly reaches 2%/hour. Moreover, oxidization of sulfur dioxide is heterogeneous and directly proportional with humidity.

This photochemical oxidization contributes to the occurrence of aerosols in HC-NO_X system; at the same time of olefine, sulfur dioxide, under light influence, it is formed sulfur acid that lies at the basis of fog and acid rain appearance. Only the presence of sulphurous anhydride, in dosages of 50 ppm, causes serious injures to plants, particularly on leaves under the form of brown spots. Instead, the presence of the two assets cause burns and dehydrated spots on all organs of the plant. There is a certain way in which this pollution acts with these polluting factors: with cryptograms green sickness is prevailing and these reduces the photosynthesis, succulent plants are the most sensitive as compared to conifers, which are considered the most resistant.

Here is a classification of plants resistance at SO_2 according to Al. Ionescu et al., 1974.

Species resistant to pollution with SO2	**District**	**Locality**
Agrostis stolonifera	Alba	Zlatna
	Hunedoara	Călan, Chişcădaga
	Sibiu	Copşa Mică, Mediaş
Allium flavescens	Dolj	Işalniţa
	Hunedoara	Hunedoara
	Mureş	Târnăneni
	Sibiu	Copşa Mică, Micăcasa
	Vâlcea	Govora
Bryum argenteum	Constanţa	Năvodari
	Sibiu	Târnăvioara
Bryum argenteum	Tulcea	Tulcea
Calamagrostis arundinacea	Sibiu	Micăcasa
Canna indica	Alba	Zlatna
	Arad	Vladimirescu
	Bacău	Borzeşti
	Cluj	Câmpia Turzii
	Constanţa	Năvodari
	Hunedoara	Călan, Chişcădaga, Hunedoara
Corylus avellana	Alba	Zlatna
	Cluj	Turda
	Hunedoara	Călan, Chişcădaga, Hunedoara
	Maramureş	Ferneziu
Plantes with intermediate resistance		
Beta vulgaris	Cluj	Câmpia Turzii, Turda

	Gorj	Bârseşti
	Prahova	Valea Călugărească
	Sibiu	Târnava
Catalpa bignonioides	Dâmbovița	Doiceşti
	Prahova	Teleajen
Lycopersicon esculentum	Caraş-Severin	Reşiţa
	Maramureş	Ferneziu
	Prahova	Valea Călugărească
	Sibiu	Copşa Mică, Micăcasa

Sensitive plantes		
Aesculus hippocastanum	Bacău	Borzeşti
	Braşov	Codlea
	Caraş- Severin	Reşiţa
	Cluj	Câmpia Turzii, Turda
	Hunedoara	Călan, Hunedoara
	Prahova	Teleajen
	Maramureş	Baia Mare
	Sibiu	Copşa Mică, Mediaş, Târnava
Alnus incana	Braşov	Victoria
Anagallis arvensis	Brasov	Codlea
	Cluj	Câmpia Turzii
	Gorj	Bârseşti
	Hunedoara	Hunedoara
Betula alba	Caraş-Severin	Reşiţa
	Hunedoara	Hunedoara
	Maramureş	Târgu-Mureş
	Sibiu	Mediaş
Dactylis glomerata	Alba	Zlatna
	Hunedoara	Călan
	Mureş	Târgu-Mureş
	Sibiu	Mediaş, Micăcasa, Târnăvioara
Medicago sativa	Bacău	Borzeşti

As regards carbon monoxide, plants are less affected by it.

Air pollutants that were created in photo-chemical processes – at the level of polluted atmosphere under the action of sunlight, oxidization processes are started and there result gaseous blend also known under the name of “smog” or oxidizing fog, which is encountered in the atmosphere of great towns and of road networks that are intensely trafficked.

The oxidizing agent most often spread in the polluted atmosphere is ozone. Studies carried out that are related to physiological action of photochemical oxidizing agents indicate ozone as a particularly toxic factor for animals, man and plants.

In laboratory, both ozone and peroxyacyl nitrates, causes necroses, pigmentation of plants and affects fruit quality. On leaves, injuries are under the form of spots, and peroxyacyl nitrates produces leaves burning by sun.

Oil residues, at direct contact, cause serious injuries or definitively destroy animals, man and plants.

3.2. Indirect effects

Life space damaging is determined also by the extent of vegetation loss that represents the normal food of animals. In only a few decades, intensification of human activities–agriculture, silviculture, industry, energy, transport, tourism etc.–determined the loss or fragmentation of natural environment leaving too little space for wild life. Agriculture and traditional pastoral activities had managed for centuries, half natural habitats, and the abandonment of these activities led to general poverty of bio-diversity and landscape variety.

Evaluation of habitats ecological potential puts together the 3 basic factors, namely: quality, capacity and habitats functions presented in the sectors of concern. Each sector may be defined as a land unity for which functional relationships are almost absolutely internal, as a result of partial or total separation due to urbanism or road network development. This is obvious in landscape diversity and in the progressive habitat fragmentation. Thus, it becomes important the study of fauna movement ways and territorial organization of different species.

Roads and their auxiliary installations (for example: fences along the road, embankments and steep canals) are obstacles in the way of animal movement on land and depend on road size and traffic volume, on morphology of crossed land, on soil type and of course on animal species that occupy this land and it is also aggravated by surrounding fences (hedges).

Thus, road capacity to act as an ecological barrier tends to impoverish the fauna, fact which is much more destructive than the role of psychological and thermal barrier, because it finally prevents the landscape from fulfilling its role of living environment. One of the unhappy consequences of road traffic is accident (some times with a fatal results) of many mammals, birds, amphibians and invertebrates caught on the road.

3.2.1. Fragmentation, network effects

Fragmentation affects not only the life of animals that move on soil, but also of creatures that move in water or air. Small habitat islands separated by a great distances become inadequate to animal life, since the energy necessary to find food and accident risks are too great.

The habitat of indigenous fauna and flora is confined to surfaces remained isolated with surroundings that are often dangerous and hostile. The smaller

these surfaces are the more necessary possibilities for migration and exchanges between them are.

The extension of the field necessary to each species establishes if a natural surface remained is enough in order to maintain an animal population. If habitat is too small, its disappearance is just a matter of time.

Diminishing of biotopes surfaces also *modify the variety of species*. More sensitive species have decreased or completely disappeared. Spontaneous movements (migration, expansion) determine exchanges of genetical material between local populations and increases of genetic characteristic diversity. Those living on little islands don't have genetic exchanges with other populations. The structure of hereditary luggage modifies and genetical diversity is reduced thus leading to the occurrence of *genetical drift* phenomenon. The small groups of isolated individuals are exposed to the danger of being consanguineous.

Due to the economic situation of Romania the road network is not developed at the level of those from West or Central Europe and implicitly the problems of impact upon environment are not placed at the same level. So that, in most of our country regions the landscape is characterized by the multitude of natural structures or with natural aspect that enable the development of abundant spontaneous vegetation, which in its turn enables a rich fauna.

New and "improved" roads threatens many protected areas, rivers sewerage may endanger riparian wet lands, and the selected routes for high-speed railways may affect valuable habitats. Also sea transport, of some often-dangerous goods may affect coastal areas.

3.2.2. Secondary effects

Diminishing of biotopes surfaces also modifies species variety. Those, which have few needs and adapt easily, may generally stand out because there are less sensitive to human activities and to structure changes, which they involve. More sensitive, vulnerable species (which usually are the rare ones) are diminished or completely disappear, thus remaining only the common ones.

Less perceptible effects are produced by isolation, reduction of biotopes surfaces and also by blocking due to roads of usual migration routes. Urban roads and agglomeration reduce original biotopes of fauna or divides them thus isolating the population. For many animals, the fact that roads are near does not represent a place for stay fully acceptable due to toxicity.

The accumulate impact of traffic amplified in the vicinity of roads by salt, herbicides, heavy metals, light, noise, oil residues and exhaust gases. Roads size, traffic density and slopes arrangement affects species passage; the traffic way may absolute isolate a population or it may represent only a obstacle for certain

animals. Crossing is almost impossible in case there are mounted barriers against noise and snow fences.

Spontaneous movement (migration, expansion) determines genetic material exchanges between local populations and an increase of genetic characteristics diversity and thus, deserted areas may be repopulated. The more isolated an area is, the more is the risk of local population not to exist. **(fig.22, fig. 23)**

3.2.3. Indicators for fragmentation

Estimation of ecological potential offered by isolated landscape structures in every ecological sector gathers the 3 basic factors, namely: quality, capacity and habitats function presented in the sectors concerned.

Fragmentation is characterized by the ***size of natural areas*** which remained unaffected by the density of transport infrastructures and communications, fauna density, population density and on the size of used surfaces (built, agriculture).

4. EUROPEAN CONTEXT

4.1. Introduction

The transport policy of Romanian Government mainly aims at ensuring a flexible transport system, sure and efficient for the international and international movement of goods and persons. It also aims at ensuring the direct and quick access to all romaine's areas and emphases is laid on resources and on its strategic position, between Western Europe and Middle East. An urgent priority is to align Romanian transport to European standards, as a basic requirement of the process of country integration within E.U. there are 41 administrative units in Romania - districts - that are responsible for local planing problems as well as for environment condition and protection. Certain articles took into account environment protection. The most important refer to:

- Roads planning and designing. It is established the necessary to take into consideration environment preservation, land use, traffic safety, environment protection, urban planing and facilities granted to old age persons ant to handicapped ones.

- It should be performed an Evaluation of Impact upon environment for all new national roads.
- Traffic congestion problems in urban areas and increase of road safety.

Other laws:

- Order no.537/1997 - provides the technical specifications for vehicles, performances and emissions being included.
- Government decision no.106/1998 establishes the tasks public administration as regards transport.
- Several laws are considered by lawmakers. Law 157/1997 that adopts European Union's convention related to protection of architectural legacy gives an example.

Article 13 refers to environment and includes consideration related to transport. Another law refers to regional responsibilities concerning transport.

After consulting several ministries, the central authority for environment protection has achieved a list with technical guidance, standards and applications upon:

- air quality and the degree of mobile sources;
- fuels and transport quality;
- phonic pollution;
- methods for measuring and analysis, including the selection of collection points location and the use of analysis instruments (measurement frequency).

4.2. Biogeographical description

At global level Eco-systems assignment depends fist on latitude, clime and especially on temperature - precipitation relationship. Regarded under the aspect of geo - climate factor, Romania is included in a temperate - continental area characterized by the presence of deciduous tree forest and of temperate steppes, both being very important in the hierarchy of terrestrial eco - systems.

On our country's territory we encounter a large wide range of Eco-systems, allowing a great number of various living creatures to evolve within this space.

From ecological point of view, the forest is a place adequate to the development of a very different range of natural elements, is protected and stabilized soil, local climate and hydrological regime, it controls the efficiency of nutrients cycle between soil and vegetation, representing the habitat of numerous plants and animal species.

The main categories of forest Eco-systems encountered in Romania are:

- ***The Eco - systems of Spruce fir forest*** located in the North of our country 1200-1700 m altitudes and in South between 1300-1400 m, which hosts species that directly depended on fir-tree needles;
- ***The Eco - systems of Beech-tree forest*** located at 600-1300 m altitudes, mainly in west of the country ;
- ***The Eco - systems of Oak forest*** (includes all forests made of the species of Quercus type - common oak, pendunculate oak) is encountered at altitudes between 300-600 m;
- ***The Eco - systems of riverside coppice forest*** made up of white or soft essence - willows, poplars, alder trees, frequently located in the meadow of lower river beds and in the plain field;

Another type of Eco - systems often encountered in our country, is that of bushes, which in its turn is divided into:

- ***The Eco - systems of Alpine small shrubs*** that appear at over 2200 m altitudes, and the main representative of which is willow;
- ***The Eco - systems of Sub-alpine bushes*** encountered between 2200-1700 m, both in North and South

The third type of terrestrial Eco-system representative for Romania is that of pastures sub-divided into:

- ***The Eco - systems of thick grass and corneal*** which are at altitudes whose barer limits is 1700 - 1900 m. the upper limit is equal to the mountains height of the area considered;
- ***The Eco - systems of pastures made up of steppe hair grass*** located under 200m altitude especially encountered in Dobrogea, Baragan, and South Moldavia;

The hydrological network of Romania is very rich and it is made up of watercourses, still water and exceptionally of Danube Delta. We distinguish the following categories of Eco - systems:

- ***The Eco - systems of swamps and lakes*****,** with plenty plant and animal populations, corresponding to the tip of fresh, salty, cold or warm water;
- ***Black - Sea Eco - system*** an area of particular international interest;
- ***Eco - systems of water course,*** subdivided into:
- ***Eco - system of spring;***
- ***Eco - system of brook;***
- ***Eco - system of river;***
- ***Eco - system of big river*** in our case it's about Danube river;
- ***Eco - systems of Biosphere Reservation Danube Delta*** considered the greatest complex of terrestrial and aquatic Eco - system of Romania.

Corridor sectors represent everywhere, territories of energetic concentration pointed out most expressively by adding hydrographic network and champing the tree graph of upstream habitats (Arial), into a linear graph, with a role of energetic transfer between upstream - downstream. The Western

part of the country points out 3 corridor sectors, exploited by "laying out important transport network" automotive and railway.

- In the South, between Poiana Ruscai Mountains and Apuseni Mountains, interferes Mures corridor, between Deva and Lipova having as extreme correspondent Arad town and Nadlac Border points with connection to Hungarian town Szeged. The corridor is crossed by railway and by the road E68 of European concern. The 2 mountain massifs in the North and South of the corridor are well forested (the surface of forest background per total, exceeds 40% of their total surface). The corridor in its natural form, by the presence of Mures was constituted like a natural barrier of communication between North and South. Arrangement of national road and then of railway has amplified the barrier effect, its "efficiency" increasing 3 times more (railway doubled by traffic, highway with specific automotive traffic, interposition of habitat - settlements - of various sizes and functions). In Eastern sectors, the presence of Deva town, of sterile-stocks resulted from the exploitation of copper ores and of Mintia central power station, annuls almost entirely the natural functioning of geo-systems.

We deal with a landscape of urban industrial type within which the natural component was entirely anihilated.

Further, to wards West, the serves of rural seltlements of corridor and small distances between maintain, sides at acceptable levels, comunication and natural functioning of geo-szstems where forests are prevailing beech forests up to Lipova where the process of blocking appears agam, as a result of urban szstem association with traffic amplification and of anthropic activities.

The proper corridor between Mintia and Lipova, functions bz diminishing forest natural component on both mountain sides and with an agricultural use of extensive tzpe in meadow sectors, without compromising natural equilibrium.

- In the median sector of Apuseni Mountains there is Aries corridor with an important waz of energetic convergence at campeni bz the confluence of Ariesul Mic, Ariesul Mare and Abrud. Up to Campeni, with ramifications towards Abrud, the corridor is crossed bz a narrow railwaz which todaz is not used either for goods or for passenger traffic.Parallel to the railwaz to Campein there is the nation road 75 that further crosses to wards West the median area of Apuseni Mountains over the vartop pass and it continues towards Beiusului Depression along corridors there are 2 major sectors of discontinuity. The one of Baia de Aries – Lupsa with habitat continuitz along railway highway and highway and the presence of stock sterile from mine exploitation of the area. That of Campeni – Miliovesti bz interposition of town and accumulation lake from the confluence of Ariesul Mare with that of Ariesul Mic. Campeni – Buru sector is more stroungly humaniyed, by divelopmz settlements and agricultural spaces in the meadow. Moreover it is added the more advanced degree of clearing. Beech Forests of and oak are maintained more compact onlz in Buru – Salcina sector. In the upper basin of Ariesul Mare between Campeni and Vartop

pass there is a Sequence of 5 commune centres from dowonwards to upwards> Vadul Motilor, Albac, Scarisoara, Garda si Arieseni. Villages belonging to it, with spead structure, occupz mountain sides sector and table-land and the river and its affluents. The natural framework underwent deep mutations, especially in the last 10 years, by intensive and wild exploitation of coniferous forests. Instead between Vartop (Alba district) and Bita (Bihor district), the highway crosses in winding roads a compact and valuable forest space of conifers and beech with unaltered natural regiune. In this sector the highway is not a major obstacle in the passage of wild animals. Settlements are totalllz missing on a length of around 20 km.

- Between Cluj – Napoca and Oradea, on the corridor of Somesul Mic, of Nadasului and Capusului continued with that of Crisul Repede there develops the road E 60 of European interest and the normal railway with correspondence to wards outside through Episcopia Bihor border point. Between Cluj – Napoca and Huenin the natural geo-szstems were strougly changed into geosystems predominantly anthropic by interposition of settlements and spaces used for agriculture and of the 2 mayor communication thoroughfares.

There are 2 sectors of natural geographic discontinuity up to Crisul Repede corridor> the one from Floresti – Gilau and the one from Huedin. Correspondent forest spaces with continuity are encountared only in Capusul Mic thinned small oak bushes Dumbrava sector, made up of secon which are crossed by E60 highway.

From Huedin to Bucea along Crisul Repede there are situated three rural settelments: Ciucea, Poieni and Negreni.

The river meadow crossed by both railway and road is used mosttly as pastures asociated with wooden hydrofile vegetation (alder trees, poplars, weallows).

The forests in sorounding spaces, constituted in majory of oak, are in a state of visible decaying due to intenssive exploitations.

In Bucea the railway separates from the road E60, the former following Crisu Repede course through the narrow path with the same name and the later winding with Piatra Craiului Pass, going down then to Vad-Borod depression. This area is forested on the whole, dissemination of the barriers imposed by the two traffic ways and the course of Crisul Repede representing favourable factors for continuity and fauna passages.

From Cornitel to the Western Plain, depression Vlad-Borod is extended in a shape of wide funnel. It is a very anthropic land, with large villages, along the road and railway. In addition quarries and cement plant in Chistay-Alesd, Coca-Cola factory from Sacadat, places for high flood retention in Lugasul de Jos and Tileagd and brown coal mines in Borozel must be mentioned. Between Plopisului Mountains, Northward and Padurea Craiului Mountains, Southward, there is a highly humanized area.

Within the three traffic corridors, of Mures, Aries and Crisul Repede there are distinguished 2 major types of natural barriers: Orographic and Hydrographic.

Major orographic barriers are presented on Turda-Beius and Cluj Napoca-Oradea axes.

In the first case (Turda-Beius) Vartop massif and the pass with the same name is well afforested and crossed by National Road 75. On a distance of around 20 km no human settlement occurs and the forest eco-system, as a whole is less affected. A traffic intensification by enlarging the present road and secondly residences location would seriously compromise the ecological equilibrium. The idea of achieving a tunnel between Depresiunea Beiusului and Campeni was along ago launched.

In Bucea – Cornitel sector the orographic barrier compels us to trace the highway in winding roads and to reduce the movement speed.

Instead, the railway that follows the course of Crisul Repede does not impose the execution of costly works of art (long tunnels, viaducts, etc).

A "joining" of automotive railway traffic by a tunnel with around 6 km length between Suncuius and Bucea would also solve the problem of forest eco-systems continuity of the respective area.

In the South, Mures hydrographic barrier, by its considerable flow (approximately 160 m^3/s), constitutes a real obstacle of continuing the habitat on the North-South direction.

Tracing of the future motorway on the right bank of Mures would amplify and even annul the continuity towards both banks. In this case the use of confluence sectors of small effluents on the south side of Zarandului Mountains, as well as the natural "tunnels" represent the only ecologically rational way and desirable from economic point of view.

4.3. Overview of fragmentation due to different land-uses

Romania has an overall area of 23.8 mil. ha. of which 14.8 mil. ha agricultural land (including 9.3 mil. ha arable land, 0.3 mil. ha orchards, 0.3 mil. ha vineyards and 4.9 mil. ha pastures) and 6.3 mil. ha forest land; there are 0.41 ha arable land per capita. The rest of 2.63 mil. ha consists of water areas, human sites, roads, etc. (in 1998).

More than half of the forest-covered area has an ecological and environment protection function (forests for water, soil, climate and biota protection: 53 %). Considering the natural context of Romania (slope areas more than 67 % of the total country area, geomorphologic and litologic characteristics in favor of erosion processes) the decreasing area covered by forest is the main cause of water and wind land degradation. The forest-covered area continuous

decreased from 80-85 % at the millennium beginning to 26.7 % today (under the European average of about 33 %, and at about 1/3 under the optimum considering the natural conditions of vegetation).

The forest is not uniform distributed over the country: (1) only 7 % in plain area where the climate becomes more arid, (2) only 28 % in hill and plateau area where soil erosion and landslides processes increase, and (3) 65 % where is the starting points for flooding.

From the 19 million ha (7 %) of the catchment area with extreme high streams about 44 % is forest and 56 % has agriculture land use. Most of these catchments have land with mixed forestry and agriculture use. Therefore, here are necessary integrated hydrologic and anti-erosion ameliorative works.

4.4. Administrative and legislative framework

International Conventions signed and ratified by Romania

Name of International Conventions	Ratified Law	The Official Monitor and issued date
Paris Convention concerning the protection of the world natural and cultural heritage	Decree no. 187/1990	
Ramsar Convention on wetlands of international importance as waterfowl habitat	Law no. 5/1991	M.O. no. 8/26.01.1991
Bern Convention on the conservation of European wildlife and natural habitats	Law no. 13/1993	M.O. no. 2/25.03.1993
Rio de Janeiro Convention on biological diversity	Law no. 58/1994	M.O. no.199/02.08.1994
Washington Convention on international trading with endangered species of wild fauna and flora	Law no. 69/1994	M.O. no. 200/03.08.1994

Name of International Conventions	Ratified Law	The Official Monitor and issued date
Bonn Convention on the conservation of migratory species of wild animals	Law no. 13/1998	M.O. no. 24/26.01.1998
United Nations Convention for deserting control in countries highly affected by drought and/or deserting process (adopted in Paris)	Law no. 111/1998	M.O. no. 222/17.06.1998
United Nations Convention on climate changing (adopted in Rio de Janeiro)	Law no. 24/1994	M.O. no. 119/12.05.1994
European Chart of Landscapes		
Convention on the Black Sea protection against pollution (Bucharest 1992)		M.O. no. 242/29.09.1992
Sofia Convention on cooperation for the Danube protection and sustainable use		
Directive „Birds" of European Community Council		
E.C. Habitats and species Directive		

Name of International Conventions	Ratified Law	The Official Monitor and issued date
Convention on fishing in the Danube		
Convention on fishing in the Black Sea		
Convention on the continental plateau		
Convention on the "Open Sea"		
Convention on plants protection		

National legislation significant for biodiversity conservation:

Law number	Name of law or normative	Official Monitor
A. Related to forest		
Law no. 26 /24.04.1996	Forest code	O.M. no. 93/8.05.1996
Law no. 2/30.10.1987	The law regarding preservation, protection and development of forests, their economic and rational exploitation and ecological equilibrium maintenance.	
G.D. no. 1112/ 7.11.1996	Romania's Government Decision concerning the reorganization of Forest Autonomous Regie – "Romsilva" RA of Forest National Regie	O.M.no. 285/13.11.1996
G.D. no 379/1993	Government Decision for approval and implementation of "Instructions related to wooden material circulation or other forest products"	O.M no. 223/14.09.1993
Law no.32/ 12.11.1968	Law concerning the establishment and punishment of law infringements	BO no. 148/14.11.1968
Order no. 572/ 10.09.1991	Order related to approval of "Instructions concerning the terms, modalities and the periods for wooden material transport from the woods:	
Law no. 5/1982	Law concerning the protection of plants and forest and pesticides regime	BO no. 105/20.11.1982

Law number	Name of law or normative	Official Monitor
Law no. 85/ 1995	Law for the approval of Government Ordinance no.4/1995 concerning the manufacture, trading and employing the products phyto-sanitary use in order to fight against diseases, beetles and weeds in agriculture and sylviculture	O.M. 213/19.09.1995
Order no. 125/ 1996	Order of Minister of Water, Forests and Environment Protection for approval the regulation procedure of economic activities with an impact upon environment	O.M. no. 73/11.04.1996
Order no. 278/ 1996	Order of Minister of Water, Forests and Environment Protection	O.M. no. 126/22.05.1996
B. Related to nature preservation		
Low no. 137/ 29.12.1995	Law of environment protection	O.M. no. 304/30.12.1995
Decree no. 237/1950	Decree of Ministers Council for protecting the	

Law number	Name of law or normative	Official Monitor
	monuments of nature	
DMC no. 518/1954	Decision of Ministers Council for approval of Regulation concerning the organisation and functioning of Commission for Nature Monuments Protection	
GD no.127/ 1994	Government Decision concerning the establishment of law infringements concerning the norms related to environment protection	O.M. no. 94/12.04.1994
Low no.18/1991	Law of agricultural land use	Republished in OM /15.01.1998
Order no.50/1993	Order of Minister of Water, Forests and Environment Protection concerning some measures in order to protect certain species of rare fauna, threatened with disappearance, reintroduced in Romania, migrating species.	OM no. 27/12.02.1993
Order no. 7/1990	Order of the Minister of Environment concerning the setting up of natural parks	
Low no.82/1993	Law concerning the setting up of "Delta Danube" Biosphere Reservation	OM no. 59/22.03.1993
Low no.69/1996	Law for changing and completion of Article 10 from Law no.82/1993 concerning the setting up of "Delta Danube" Biosphere Reservation	OM no. 150/17.07.1996
C. Relevant legislation for hunting		
Low no. 103/ 1996	Law of hunting fund and its protection	OM no. 235/27.09.1996
Low no. 17/ 02.04.1996	Law regarding the regime of weapons and ammunition	OM no. 74/11.04.1996
D. Relevant legislation for fishing		
Law 12/1997	Law regarding fish breeding and fishing	
GD no. 971/1994		

Biosphere Reservation – Romania's situation

In Romania there were declared up to now 3 reservations of biosphere, namely:

- Danube Delta – declared at September 1, 1990 by Decree 983;
- "Retezat" National Park – declared at January 10, 1980;
- "Pietrosul Rodnei" – declared at January 10, 1980.

Site of Cultural and Natural World Patrimony – Romania's situation

- Romania ratified the Convention upon the Protection of Cultural and Natural World Patrimony by Law no.178/1990. Danube Delta – 50% of its surface was included in the list of Natural World Patrimony in December 1991.

Ramsar Area – Romania's situation

- Romania ratified the Ramsar Convention by Law 5/1991.

- Danube Delta is the only protected area of Romania designated as Ramsar Area.

Important areas for protection and preservation of wild birds– Romania's situation

- There were identified 59 Areas of Importance by SOR (SOR, Bulletin AIA no. 1/December 1994)

Area of Special Protection – Romania's protection

- The process has not yet started although the other Eastern and Central European countries, which are still EU members states, have already begun the identification of these areas a few years ago.

Special Area for Preservation – Romania's situation

- The process has not yet started although the other Eastern and Central European countries, which are still EU members states, have already begun the identification of these areas a few years ago.

4.5. Land use planning in relation with nature, landscape preservation and transport infrastructure

The plan of territory arrangement aims at optimizing the use of soils and sub-soils natural resources, of labor resources and of the way of population assignment, with a view to ensuring a permanent equilibrium between the way of rendering them efficient and the conditions of natural environment protection, within the concept of durable development of territories and localities.

The content of problems of the plan for national territory arrangement:

- Turning to good account of soil and subsoil natural resources;
- Harmonization of human settlements development;
- Development of territorial technical-urban infrastructures;
- Rehabilitation, production and turning to account of natural and built environment.

The Plan of National Territory Arrangement (PNTA) is oriented towards an assessment of country's social-economic potential and identification of main lack of balances and malfunctions at the level of country's territory and on the entire locality network.

As a result of these actions there were pointed out malfunctions related to communications ways infrastructure, population distribution, not-equilibrated actions within the general towns network for population territorial mobility, area aspects of natural resources management.

Within PNTA there were approached with priority 4 complex groups of problems (called Sections of PATN):

- Section – Communication Ways

- Section – Rational Management of Romania's Water Resources
- Section – National, Natural and Built Protected Areas
- Section – Network of Localities

Section – Communication Ways – concerns the development of communication infrastructure as a major condition in ensuring the development framework of market economy and of speeding up the restructuring process. Its concept aims at emphasizing the favorable conditions that Romania's geographical position offer for a rapid European and international integration and it has in view, mainly:

- Infrastructure equilibrium at various territorial levels (districts, areas);
- Assurance of some equitable living conditions for population as well as protection and rendering efficient the natural and built patrimony;
- Integration within European major network, adequate arrangement of border points or development of some free zones will enable the connection of transport infrastructure to European communication systems.

The section covers soil communications (railways, roads), water (waterways on channels and rivers), air (airways), that define the bases of national network of communication ways by:

- Identification of guiding schemes for the national network as an instrument of coordination and orientation, that takes into account country's political, economic or social evolution;
- Identifying priority projects related to the main transport flows at national level, servicing of territory peripheral areas, a better use of space and improvement of connections with the neighboring countries;
- Measures for harmonization necessary to develop a national network related to Pan-European requirements, depending on priorities established by government.

Development of communication ways was achieved by taking into account the elements related to environment protection, defense, to energy and land rationally use, but also to real financial possibility referring to designing, maintenance or exploitation of major infrastructures. Also, communication ways were correlated with interests of neighboring countries and with EU orientations for the development of transport policy and communication ways.

Thus, section I – Communication ways is connected (adapted) to the recent European Commission's proposals, that were presented within Pan-European Conference of Transports that took place in Crete, in March 1994, where there were establish priority corridors of multi-modal communication ways that should link Central and Eastern Europe to the Western Europe.

Section – National, Natural and Built Protected Areas, concerns the protection of natural and built country's patrimony in compliance with the principle of durable development, and constitutes a legislative framework for the

management of preservation, of accessible conditions and of modalities to financially support this protection.

Determination of natural and built areas, of natural importance represents the premises of actions concentration upon exceptional patrimony values about country and upon aggression factors that may compromise their preservation and turning to account.

The activity of territory arrangement represents the main framework, instrument and mechanism for application and observing the provisions of specific protection for each typological category of national patrimony.

The way of ensuring natural and cultural patrimony protection by means of territory arrangement activity is to set up protected areas, which represent this prestigious territories due to the existence of one or more assets of national patrimony, that represent a development potential and consequently imposes the set up of a controlled way of intervention to the national public interest for a durable development.

From the point of view of Romania's European integration, by signing agreements with EU, our country is engaged in a close co-operation with European Commission and Member States in the field of territory arrangement and therefore in application of "Development Schemes of Communitary Space", which basically aims at solving economic and social problems, correlated with the exigencies of a durable development.

As a result, the operative objects of community territorial arrangements will have in view the economic development of environment, by:

- Strengthening of stability and equilibrium of spatial structure;
- Correlation of economic development with a cautious management of natural and cultural patrimony;
- Combination of 3 major objectives: development, equilibrium and protection in territory arrangement policies.

A particular importance is given in this context to the cautious management and the development of European natural and cultural patrimony, which is considered as a basic action field of durable development strategy.

Biosphere reservations and natural parks with an exceptional value occupy a surface of around 10.780 km^2 and represent a percentage of about 4% of total surface from our country.

Within Romania's territory the area that also contains monuments of nature occupies a pretty important surface, namely: around 25.250 km^2 and represents a percentage of around 10.7% of total country surface.

Besides the mentioned areas, the surface of areas with great complexity of natural resources: forests, water, resort station, agricultural-pedological and mineral resources represents about 37.750 km^2 and constitutes a percentage of around 15.8% of total Romania's surface.

PNTA - section III of protected areas distinguishes:

1. Protected natural areas of national interest and nature monuments that consist of biosphere reservation and national parks; 827 reservations and nature monuments.

Geographic grouping and territorial location of these areas of national interest, by 14 groups (Carpatii and Subcarpatii Subcentrali, Carpatii Meridionali and Subcarpatii Getici, Podisul Sucevei and Campia Moldovei, Podisul Barladului, Podisul Dobrogei, Campia Careilor, Campia Muresului and Timisului, Campia Vlasiei, Lunca Dunarii, Danube Delta).

2. Values of cultural patrimony of national interest that consists of:

- Architectural monuments and assembles;
- Monuments and archeological sites.

Reservations of Biosphere, national and natural parks in Romania

No.	Name	Surface, (he)	Location
1	Danube Delta	580 000,0	Tulcea, Constanta
2	Domogled - Valea Cernei	60 100,0	Caras-Severin, Mehedinti, Gorj
3	Retezat	38 047,0	Hunedoara
4	Iron Gates	115 655,8	Caras-Severin, Mehedinti
5	Cheile Nerei-Beusnita	37 100,0	Caras-Severin
6	Apuseni Mountains	75 784,0	Alba, Bihor, Cluj
7	Rodna	46 399,0	Bistrita-Nasaud, Maramures, Suceava
8	Bucegi	32 663,0	Arges, Brasov, Dambovita, Prahova
9	Cheile Bicazului-Hasmas	6 575,0	Neamt, Harghita
10	Ceahlau	8 396,0	Neamt
11	Calimani	24 041,0	Bistrita-Nasaud, Suceava, Mures
12	Cozia	17 100,0	Valcea
13	Piatra Craiului	14 800,0	Arges, Brasov
14	Gradistea Muncelului- Cioclovina	10 000,0	Hunedoara
15	Semenic- Cheile Carasului	36 664,8	Caras-Severin
16	Macinului Mountains	11 321,0	Tulcea
17	Balta Mica a Brailei	17 529,0	Braila

5. HABITAT FRAGMENTATION DUE TO TRANSPORT INFRASTRUCTURE

5.1. Introduction

The relationship between transport infrastructure and habitats fragmentation should be consider within the geographic context particularly to Romania.

Territorial factors and the topographical structure are determining elements for infrastructure technical solutions especially in the transport field.

The quasi-concentric structure of relief, with the mountain chain in the central of the country, circumscribing Transilvania's tableland, followed by the chain of sub-Carpathian hills and then by plain areas, in approximately equal proportions, had as a first effect a specific hydrography, by water courses developed towards some what radial directions, with few rivers that cross the mountain chain.

Directly related is the vegetal structure, which has forest essence grouping by altitude levels and which it gets downwards to lower areas of steppe and forest steppe, to which there are directly related the specific components of fauna species.

Passes – natural forms that were rendered valuable from oldest times, generally achieve the passing of mountains. The access to passing areas was achieved by valleys (Valea Prahovei, Valea Oltului), climbing along watercourses, on one side or another of the river depending on the width of upper routes.

The area adjacent to river is at the same time the area that were developed human settlements, fact that impose a continuous withdrawal of natural vegetation areas and implicitly the pushing – confinement of habitats for various animal species.

An essential condition in order to develop human settlements is water resource. It is found out a certain differentiation according to this criterion, with the most numerous populations in Transylvania and more reduced – in the field – for example Baragan, South of Moldavia, etc.

The prevailing professions by territorial units, of intensive type (industrial) or extensive one (agriculture and silvicultural), generated adequate changes corresponding to natural framework, with various forms of aggression upon habitats.

Great aggressions are in plain areas where extensive areas of old forests have become agricultural lands, or there disappear many wet areas of swamps and meadow lakes, but also in hill and tableland areas – where extractive and

processing industries may associate with major forms of pressure upon environment.

This led to the decreasing and disappearance on many flora and fauna species, or to the change of initial eco-systems structure.

There is a direct link between the effects and the extension area of anthropic changes, also developed by altitude stages and the more serious in plain areas and easy forms in mountain ones.

A transport infrastructure represents fragmentation sources of habitats, or barriers for certain species.

Their guiding is differentiated by types of ways (road/railway) where thoroughfares generally follow water courses, and secondary one intersects them. As a rule, their construction aimed at meeting the demands of populated areas, on corridors with areas already disturbed.

We can also speak about re-equilibration of habitats due to plenty resources of natural framework under particular conditions of the country, both for migration and the access to watering, without neglecting the general tendency of natural eco-systems impoverish.

Thus, the assessment of effects of fragmentation degree generated by the existent transport infrastructure, upon habitats may be limited to territorial situations much more restrained, where their modernization comes into conflict with sensitive areas, or where infrastructure is of a relatively recent date, on other routes than traditional ones. As an example we have Transfagarasanul for roadways or Danube Black Sea Canal for waterways.

On traditional routes the pressure factor upon habitats is related to the increase of traffic value and to vehicles types, especially in combination with other agents acting in the sense of their restrictions.

As a global situation, we can speak about reach fauna, particularly in mountain areas (in Romania), fact, which does not imply the decreasing of ecological aspect importance in relation with transport sector.

The present legislative framework makes the evaluation of environment impact obligatory for all actions in order to promote investments, including transport ways rehabilitation, both in order to have knowledge of present condition and to limit the negative effects by adequate measures still from the project stage.

5.2. European transport network

The third European Transport Conference from Helsinki of June 1997 has promoted a set of European corridors and areas, which represent the structure necessary for long term planning of the development of European transport network.

As a completion of the 9 priority corridors identified at the Crete Conference of 1994, it was re-established the route along "E" European roads of the territory of the former Yugoslavia by adopting the new corridor no. 10.

The attached map shows the 10 European transport corridors.

The 10 corridors were completed with 4 transport Pan-European areas, covering Euro-Arctic basin, Black Sea basin, Mediterranean basin and the basin of Adriatic and Ionic Seas, to the purpose of satisfying the most urgent trade and mobility requirements of Europe's citizens on the whole continent.

Romania has a key position in the area of central Europe at the intersection of main transport routes, which connect Western Europe towards Black Sea area and towards the Middle East, on the direction West-East and North of Europe with the regions of South-East continent and the Mediterranean Sea basin on North-South direction.

The confirmation of this key position is given by the fact that Romania is crossed by 3 of the 9 priority Pan-European transport corridors established at Crete Conference of 1994, namely:

- Corridor no.4: Dresda/Nuremberg – Praga – Bratislava – Vienna – Budapest – Constanta/Thessalonik/Istanbul
- Corridor no.9: Helsinki/ Moscow – Odessa/Chisinau – Bucuresti – Dimitrovgrad – Alexandriupolis
- Corridor no.7: Danube, which together with Main and Rhine rivers and their connection channels cross the center and West of Europe and covers the entire waterway between Black Sea and North Sea.

Corridor no.4 is the most convenient for completion the interconnection of EU Trans-European networks with the regions of Near East and Middle East. Corridor no.4 of road transport crosses Romania's territory to the direction West-East from the border of Hungary and Romania (Nagylac-Nadlac) up to Constanta port, via Timisoara – Lugoj – Deva – Sibiu – Pitesti – Bucharest – Constanta (about 800 km).

Corridor no.9 oriented towards North-South, crosses Romania on Iasi – Focsani – Buzau – Bucharest – Giurgiu route on a length of around 500 km.

Railway transport mostly follows road corridors, the routes for corridor 4 are: Arad – Alba Iulia – Brasov – Bucharest – Calarasi – Constanta and Ungheni – Pascani – Bacau – Focsani – Buzau – Ploiesti – Bucharest – Giurgiu, for corridor 9.

The influence of these roadways corridors upon habitats is related to traffic volume increase especially in goods transport, by prolonging/continuing noise and noxious elements period of existence and by measures of traffic safety in relation to the passage of different fauna species, as well as by new land use for modernization and sanitation operations, or various facilities corresponding to road ways.

Railway transport modernization firstly assumes the achievement of a higher traffic speeds and traffic volume increase, with effects similar to road transport upon habitats, but with a proportions in which they participate in the global traffic.

Improvement of river transport parameters by corridor no.7 involves a series of influences for habitats, by dragging operations in order to ensure draught and by locks, as well as by the disturbances generated by tonnage and navigation speed increase, with effects also upon banks.

5.3. Transport network (and European typology)

Romania undergoes a great process of transport infrastructures preparation with a view to their integration in the EU transport systems, in order to be able to take over the ever increasing needs regarding road, railway and shipping transport determined by the economic development.

Romania has as strategic objective modernization of road and railway transport systems and it aims at integrating them into the European system. They are predominantly oriented on the Pan-European corridor no.4 and Pan-European corridor no.9.

Both corridors will be modernized as regards railway and road routes by 2010.

At the end of rehabilitation program road thoroughfares of European technical level of which we mention will connect the 16 border points of Romania between them:

- E70 that links the Atlantic Ocean to Middle East
- E60 that links North-West Europe to Black Sea basin
- E68 together with a part of E70 and E60 cover a part of sector 4 which crosses Romania
- E85 and partially E70 are situated on corridor 9 that ensures the connection oh Northern Europe to the South-East of continent
- E574 and E576 ensure additional links between corridor 4 and corridor 9

5.3.1. Highways/motorways

In Romania the roads network of national importance (map attached) contains:

- Motorways
- European national roads (E)
- Main national roads
- Secondary national roads

The integration of roads of national concern into the above-mentioned categories was achieved based on the following criteria:

• Motorways: national roads of high capacity and speed, exclusively for vehicles traffic, which do not serve riparian private properties, provided with two unidirectional ways, separated by a median area, having at least two lanes and a lane for emergency stationing; disleveled intersections and limited accesses, vehicles going and out will be allowed only in especially arranged places.

• European national roads (E): are open to the international traffic. Their integration in E roads was established according to the European Agreement provisions concerning great roads of international traffic (AGR).

• Main national roads ensure the link of country's capital with the residence town of the district, the connections between them, as well as with the main control points for Romania's border crossing.

• Secondary national roads: the remaining national roads, which do not integrate into the above mentioned categories.

The length of roads which are of national concern:

• Motorways	114 km
• European national roads	4,576 km
• Main national roads	5,333 km
• Secondary national roads	4,660 km
Total	14,683 km

5.3.2. Infrastructure of secondary roads

Within the category of these roads there are contained roads of local concern:

• District roads
• Commune roads

5.3.3. Railways (map attached)

Railways of Romania are:

• With normal gauge (1435mm)
• With one track
• With double track
• With narrow gauge
• With large gauge
Total

Of which:

• Electrified

5.3.4. Navigable canals (map attached)

Danube – Black Sea canal between Cernavoda and Agigea, with a branch detached at Poarta Alba towards Midia – Navodari.

The length of main canal is 64 km and that of the branch is 22 km.

5.4. Effects of transport network upon nature

5.4.1. Loss of habitat

Loss of habitat is a slow process and generally non-reversible, which depends on complex phenomena, associated to the economic development and to demographic increases of the country.

A certain structure of natural eco-systems depends on a viability area that should ensure the normal development of each species from the trophic chain. Because numerical data are missing we encounter difficulties in studying these dependencies. The quantification processes even if only for ecotopes is an extremely difficult operation and the more the surveillance of their dynamics.

Systematic actions for noticing and interpreting the natural biological processes it was reached to the knowledge of multiple relationships of cause – effect type by which one may describe the behavior of biotic factor in the context of natural dynamics environment and under anthropic influence.

Such relationships become very useful in assessing dynamics aspects by means of connection factors of natural environment, which are much more accessible to the measuring process.

A work instrument of great utility in this respect is The Geographical Information System, where databases may be coupled for the components of environment.

Primary and processed information is organized by plans of topics according to every factor of interest, which could than coupled by superposition according to series of rules particular to each type of estimation desired.

Real assessment of habitat loss effects generated by transport routes is difficult without an analysis instrument, as each route presents plenty particular situations, especially under Romania's relief conditions.

Besides specialized way of analyses developed in GIS environment the aspect of habitat loss may be presented by particular examples starting from an initial classification by units of relief.

In high areas, crossing of mountain chain being achieved on the separation lines of mountain massifs (example: Carpatii Meridionali with massifs: Parang, Retezat, Fagaras and Bucegi), initial habitat surfaces are practically mentained.

At the same time there is a series of areas protected as natural reservations, such as in Retezat or Rodnei Mountains of Carpatii Orientali which are made up either for the whole preservation of the eco-systems or for

protecting certain species which are in danger to disappear – European bison, lynx, wild cat, mountain cock, chamois, a series of predator birds.

Pressure factors upon habitats are recent routes, from Transfagarasan – which crosses really wild areas, up to forest roads and roads with tourist purpose – it is worth mentioning the roads of Bucegi Mountains up to Babele cottage, or up to the cottages of Ceahlau Mountains. Although these have a season or temporary utility may represent aggression sources for habitat with effects greater than those upon traditional routes, just by attacking certain previously areas that are less accessible to man.

Hill areas are characterized by the overlapping of roadways over localities area generally near water courses, in which their crossing also assumes the proximity to water courses, respectively affluents.

Habitat fragmentation may be considered in this case as being dependent on the mode of land occupation (land cover – land use), on hydrographical network density, on human settlements density, with a certain development by altitude, as well as on the traffic volume and intensity.

Because certain direct, experimental and calculation determination are missing, as related to a transport ways – habitat we can use certain qualitative indicators of frequency type.

Habitat loss in hill areas may be appreciated by comparing the relationship between certain species and rural localities as they are situated along the roadways or they are more isolated. It is known the increase frequency, with which there are attracted towards more isolated households in various periods, wild animals such as bears, wolves, wild boars as compared to the more intensely populated areas. Such a differentiation may constitute a factor in appreciating the pressure upon the habitats generated by roadways together with the other infrastructure elements.

Another way of appreciating may depend on the frequency of traffic size and of accidents registered when wild animals were victims, as a rule: goats, deer, hares, squirrels and other small rodents. For such species we don't speak about a habitat loss, once they can be victims of road accidents, but for predators that live in a relationship with these.

The situation in the field areas is similar to that of hill, with the difference that eco-systems may be of several types in the relationship with forest-steppe, steppe, particular to wet areas, as well as to agricultural area.

A source of information with qualitative image upon the dynamics of certain species is represented by publications/magazines about hunting and fishing.

These reflect the dynamics of hunting and fishing background, by certain descriptions with monographic character for places with cynegetic (hunting) tradition. According to the evolution of interest in certain areas (related to species types and their number) we may obtain certain assessments for habitat limitation especially with birds in plain areas.

The reduction of hunting background is a general effect of economic development. The separate effect of transport infrastructure may be appreciated by the combined analysis of areas position and characteristics, becomes more and more difficult. This effect may be appreciated as a direct effect of roadway development and traffic parameters for habitat loss.

Habitat loss in wet areas becomes the more significant, the more it involves protected areas of natural reservations. The landscape of Danube Delta is totally different along the navigation channels from quiet areas, aspects that would be the most accessible in order to quantitatively asses the habitat loss.

The effects of tonnage and river traffic intensity are also accessible for a comparative appreciation both as regards direct and indirect effects. Reduction of the number of fish species is explained not only by decreasing quality parameters of river water but also by habitat loss due to naval infrastructure elements. For example hydro-energetic nodes seriously affect sturgeons on the Danube. In wet areas there are lakes of Prut meadow on downstream sector (L. Bratas) in relation to earthworks. The achievement of draining channels networks made possible to change the use of land to an agricultural purpose and to get better condition for earthworks; thus affecting the areas with humidity in excess and therefore determining a severe reduction of habitats by total or partial disappearance of wet area.

5.4.2. The function of corridor

Corridor 4 and 9 for roadways and railways and corridor 7 for shipping transport achieved the function of linking internal transports to European transport networks. This implies first an increase of traffic values as well as rehabilitation/modernization operations in order to obtain comparable parameters of transport ways.

Excepting the operations for proper enlargement by building at least wide consolidated shoulders, together with structures related to environment protection for water and soil by ditches, settling reservoirs and dispersing basins, there are also infrastructure elements associated to the development of road transport ways, such as parking, refuge, tourist and commercial halting place, or operations for traffic safety and animal protection that involve types of land use.

Among these, those situated in the vicinity of more sensitive areas (forests, wet areas, etc) together with the increase of parameters and barriers for species migration, generate a certain inconveniences for human activity continuity on one side and another of the road. Works of the types: over-ground and underground passages, together with bridges and viaducts, finally constitute measures for compensating the mentioned impact.

A more difficult situation is shaped up for the impact of river traffic parameters.

There are known the increase aspects of Danube's right bank infrastructure due to changes in hydrological regime by Iron Gates centers working, but also due to speed and capacity of transport ships.

We remind the fact that a function of Danube-Black Sea Canal directly refers to the increase of river transport ships capacity.

5.4.3. Disturbance

Road transport determines a negative impact upon environment either by chemical pollution or a physical one (noise, vibration).

The length of areas affected by railway transport is one km maximum. On this distance air currents entrain various substances and particles. The noise produced by railway transport influences fauna.

The perturbations registered on maritime routes relate especially to pollution by accident with oil and oil products due to wrong maneuvers of ships in ports during their loading/unloading, their faults at pipelines, valves, etc.

Lost oil quantities are small, of the order of tons; as a matter of fact the process of such accidents is of the order of 10% of total accidents. Serious pollution are due to some ships collisions, explosions, ship wreck, accidents from marine drilling platforms etc. in case of these accidents, from statistics made up to now it results that there are lost annually as an average, 10000-20000 oil tons.

The rapidity of intervention is a determining factor for load rescue, but the success depends firstly on the water sea condition (at waves of over 3 m height, interventions are practically impossible).

5.4.4. Fauna victims

A typical case of fauna natural habitat fragmentation is at present in process of achievement by modernization works of Bucharest-Pitesti motorway with a view to introducing tolls.

A sector of about 6 km of motorway route goes through a compact forest area – Padurea Cascioarele, where live: about 100 deer, 300 roebucks, 80 wild boars, 700 hares, 400 pheasants and plenty of small animals.

The remaining route crosses a plain territory with forests of small extension.

Previous to modernization works beginning, habitat area practically contained also the road territory, especially at night, for crossing. With the time, many traffic accidents involving wild animals were produced.

Statistical data show that the annual number of accidents caused by wild boars, roebucks and deer in Padre Cascioarelor area vary in the range of 3-15. But the figures refer only to events that determined vehicle damages, when it

was necessary to be announced at police department, being obviously that the number of victims among animals should be greater.

Similar data are also for other motorway sectors, but these are the most significant, by the greater fauna resources in this habitat.

At the request of territorial agencies for environment protection, but also in compliance with national and international technical norms it was provided motorway surrounding with a wire fence in order to prevent any kind of penetrations from outside the roadway – slow vehicles, pedestrians, wild and domestic animals.

Also taking into account land unevenness, the height of the fence vary, depending on animal population of the respective forest area, this may be of 2.6 m in areas with deer, of 1.8 m – in those with smaller animals and of 1.5 m on the remaining route.

The meshes of wire net are differently dimensioned by height, from 5 X 5 cm on the first 30 cm up to 20 X 15 cm at the upper part, with the purpose of barrier for most existent animals.

Achievement of animal passages, from one side of the motorway to another, has led to the solution of underway passages, since over-ground version would have led (in the plain area) to a corridor of 7 m on about 700 m with a height of about 10 m. The over-ground solution would not have been ensured, according to the opinion of the respective field's experts enough conditions of attractiveness for animal world, in order to be functional, with all measures meant to reproduce a natural environment – earth layer with grass, bushes, shrubs, etc.

The underground version imposed the repair of culverts with great spans of 2 m in order to achieve also heights of 3 m minimum, respectively the height of animals of the greatest size.

Water layer that would form in wet periods and the corresponding vegetation do not constitute obstacles in the way of achieving the function of passage. In order to exemplify we attach one of the drawings elaborated within the impact study for Bucharest-Pitesti motorway where fauna protection was dealt with.

5.4.5. Barrier effect

When passage ways of underground or over-ground type – ensuring certain sizes, the roadways become real relief areas, being obvious that more uneven topography of hill and mountain areas, involve a significant number of passages by solving flowing conditions on rivers and brooks by means of bridges/culverts, as well as viaducts in situations that impose this solution. Also the possibility to have over-ground passages is more accessible with a more natural integration into the landscape.

Plain areas are more difficult for achieving the conditions so that great size animals should pass, but this can be solved like in the example of Bucharest-Pitesti motorway. Embankment sectors in areas with humidity in excess may isolate certain populations and species on one side and the other of transport way, and regressive processes may be more rapid in such an environment. A real barrier for land fauna is Danube – Black Sea and Midia – Navodari Canals, where this is poor enough and generally made up of small size species.

The way of Danube – Black Sea Canal working in the range of shallow waters creates a barrier also for aquatic fauna during the time when Danube's flows are close to low water values, when damming up are achieved by pumping. The degree of impact upon species involved obviously depends on the duration and installation period of shallow water regime. A series of barrier effects appear at local scale where transport ways cross eco-systemic habitats that are already restricted enough, and normal traffic increase and modernization operations become additional pressure factors. The evidence of these situations involves a systematic analysis in GIS environment, all inter-conditioning factors.

5.4.6. Effects upon population

Transport ways represent an important factor of economic development dynamization, with positive effects for local communities. Inconveniences appear when the needs of transport way updating to the current stage of development come into conflict the existent way of land use, especially when development/systematization plans did not provide such perspectives or did not taking into account enough the aspects of economic dynamics.

A systematization that is not adapted to the conditions presented inherently generates a series of inconveniences in relation to roadway modernization, from the forms of land use up to traffic safety. In a narrow space, roadway modernization inherently means their proximity to dwellings and more difficult conditions of access to houses court yards or parking in more agglomerated areas, as well as for pedestrian traffic. The access to agricultural portions becomes more difficult, especially in case of certain traffic restriction by vehicle types, as well as their repair on one side and the other of the road. A way of compensated these negative effects is by means of over-ground passage ways of the ways with busy traffic, both for pedestrians or vehicle types which are frequent in rural areas.

Thus, for Bucharest-Pitesti there were achieved 10 additional passages, besides the rehabilitation of 16 existent ones, and for DN 1 on Bucharest-Ploiesti-Brasov sector, 33 additional pedestrian passages are underway.

Compensating measures of some inconveniences should be accompanied by rural and urban development policies, adapted to the present requirements and rhythms of economic development in the sense of durable development.

5.4.7. Overview environmental bottlenecks (identification of conflict spots between ecological corridors and transport infrastructure)

The problem of ambient narrowing could be achieved in areas with very high eroding activity (example: Subcarpatii de Curbura) where the combination of land slidings – bed eroding exemplified in locality area and transport infrastructure, and habitats with natural vegetation register a process of withdrawal in favor of land degradation, as well as in areas with excessive forest exploitation.

These processes lead to habitat restriction as well as to changes in fauna structure in favor of small size species – wild boar and rodents.

Another aspect of ambient narrowing may be of Valea Oltului type, which due to overlapping several types of infrastructure, for example: roadways, railways and ways assigned to river regularization and the hydro-energetical use.

5.5. Secondary effects of transport infrastructure

The explosive increase of vehicle number in the last decade led to agglomeration in urban areas and they frequently exceed transport capacities.

There is a series of conflicts between the participants in traffic at peak hours, which become more and more extensive, with direct consequences upon environment, particularly the increase of noise and toxic element values.

The solution adopted in this period is the rehabilitation of existent bypass traffic belts for heavy traffic, as well as the achievement of new ones – example: Cluj, Tecuci, Timisoara, Lugoj, etc. as well as of uneven crossings in great urban agglomerations and of roadways with busy traffic – intersection of roadways or with railways.

An important aspect is the increase of traffic accidents frequency, both due to greater traffic values and to running speed that are unadequated to real road conditions.

These are frequently accompanied by life loss, accidental pollution or destruction of riparian dwellings.

Also, a series of inconveniences are derived from the fact that there are not versions for slow vehicles, which are further participants in traffic on modernized roads.

5.6. On-going researches and review of relevant studies

Researches regarding the relations between biotic factors and natural environment dynamics under anthropic impact were achieved in research institutes specialized by certain groups of priority interests. We may mention those related to Danube Delta Reservation or those for ecological rehabilitation of watercourse, those associated with environment engineering denomination, as well as with orientation on a single environment factor – air, water, soil.

There is a series of preoccupations of bodies directly involved in the actions of environment and health protection, or in the evidence of forest, fauna or fish background.

A form of action that pursues the relations between environment components is achieved by means of impact study and environment balance sheet. Such a study is a dynamic factor of researches in the respective field, both in direct form in order to satisfy the requirements and obtain environment agreements, and in indirect form, as a reverse of actions due to public consulting.

Practicing the communication forms especially with civil society will obviously impose an increase of applied information, of phenomena dynamics understanding degree, as well as of arguing capacity of project solutions.

It’s of a real interest for the researcher that elaborates the impact study, as a final form that it should derive from an increased degree of environment problems in the area of study.

6. TRAFFIC SAFETY IN RELATION TO FAUNA CAUSALITIES

Traffic safety in relation to fauna causalities represents an indicator of civilization level and animals welfare. A global approximation al European level is difficult to be made as at present there aren't a clear and relevant data regarding car accidents with fauna.

As rule, these accidents are recorded only when human causalities or important economic damages are produced. Although general data are lacking, accidents caused by crashes with animals are reduced, in relation to the whole number of road events. In this view the theme doesn't represent a priority in most of the countries. For instance, only 0.3% (29 accidents from 11 124) of accidents with harms and human causalities involves animals.

In most of Europeans countries the average of road accidents produced through crashes with wild animals is reduced.

Factors characterizing this phenomenon are:

- traffic density is obviously proportionally with number of road events;
- cars speed - there is a straight correlation between the vehicle speed and gravity of the accident. High speed may produce sometimes accidents also by tendency to avoid impact with the suddenly occurred obstacle, al the last moment;
- weight of animals involved in collision.

The lack of a certain strategy in this respect in most of European countries makes an overview in this field difficult to get, as well as the establishment of some comparisons respectively evaluations of financial costs determined by collisions with fauna and their implications (on different plans: damages, death, prevention measures).

Collisions with animals are recorded along and across railways, too, but these accidents are lesser dangerous and with less serious consequences. Anyhow, the tendency to higher speed may lead, in the future, to the situation of derailment caused by crashes with animals.

7. AVOIDANCE, MITIGATION, COMPENSATION AND MAINTENANCE

7.1. Introduction

Avoiding the ecological impact by non-developing the infrastructure represents in most COST member countries a final solution towards habitat fragmentation. Even if in EU there is a specific legislation in order to avoid ecological impact, taking a new decision related to the adaptation of a new project involves:

a) adaptation of the designed communication way alignment;
b) minimization of the space occupied by the communication way.

All COST member countries elaborated manuals with a view to reducing ecological impact produced by communication ways. It is recommended to implement these measures in the design stage of infrastructure.

Compensation refers to areas that are under the auspices of EU Directives (EC Habitat and Species Directives). In this situation it will be proceeded to the compensation of some ecological values, it is not admissible financial compensation.

Administrative and legal framework: all countries excepting Estonia and Bulgaria implemented EU Directive in order to check the ecological impact (EIA).

Thus, when designing some ample objectives there will be also studied alternative solutions in order to decrease ecological impact.

7.2.Avoidance of habitat fragmentation

Avoiding fragmentation effects still from the design stage leads to decreasing of victims in fauna. For ample projects and for modernizing ones fauna passages are integrated in the process of designing.

In many cases habitat fragmentation is unavoidable, as a consequence there will be adopted measures in order to diminish traffic accidents.

The own communication way network reflects the power and the extent of the economic and social development of a state also. Infrastructure evolution and especially those of road should be focused upon the changes that it could produce both in society and in environment.

May be due to environment factor pollution effects, natural habitat fragmentation has sometimes critical results as regards fauna and flora of a country.

These are materialized in the decrease of certain species populations or even in their disappearance, migration towards other areas that became attractive from landscape and food point of view.

In order to avoid habitat fragmentation due to communication ways infrastructure also in Romania the problem is raised still from the designing stage of a road or railway, taking into account many factor, each of them with its own importance.

Thus, we take in consideration first of all:

- perturbations of eco-systems that are riparian to communication ways, flora and fauna, by the necessary clearances;
- removal of vegetal land, deviations of water courses, soil erosion;
- intersections with the terrestrial routes of wild animals or with birds migration corridors;
- perturbations of landscape, of groundwater continuity, interruption of soil continuity by placing borrow pits and land use;

• perturbations of protected areas that are declared monuments of nature, both from bio-diversity and landscape point of view.

We must not ignore that also in this stage, secondary effects derived from collateral activities involved by the works for exploitation and maintenance of these transport ways, such as: repairs of carriage way, placing of work tools in the field, snow removal during winter, etc. Even if some species may easily adapt to a fragmentation of their habitat, they may be extremely sensitive to substances involved in the above mentioned processes.

These are carried away by rainwater at great distances as compared to road edges, contaminating also areas that contain food for animals, fact, which could lead to diseases and mortality among the respective population.

The execution stage of the works imposed by communication way construction concerned, involves the protection of all crossed habitat environment components, respectively: water, soil and air.

So, we will take into account the possible pollution of underground water as a result of accidental residue leakage on unprotected soil, inadequate deviation of watercourses, draining of some interesting lands.

Air represents in its turn an important environment factor and an essential component of insects and birds habitat. Its considerable damaging would determine the species directly dependent on this element to leave the respective area.

Therefore, we will pay a particular attention to correct and ecological operation of equipment and facilities used as well as to isolation and sealing all reservoirs and recipients that contain noxious and volatile substances.

Soil, being the vegetation background of which animals take their food or live, make contribute to habitat changing by depreciating the biological potential of component plants, by destruction of rare botanical regions or of fragile vegetal groups, etc.

Therefore, measures are imposed in order to ensure its pollution avoidance, land continuity and connectivity. The attention paid to this element should be more special, taking into account that this is the component upon which is very difficult to intervene for de-pollution and which retains and sends for a long time the negative effects.

One of the most modern possibilities offered by informatics technique in order to avoid habitat fragmentation, is the forecast of fauna dispersion (by computer modeling), in case of a new road construction, taking into account all factors involved (rare species that populate the respective territory, land geography, bio-diversity maintenance, green corridors, topographical data, etc).

The result consists in assessing the potential impact of the effective construction upon habitats, which they cross. Depending on it, decisions are taken as regards work starting or there are looked for other possible versions.

Romania hasn't at present such an integrated modeling program. Although, the laws of our country clearly impose fauna protection and the preservation of its bio-diversity, we must surpass financial problems of interests that are at stake in order to fulfill them.

With a better collaboration, the interests centers could mitigate such problematic situation. This solving is necessary particularly for experts in traffic planning.

7.3.Overview mitigation measures

7.3.1.General, measures

Habitat fragmentation has many aspects and therefore the avoidance of this phenomenon involves several measures. A distinction will be made between measures that directly reduce fragmentation, by creating some connections between habitats (fauna passages) or measures that reduce mortality by animals impact with vehicles.

In Europe there are applied the following measures:

7.3.2. Measures in order to reduce mortality

- ***barriers, fences, shields***

Fences are provided in order to prevent greater or average size mammals to reach the highway of railway. Usually they consist of a wire net with smaller meshes towards the bottom of the fence and which is buried into the ground. In spite of the fact that they prevent accidents, fences create a physical barrier for animals.

- ***preventive means: retro-reflective strips, road mirrors***

The efficiency of retro-reflective strips is discussible, in the last years they were experienced in Germany, Norway and Switzerland where chemical substances produce a repulsive response on the behalf of animals. To this direction, experience is yet reduced.

- ***habitat adaptation: vegetation planting and shifting, green corridors***

Vegetation from the edge on communication ways may have a role for fauna attraction or rejection.

Plantation of hedges reduces the possibilities of fauna traffic and guides it towards passages.

In Norway, vegetation becomes more and more rare in the vicinity of communication ways in order to reduce area attractiveness for animals and visibility improvement. By planting high vegetation, birds are obliged to cross

the communication way at great highs and thus, to avoid the impact with vehicles.

- ***infrastructure adaptation: out-puts for fauna by means of fences or along channels;***
- ***reduction of impact produced by vehicles.***

This is mainly achieved by decreasing the traffic speed.

7.3.3. Measures concerning elimination/reduction of barrier effect and habitat isolation:

- ***artificial crossing structures: passages for fauna;***
- ***changing of certain structures initially built for other purposes;***
- ***change of road surface.***
- ***passages for fauna.***

Some countries like France, The Netherlands and Switzerland elaborated norms for fauna passages designing. These are divided into two categories: passages above or under the communication way. There are also distinguished passages exclusively for animals, or mixed passages meant for human traffic.

Under passages for small animals, tunnels, tubes: are made up of metal tubes or concrete tubes with a diameter of around 0.4–2.0 m. the bottom is generally covered with earth.

Under crossings for great animals: are built usually for animals of foxes or hares' size. The width vary between 5–12 m for small species and up to 25 m for the great ones, and the height is 3–5 m. the bottom is covered with earth and on lateral walls it is planted a vegetation in order to increase animals' attractiveness to crossing.

Tunnels for amphibians: are built in many countries in order to allow frogs to cross the communication way. Tunnels are placed in one direction or there may be provided 2 tunnels in order to allow free traffic in both directions.

Crossings for wild animals: they are also called "ecological ducts". These are bridges, covered with natural vegetation crossing, as a rule, motorways.

The contact line hinders railway crossing. Their width varies between 8–80 m. In France it was experienced also the shape of funnel (variable width) with a width of 8-15 m in the narrowest place.

Wide crossings: have widths beginning with 100 m. There are used in order to re-established – as much as possible – the previous situation.

Passages for climbing: are meant for climbing animals like squirrels. There were experienced in Spain and Netherlands.

Structures adapted for fauna passing

***Viaducts*:** are used in steep areas.

Crossings and bridges: are used in less populated areas and there are obtained by combination of forest or agricultural road with a passage for fauna.

***Crossing of watercourses*:** are used where rivers are regulated and traditional places (sand bank, fords) for animals do not exist anymore.

***Wet culverts*:** are placed for small, aquatic animals.

Other measures for reducing the barrier effect refer to small constructive improvements of communication ways in order to allow fauna passing.

In most of European countries, preventive measures for avoiding animal mortality are prevailing. The only country that has a concept and a general plan in this respect is The Netherlands.

7.4. Overview of compensation measures

Few countries have conceived a compensating policy in order to avoid the impact produced by infrastructure development. Most countries employ a compensating policy on a regular or non-regular basis.

7.5. Existing quality standards for measures; justification, minimal requirements

At macro-economic level (national, regional, international), products and services quality is more and more assessed in closed relationship with life quality. We pay a particular importance to health and genetic characteristics of products decreasing of ambient impact, at the same time being introduced more restrictions: regulations, compulsory standards related to life, health and environment protection.

By admitting that there are necessary mutations in the approaching way of aspects referring to polity assurance, we registered in our country, in the last year, to an intensification of preoccupation in this field, at the level of economic agents, but also at the level of government bodies.

Taking into account good quality, the problem of approaching long-term success is raised in a new manner for all managers and experts quality field.

We can already speak about the phenomena of ISO 9000 standards, with a particular impact upon international economic relations.

Within this context, our country has aligned to the existing norms of European and world level, as regards environment standardization.

International standards adopted as Romanian ones:

- SR ISO 14004: 1998 Systems for environment management. Guide concerning the principles, systems and techniques of application.
- SR ISO 14020: 2000 Environment labels and statements.
- SR ISO 14040: 1999 Environment management. Evaluation of life cycle. Principles and work framework.

General principles:

- SR ISO 14050: 1999 Environment management. Vocabulary.

European standards adopted as Romanian standards

- SR EN ISO 14001: 1997 Systems of environment management. Specifications and guide for use.
- SR EN ISO 14010: 1997: Guide for environment audit. General principles.
- SR EN ISO 14011: 1997: Guide for environment audit. Audit procedures. Audit of environment management systems.
- SR EN ISO 14012: 1997: Guide for environment audit. Qualification criteria for environment auditors.
- Section A – Management and Communications
- Section B – Approach for implementation of quality system in industry
- Section C – Evaluation techniques of quality systems
- Section D – Products security in agricultural-food field
- Section E – Certification and Standardization
- Section F – Metrology
- Section G – Security / Environment

7.6. Aspects regarding maintenance

Protection system maintain their efficiency as long as they are regularly maintained and checked (if necessary), repaired or re-located. They should be kept all the time under perfect conditions. Animals rapidly detect any superficial defect in any kind of structures, especially as regards barriers, which they will inevitably penetrate, thus entering the traffic route. Plantations associated with the facilities meant to protect fauna do not require an intensive maintenance. For these reasons, it should be planted only the vegetation, which is adapted to the respective environment.

We should also take into account the landscape that surrounds the area and at the same time we should check structure integration within this landscape. A quick maintenance team, which is well equipped, should be able to repair all areas with defects and to permanently ensure the efficiency of structure.

7.6.1. Verge management (adjacent areas)

The importance and the increase of areareness related to margins management (habitat limit areas) is an important side of the problem, therefore these should be observed and the biological requirements should be imposed **(figure 31)**:

a) to determine what species are within the project perimeter and within surroundings, especially protected, threatened or rare species;

b) to determine the daily and seasonal use of space by the existent species: central areas, food areas and their quality, mating places, places for sheltering, fauna passages, migration routes, main points of arrival at the skirt of forests;

c) to evaluate biotopes potential for various species;

d) to point out the corridors between natural biotopes. To schematize the necessary links.

In order to comply with the requirements, a system should be well built and perfectly adapted to the requirements imposed by the surroundings. Most details can be established only in the land. For these reasons, the construction should be surveyed from the beginning to the end by the biologist who also participated in planning and who is the person in charge with achievement of changes that are imposed. The decisions taken during work execution may prevent the prejudices brought to fauna.

Calm and quiet are extremely important in areas reserved only for the exclusive use of wold animals. Plantation of attractive vegetation is one of the factors, which determine animals to safely use the areas adjacent to roads. In order to be sure that animals have access, all the time, to passages without being disturbed, the surrounding areas, they should have a statute as regards their preservation or they should be protected by agreements or other legal acts, contractual obligations that should restrict human activities, such as hunting for example.

We should also take into account landscape elements that animals need (afforested valleys, thickets, which are structures upon a movement canal is being built).

7.6.2. Management of other surfaces

In order to arrange the works and their slopes from vegetation point of view, it is recommended that we should use exclusively indigenous plants that are adapted to the respective place.

It is possible to increase work attraction by placing various resources (food areas alternating with shelter areas) at fauna's disposal.

Various structures on the bridges contribute to the increase of species number that use the passages. There are favorable the following elements:

- hedges;
- high grass;
- dry meadows (grass lands);
- heaps of stones and branches;
- land elevations and hollows;
- small water courses;
- fruit trees.

Arrangement should be planned for each case separately by experts, depending on fauna. The vegetation, which is planted, should be maintained so that the respective passage should fully meet animals needs (the species concerned).

7.7.Evaluation and monitoring of the effectiveness of measures

A system's efficiency may be determined after a period of time, that depends on how correctly was the initial project conceived and executed and on how much attention was paid to its efficiency and what improvements should be made as a result of its monitoring.

As long as we tend towards an optimum performance, using the principles of quality cycle, it is essential to ensure stability performing repairs under a direct guidance that should ensure the observance of condition imposed by environment quality. Supervision of protection structures further to their construction assumes that we should notice the behavior of wild animals from vicinity (neighborhood). We should also carefully pursue the surrounding land use, particularly near bridges or underground passages. Land use should comply with the purpose for which these passages were created, and in case of abusive use we should immediately report and take measures.

7.7.1.What do we mean by measures efficiency

Control of measure efficiency should be a part of project elaboration. Ecological objectives, in particular animal species to be protected or favored by measures (species concerned), should be established from the start within planning.

The following elements belong to efficiency control:

- analysis of initial situation before starting the works;
- supervision of construction stages;
- situation assessment after putting into operation the communication ways;
- appreciation after a certain stage of adaptation (for example after 10-20 years).

7.7.2. Minimal procedures and requirements for measures assessment

The points that must be taken into consideration in systems quality assurance are:

- basic knowledge and information about animals to which the structure is dedicated, their vital needs and the possible population evaluation on medium or long term;
- environment condition around the route planned for road location, before starting the construction or other previous activities;
- the foreseen impact of infrastructure upon environment and fauna;
- the location area and the components which define it: morphology, geology, hydrology, vegetation, land use, human activities, etc.
- the evolution foreseen for the land as well as for its other components;
- efficient, preventive, protective and compensating measures that may be applied;
- technical conception in collaboration with experts in fauna biology.

7.7.3. Organizations involved in measures assessment

Supervision may be made by a person, society or administrative department, designated for this purpose, and which should possess good knowledge about fauna and the ecology applied, to have the authority and necessary resources in order to take decisions in road area and in its vicinity.

The purpose of fauna supervision is to detect any perturbations produced to animals or any changes in their movement and behavior that may lead to re-consideration of the protection structure and its design. Supervision should be made at regulate time intervals for a period of at least 5 years, after which the frequency may be changed according to each case apart.

Supervision performed in the surrounding area consists in checking environment behavior and condition in order to prevent degradation, and significant negative changes that might make these passages, inadequate for animal use.

These changes may be caused both by natural phenomena (wind, rain, dryness etc) and by man (forest clearance, stones of concrete pieces on animals' passages, hunting, etc.). The campaigns for correct informing as well as resorting to legal actions should be enough in order to determine local authorities and residents to give up their activities, which may affect the efficiency of these protective systems.

7.7.4. Overview upon main methods and results

Measures efficiency concerning fauna and road traffic safety, depend on plenty of factors that may be defined as basic:

- the need to be aware of "fauna problem" in the context created by the construction of a roadway;

- the protection facilities should be integrated in the landscape and be permanently maintained in good conditions;
- constant pursuit of their performances.

When we apply these measures we have to be particularly careful and it should be a full agreement between all those involved.

Application of such measures is a sign of emphasis change as regards the ratio: fauna/traffic safety towards keeping life patterns already existent, which determine that landscape and its structures should function in harmony, despite of the intrusion represented by traffic routes.

7.8. Summary

Avoidance of ecological impact by non-developing infrastructure represents in most COST member countries an ultimate solution towards habitat fragmentation.

Even if in EU, a specific legislation with a view to avoiding ecological impact and taking a decision referring to a new project adapting may involve:

- adapting the alignment of the designed communication way;
- decreasing the space occupied by the communication way.

Avoidance of fragmentation effects still from the designing stage leads to diminishing the number of victims in fauna. For ample and modernizing projects, fauna passages are integrated within the design process. The protection systems maintain their efficiency as long as they are regularly maintained and checked, if necessary, repaired or re-located. They should be maintained all the time under perfect conditions.

In order to meet the requirements, a system should be well built and perfectly adapted to conditions imposed by surroundings. Most details can't be established, but directly in the field. For these reasons, the construction must be supervised from the beginning to the end by the biologist who also participated in planning and who is the person in charge with modifications imposed. Decisions that are taken during execution may prevent the harms to fauna. Construction of a new road generally involves re-organization of lands as well as changing of owners. Land owners , farmers, local authorities, hunters as well as hunting associations, or other involved partners, should be fully informed about all problems and their implications.

8. HABITAT FRAGMENTATION AND INFRASTRUCTURE FUTURE DEVELOPMENT

8.1. Introduction

The interest show in a durable development, as an alternative to the obvious environment deterioration process, requires Romania to re/examine the possibilities to asses and supervise the condition of natural ecosystem, to detect the causes and tendencies of changing their functionality.

Our country takes part in various international Conventions and Programs. These Conventions and Programs contain tasks that are assigned to all parts.

The measures for environment protection, for economic and social development at national plan, should integrate themselves into all measures that are taken at regional and world level, both as works volume and terms.

The strategy of environment protection, which is elaborated by the Ministry of Water, Forest and Environment Protection, should meet the agreement and obligations of those involved in environment protection.

Strategy takes into account both tasks assigned at national level and those assigned to our country and which are specified in the International Conventions to which Romania joined or to which it belongs.

At present stage, we are looking for a general definition of priciples, directions, objectives and identification criteria that should lead to a durable development (economic and social) of our country, under the conditions of tradition towards market economy and of Romania′s preparation to EU′s integration.

8.2. Policies and strategies / tendencies

Bio-diversity preservation is one of the principles of environment protection.

Strategy and means polluting agents elimination, eco-systems maintenance and their functioning capacities, of their stability and resistance to de-regulations, of their productivity and adaptability. Another general principle adopted for elaboration of environment protection strategy is that of durable development.

Durable development means the maintenance of life possibilities and conditions for future generations, especially of natural resources that may be regenerated at least at the level of those existent for the present generation, as well as recovering of environment factors affected by pollution. According to the definition given by the Commission for Environment and Development, durable development involves the fact that the total volume of capital, made up

of physical capital (machines, factories, roads), human capital (people′s health, knowledge and skills) and natural capital (forests, air, water and fertile soil), stays steady or it increases over time.

Maintenance and improvement of existing nature potential, corresponds to the principle of durable development. It refers to long term actions and aims first at developing of nature resources that may regenerate water, soil, forest, flora and fauna, but also at consuming in an (balanced) equilibrated way the resources that cannot be regenerated.

Medium terms objectives till 2005 (2010) emissions of substances that destroy ozone layer, will be reduced to zero in 2005 (2008 for certain substances), being aligned to the provisions of the national study elaborated, as well as of other studies carried out in various countries by commissions of United Nations Programs for Environment Protection.

Long term objectives, till 2020 for environment protection are assessment of economic activities impact (in the context figure 10) bio-diversity preservation< the use of natural recoverable resources up to their potential of regeneration (water, soil, forests, fauna, floral, achievement of a coherent system for regulation concerning environment protection that should be aligned to that of EU countries/monitoring system of all environment factors development of a scientific research activity on environment problems in correlation with the research activity of European space.

8.3. Fragmentation indicators / indexes

Environment indicators are an instrument necessary in strategy designing for a durable development.

In principle, we cannot speak about a system of valid universally valid/this should correspond to the concept framework and specific proposes, that are promoted with time and space. Beyond the system of indicators adopted by Romania contributes to the assessment of environment condition in compliance with the intensity of changes, (that take place) related to its quality, with the objectives defined by national policy and international agreement integration of environment interests within sectorial and economic polities. This, environment indicators may be grouped in 2 great categories; indicators of environment quality and indicators of the source (emission).

As regards indicators of environment quality Romania has in view the following fragmentation indexes:

- the affected surface, appreciated from the point of view of its role in habitat fragmentation;
- the extent of its affecting – passing points and routes of migrating birds;
- the number of individuals affected and the number of individuals who are in danger - fauna species and populations;
- species density, that is appreciated, depending to their quality;

- barriers in the way of movements – species migration;
- surface used for infrastructure transports;
- road density;
- the degree of roads loading with traffic;
- number of accidents registered on road thoroughfares, depending on their causes.

Transport is also one the main sources for atmospheric pollution, due to: roads conditions, traffic that is not enough organized; imperfect engines combustion fuel with lead content and lack of catalyzes in order to decrease carbon monoxide.

Thus, the indicators of source (emission), planned in Romania are; emissions of carbon dioxide, sulfur dioxide, nitrate oxides, gases with greenhouse effect.

Unlike the "favorable" effect upon environment, incurred by diminishing productive activities after 1989, vehicles circulation produced a reverse effect. The number of vehicles with diesel oil in 1990 has increased almost 4 times, fuel consumptions have doubled and as a consequence the emissions of atmosphere pollution have increased correspondingly. Two main reason have determined this "explosion": limitation of consumption restrictions and the massive import of vehicles, particularly "second hand" ones.

8.4. Models to predict fragmentation by new infrastructures

European infrastructure for a wide spreading and a successful use of GI in Europe are not technical, but political and organizational.

The lack of an European mandate in GI, delays the development of GI common strategies, produces useless costs, stops new assets and services and reduces competitiveness.

The situation may be improved by an European Infrastructure of Geographic Information (EIGI), which should be achieved at European governmental level and should be operated for and by GI community.

EIGI will be series stable and European level rules, standards and procedures established in order to create, collect, exchange and use GI. EIGI will also ensure the availability of basic data series, of European level and the existence of meta-data services, so that potential user should easily detect such data.

The technical infrastructure is a " sine qua non" condition for an GI infrastructure and for many similar TI applications. Most of CEE countries understand the importance of this technical infrastructure and push towards the achievement of a largely distributed network.

At the same time with this network it also comes a series of low level standards for data exchange (TI standards, for example the standard series usually used on Internet and WWW).

Theme standards that enable the real use of TI infrastructure for GI network construction are pushed towards different levels. There are ISO and CEN standardization efforts (for example CEN WG 278, ISO WG 211) and the corresponding groups for standardization at national level. In many circumstances, the national groups work at particular national standards and at adaptation of international standards. Construction of GI infrastructure requires the systematical collection of spatial data and description of the content of data series and the quality. It should be achieved a systematic method in order to distribute the content of data series and quality. It should achieved a systematic method in order to distribute these meta-information. This is currently the subject of intensive researches at international scale.

National infrastructure of spatial data

The most comprehensive objective of the center is that to contribute to the building of Information Society bases of Romania in a particular area that of GIS, by achieved a national infrastructure of spatial data (NISD).

In this case NISD is mainly, a "covering" of policies, standards, partnership between various sectors and disciplines that will promote the efficient production and the use of high quality geo-special data.

Briefly NISD consists of:

- organizations and individuals that generate or use special data;
- technologies, which facilitates the us and transfer of spatial data;
- present special data;
- relationship and interactions between these entities and has the following components;
- data sources;
- spatial data bases, special meta-data and databanks;
- data networks and the average for data transfer;
- technologies that affect data bases, policies, standards and computer networks;
- institutional arrangements that affect data bases, policies, standards and data networks;
- the users of special data.

Naturally, these components are part of a system and they are not functional in an environment that is very influenced by cultural, legal, financial and educational conditions.

Infrastructure may include among others:

- a register of general cadastre;
- standards for information classification, qualification and digital communication;

- technical and legal bases of universal connectivity with data bases and legal rights to interconnection;
- data meta-bases that describe the content and components of data bases.

Identification and development of priority special databases based on request of users' community

This strategy includes:

- the development of Main Spatial Data Base at National Level (MSDBN) that should supply basic spatial data which will allow the users to link and to relate their own series of digital data and will help in selecting other data for Presentation.
- Development of priority theme data base (about soil, land use, etc.).

The way of attesting / assessing the quality and efficiency of research activities

The quality of research activity will be ensured by the integration into research trends from European level. In this respect the activity will be related to viable approaches of which:

- DIS GIS - ESPRIT no. 22086 project
- GEOWORKS - ESPRIT no. 6339
- IG projects approved within INFO 2000
- Three studies on IG (Policy / Base / Meta)

Categories and volume of research activities including the involvement in the achievement of CDI national programs

At present, in Romania there are similar approaches, but only at the level of some European projects. European initiatives where Romania is involved are: INCO - COPERNICUS 977136 project, called "Pan - European Link for Geographic Information" (PANEL - G1) and INCO - COPERNICUS project 977050, called Administrative Boundary Data Services for Central and Eastern European Countries" (ABDS for CEEC) in the achievement of which it also participates ICI, by GeMaSoft (GIS) laboratory.

At the level of central and local public administration from Romania, there are imperious requirements concerning the achievement of a common fund of spatial data, which should constitute in a nucleus of information coherence in order to develop plenty of applications.

The Centre will be further involved in the national research program, by sustaining the re-engineering of public administration in order to create an infrastructure of spatial/national/regional data.

At present, in Romania there are not used models (patterns) for fragmentation forecasting. The achievement of a national/regional/local database in under development.

8.5. Data on development of transport network

In compliance with the European level assessment in the next years, as a result of Pan-European establishment the are foreseen significant traffic increase, particularly the road one.

For there increases there are ensured both the functional framework, and the credibility and for foreign investors by ensuring a legislative framework **(fig. 32, fig. 33).**

The Plan of National Territory Arrangement, the communication way section, has defined the works on the basis of feasibility studies elaborated and approved according to legal orders.

The provisions of this development plan of communication ways are applied within the arrangement of district, municipe, towns and communes territory. There are differentiated the following development of communication ways:

I. Roadways for motorways development on 13 routes, as a rule to the direction of Pan-European corridors- around 3000 km;

- roads on 16 priority routes – around 3300 km;
- main bridges over Danube (7) and Prut (5) – 12;

II. Railways:

- simple or double tracks on 33 new routes – around 1200 km;
- arrangement of 13 existing routes for lines with increased speed – around 3200 km;
- works on 4 main routes for high speed lines – around 700 km.

III. Waterways:

- 5 new main ports – on Danube and Prut;
- waterways arrangement works on 15 sectors particularly on Prut and Olt sectors on a length of about 630 km;
- works in 12 points for bac crossing;
- RO-RO systems in 3 passages;
- arrangements on Danube-Black Sea and Poarta-Alba-Midia-Navodari canals;
- arrangement in 2 existing ports.

IV. Airways:

- works for modernizing the infrastructure, the protection means of air navigation and the servicing means of 17 existing ports;
- 4 new airports in the areas: Brasov-Ghimbav-Prejmar, Braila-Galati, Alba Iulia-Aurel Vlaicu and Bistrita;
- works in order to ensure international traffic conditions in all airports of the country.

8.6. On-going researches

After 1989 in Romania it was achieved a national research plan aiming at "delimiting and describing the eco-regions of our country". Determination of eco-regions allowed the knowledge, on ecological bases, of main landscape types from Romania.

After 1990 it started the greatest technical and scientifically action of territory arrangement at national level. It's about PNTA = Plan of National Territory Arrangement. Obviously, by this work of great dimension and of national value and for parks – of international value, there are also concentrated data regarding the habitats that should be taken into account for their possible fragmentation (de-fragmentation).

Beginning with 1991, there were achieved great works of synthesis of many specialized researches (already existent). Moreover, it was passed on to the inventory of *flora and fauna bio-diversity* of Romania, that are elements absolutely necessary in COST 341 study. The keen necessity for modernizing and developing the *communication ways* network s expressed by the absolute priority that PNTA gave to communication ways. Thus, in July 1996 it was approved Law 71 concerning PNTA – Section I: Communication ways. Thus, there are legiferated the results of the complex study of all Romania's communication ways – respectively roadways, railways, etc.The major role of these Natural Environment Components is not to be doubted, each geographic form is expressed by its specific space. This way of approach was enriched by the "geo-system" concept (Suceava 1963).

Landscape picture-architectural approach (Dr. architect V. Mitrea 2000) that deals with the possibilities and action means of urban and landscape architecture, represents the prevailing element.*Landscapes that are considered close-urban and sub-urban* and which are studied like a System (Berindan 1968, 1975), with a view to using them as a major protective factor, as a recreation and recovering factor of human community; like The Ecological Approach of Landscape – 1977 (A. Rosu, Irina Ungureanu), are works that integrate in the general preoccupation of studying the eco-systems and human activity implication upon them, from the point of vince of natural habitat fragmentation.

In Romania there were achieved researches related to fragmentation indicators especially for those of the source (emission) by impact studies and environment balance sheets carried out by authorized institutes with the agreement of Environment Protection Agencies.

8.7. Summary

Taking into account the real situation of Romania as regards economy and environment condition, it is imposed the elaboration of on own action program, which is recommended to be integrated into "Program of action for environment protection in Central and Eastern Europe", document the principles of which were approved at the Ministry Conference at Lucerna, Switzerland, April 28-30, 1993 as well as in the process of preparing Romania′s adhesion to EU.

The development of communication network on water, soil, air, is also correlated with actions to which Romania gives its signature, such as TEM program concerning the North-South motorways network or the program of railway corridors TER, programs which are under the auspices of CEE – European Commission of United Nations Development Program (E.C.U.N.D.P.)

9. ECONOMICAL ASPECTS

The present means of transport influence radically our way of life. The needs for space meant for roads, parkings and gas stations changed the structure of our towns and villages and the intense traffic influenced fundamentally the interacting way between people.

Transport for goods and people requires a series of costs – and we are not talking only about vehicles, fuels prices or taxes, but also about costs of:

- life loses or injures due to accidents;
- health affectation due to pollution and noise made by vehicles and plains;
- property loss due to transport ways;
- time loss due to traffic congestions – delayings at office or in goods delivery or clients services are very expensive.

Estimation of transport financial costs

Economists tried to assess external costs due to climate changes, but this involved much controversy suppositions. Transportation costs internalizing in UE – Action Mutual Program in Transport 1995-2000 – admits that environmental problems are part of transport policies planning. Moreover, the program proposes internalization of all external costs, including those related to

environment decay. The act tries to focus upon economical benefits of an efficient transport network.

The attempt to turn the value of social and ecological transport costs into money is a controversy one. Some people consider things like health, peace, quietness and clean air to be priceless. The real road transport costs include the following:

- traffic jams;
- accidents;
- road damaging and maintenance;
- noise, vibrations and visual disturbance;
- local and regional air pollution with suspensions, ozone and lead;
- pollution at a larger scale due to volatile organic compounds, nitrogen oxides and sulfur oxides;
- global heating due to carbon dioxide emissions;
- use of unregenerable resources, such as: fossil fuels and building materials used for roads;
- land loss in order to build roads and their associated facilities;

Costs related to environment depreciation, accidents and traffic jams are either partially covered or uncovered at all. The road users support some of road transport costs, these internalize including costs with vehicle property, fuels and taxes. On the other hand externalizes, reflected by the other road users, environment and the society affecting, are supported by others. If all costs related to transport had been internalized, road users would compensate the rest of society for damages they produce. In this case, costs imposed by driving would be so great that humans' behavior may be modified, meaning a shorter changing of place, a higher use of public transport, more fuel savings and others. Thus, internalization is a very powerful tool for establishing the transport policies.

Traffic jams decrease the trade and waste people's time. To calculate the costs of the traffic jams it must be made the correlation between "cost" and "speed" and between "speed" and "traffic flow". The building costs regarding a new road were justified by assigning a value to the time saved due to its utilization. The same methodology may be used also to establish the value of the time lost due to traffic jams.

Only one lorry can make damages to the road, which are equal to those made by 100000 cars at least. This study can be used to calculate the value of road degradation, using value data about traffic and building costs of Romanian roads. External costs due to road transport represent a significant percentage from PIB.

Financial value of environment degradation

Economists proposed a variety of techniques in order to assign a financial value to environment degrading process.

Preventive expenses: the amount paid to prevent or ameliorate undesired effects. An example may be the expenses necessary to isolate buildings and double windows installing in order to avoid noise pollution.

Replacing/restoration costs: the amount spent by public institutions or associations to restaurate buildings and relief, for instance.

Property evaluation: differences between the market values of some similar properties, which reflect differences within the local surrounding. As an example, the price of a house neighboring a heavy loaded road is lower.

Gains loss: productivity decreasing due to accidents or sicknesses.

Changes in productivity: the value in money of harvests, forests reducings or due to the extra-quantity produced by environment damage.

Probable evaluation: the amount people declare they would like to spend in order to avoid undesirable effects. This may differ from the amount they would like (or be capable) to really pay.

But this approach of the problem doesn't consider that we are living in a world with finite resources and they have to satisfy the request of different activity sectors. In this case, only a correct evaluation of these costs can offer the possibility of their right distribution and reducing up to acceptable limits. Road users pay only a fraction of the costs they impose to the society.

Accidents in Romania

Road accidents bring about over 2800 deaths every year and over 7700 bad injuries, figures that, considering the country's size, are big. The average between traffic values and number of accidents is six times greater than that of EU's.

2/3 of the accidents involve pedestrians, most of them being children. As well, 2/3 of the accidents happen in urban or in second class areas. Because of fast increasing of population within urban areas and of increasing vehicle numbers, the deaths produced by road accidents will increase too in the absence of an efficient implication. The number of injures, as result of road accidents is greater than that of the deaths. Studies accomplished in different countries confirm that there are 10-20 times more injuries than deaths. Many of them are bed injured and remain with infirmities. Usually, injured people aren't caught in national statistic systems of the health state.

Road accidents stand for one of the most serious problems that affect health in many countries especially if these effects upon health are evaluated considering the productivity loss due to premature deaths and infirmities. To people with ages between 5 and 44, road accidents are the second cause of morbidity at world level.

The total number, the gravity of accidents and proportion of the deadly ones are directly dependent to car speed.

A great number of accidents in Romania take place in Bucharest. Here, as in other towns, the speed limit is 60 km/h, much greater than in other European cities.

The right price?

If vehicle drivers paid a rate proportional with the impact they have on the road surface, there could reach some radical changes regarding the distribution of goods transport between road and railway and a higher energetic efficiency.

Human life quantification and life quality decreasing due to accidents or sicknesses is a disputed problem based on productivity decreasing and costs involved by an accident (medical, funerals, police inquires costs, etc.). As well there are included the "costs" of an anger state and the suffering one, based also on productivity decreasing.

"Polluter pays" principle

"Polluter pays" is an important principle of environment protection policy. It is a part of the 16-th principle of Rio Declaration on Environment and Development and EU both adopted it by EU Treaty and Environment Program for 5 years. The Environment Program for Europe in 1995 demands that all-external costs should be internalized so that polluter really pay them.

At present, a car user pays:

- an annual steady tax for roads using;
- a variable tax included in fuels price – 25% of the price gets into The Special Found for Roads;
- a steady tax collected when the car is bought – 10% of the selling price for a new car, Romanian or foreign provenience, gets into The Special Found for Roads;

These taxes are intended to cover the costs necessary to maintaining and modernizing the road infrastructure. However, there isn't any tax upon any external cost, like air pollution, noise pollution, traffic surveillance or road accidents.

10. GENERAL CONCLUSIONS

Territorial arrangement and transport are two main elements which by supporting each other, participated in the occurrence of a more dispersed and a much mobile society. While traffic increase should restrained in order to observe the ecological objectives, it seems that the modern patterns of territory arrangement make out of automobile and truck use, a necessity and not a selection.

The development model influences the mobility requirement. The durable regional development is focused upon *flow equilibrium* of and in the respective region. Bio-regional images adapt the functional relationship between food production and consumption and so the landscape will be re-oriented towards a productive use, fulfilling by it a tendency of rehabilitation.

As regards world strategy of environment protection, Romania finds its due opinion in "National Action Program for Environment Protection" elaborated by Ministry of Water, Forests and Environment Protection, which is at the same time a materialization of Government policy for which environment and "durable development" represent national priority objectives.

The transport policy of Romanian Government mainly aims at ensuring a flexible transport system which should be sure and efficient, for internal and international movement of assets and persons.

Also, it is taken into account the insurance of direct and rapid access to all Romania's areas and the emphasis on mineral and agricultural resources of our country and on its strategic position, which is between Western Europe and Middle East.

An urgent priority is to align Romanian transport system to European standards, as a basic requirement of our country integration process into E U.

From the point of view of European integration, by signing the agreements with EU, our country commits itself in a close cooperation with European Commission and its member states in the field of territorial arrangement and consequently in applying The Development Scheme of Communitary Space, which basically aims at solving the economic and social problems correlated with exigencies of a durable development.

The Plan of National Territory Arrangement is oriented towards an assessment of social-economic potential of our country and towards the identification of main malfunctions of territory level and at the entire localities network.

As a result of these actions, there were pointed out malfunctions related to communication ways infrastructure, population distribution, lack of balance within town network, which were determined by population territorial mobility, zonal aspects of natural resources management.

Due to Romania's economic situation, the road network is not developed at the level of that of Western or Central Europe and implicitly the problems of impact upon environment are not raised at the same level. So that in most regions of our country, the landscape is characterized by plenty of natural structures or with natural aspect that enables the existence of a reach fauna. New and "improved" roads threatens many protected areas, and river sewerage may endanger riparian wet lands, and the routes chosen for high speed railways may affect valuable habitats. Also sea transport of goods which are often dangerous, may affect coastal areas.

Romania's surface is covered by the communication ways in a percentage less than 1%, which is not worrying in relation to the country's surface and in comparison with other European countries. The routes of communication ways are established for years - if there were registered changes, they aimed at maintaining or rehabilitating the roads – absolutely new routes are not significant in length.

The density of district roads, which contributes to the mobility necessary to small industry and agricultural enterprises, is three times less than that of Germany or Poland. The increase of space use percentage will be made, taking into account the proper roads, link roads and other facilities (gas stations, parking, restaurants and motels).

The area of wild animal species is generally located in afforested mountain massifs and in the hill area. The habitats of different species were re-dimensioned and were strengthened. Animal movements (of the type: day or season shifting, spreading or migration) along the corridors or across them are reduced enough in relation to important routes. A more intensive activity may be noticed on the routes of low category public roads, roads of non-aggressive exploitation (forest, agriculture, etc.). Due to the small number of events where wild animals are involved, there isn't a statistics of collisions between animals and traffic means.

Romania's morphological characteristics – corridors sectors, represent territories of energetic nucleus, pointed out by adding the hydrographic network and by changing the tree graph, with a role of energetic transfer and exploited by "tracing certain transport network" – road and railway. In these units we may distinguish two major types of natural barriers: orographic (communication ways) and hydrographic (water courses and accumulations), together with concentration of human population and elements characteristic to landscape anthropization (sterile stock, polluted areas).

In our country there is a criminal lack of responsibility in land use and management of green surfaces. The last ten years are characterized by unprecedented aggression and with consequences difficult to quantify all that means natural environment, irrespective of location. In rural localities and pre-urban area we find out wild and irrational clearing, invasion of green areas by tourist constructions or dwellings, more or less legally located, tourist invasion of protected areas, set up of new access roads and traffic extension on the existing ones, the wild exploitation of certain resources (for example: quarries).

At the same time many agricultural lands are not exploited. These actions lead to restriction of habitats, changing of land functions and of life conditions with negative effects both upon fauna and flora.

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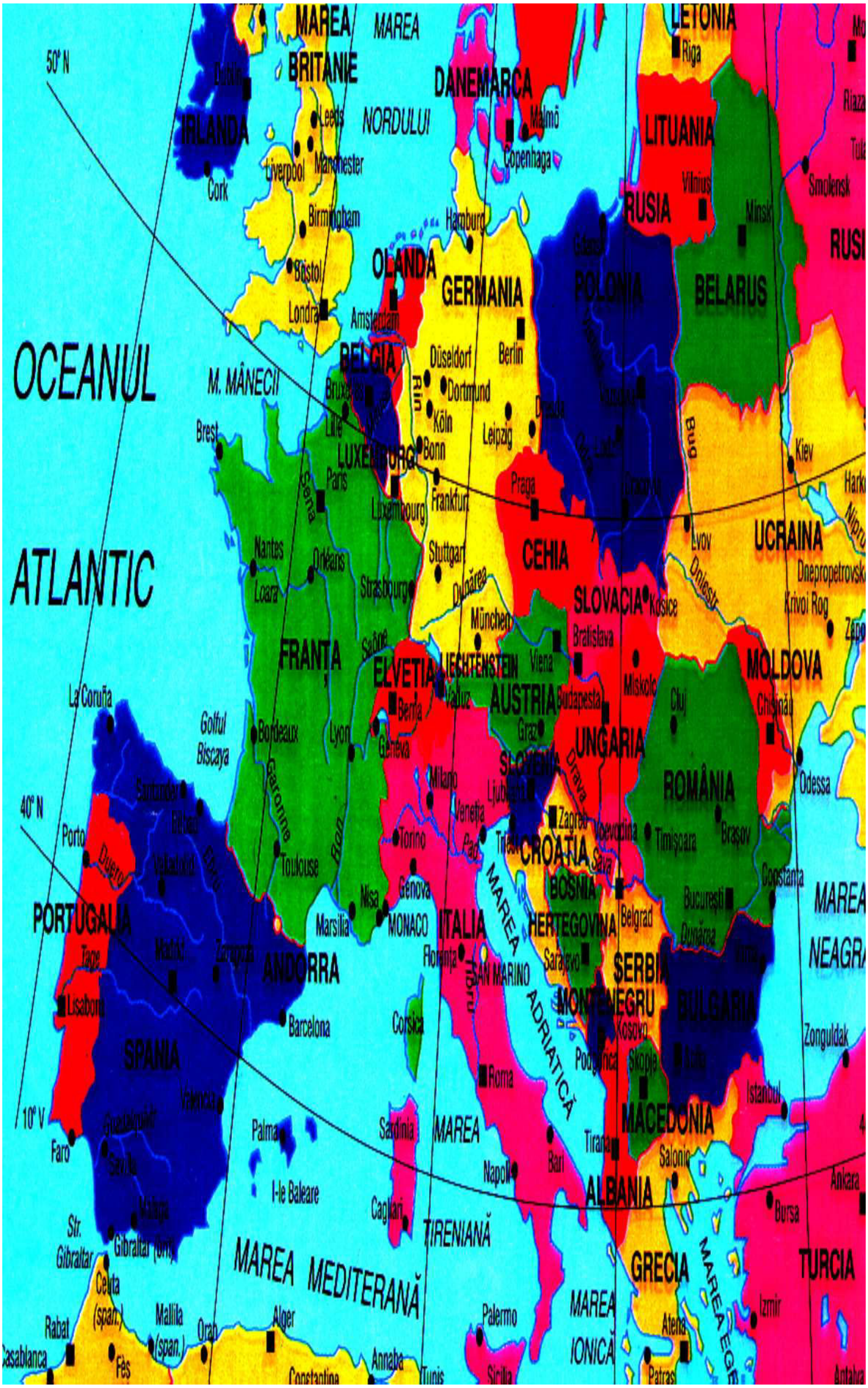

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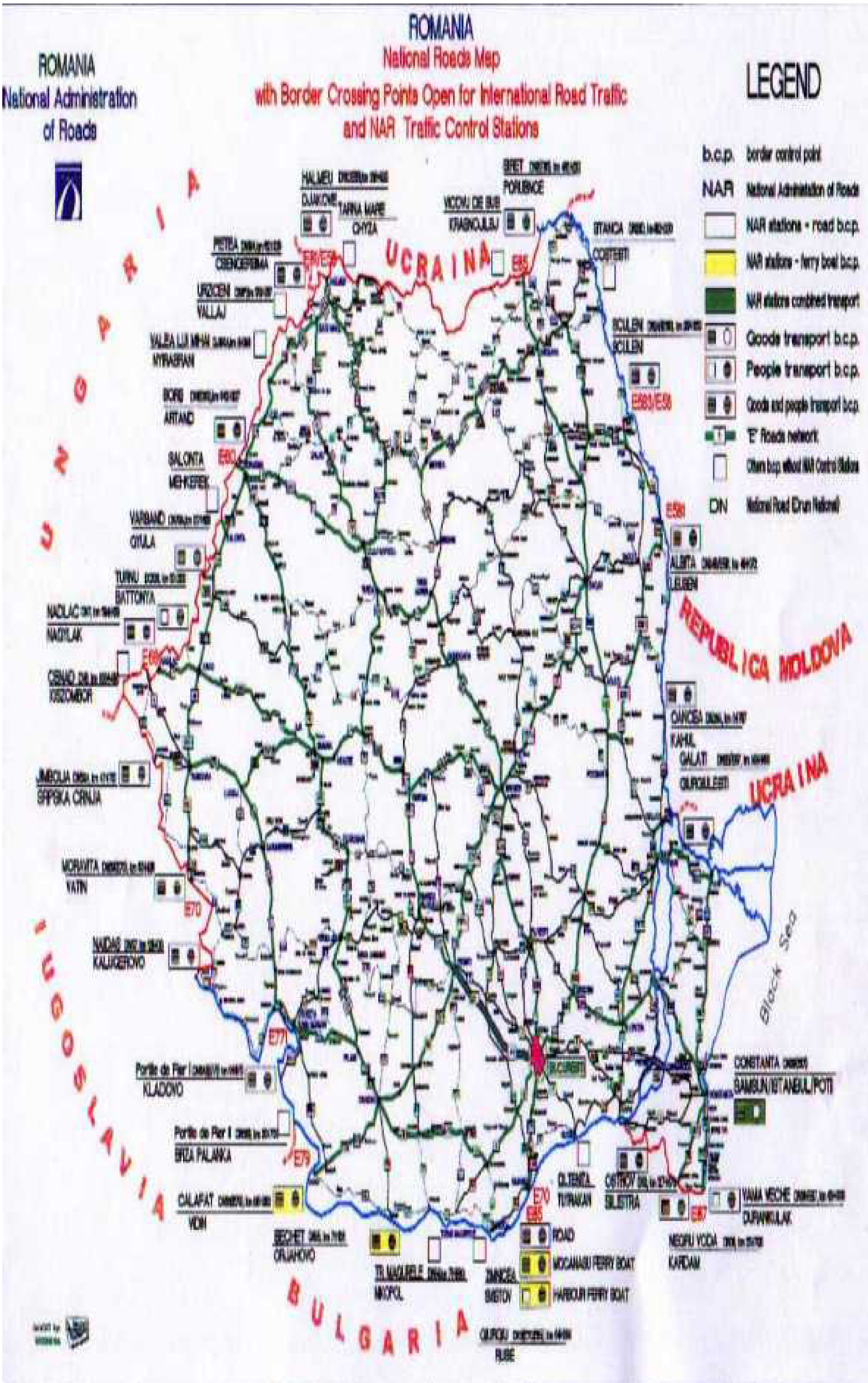
Timișoara
Brașov
Porto
Duero
Valladolid
Ebro
Toulouse
Ron
Torino
Pad
CROAȚIA
Sava
BOSNIA
HERȚEGOVINA
Constanța
Genova
Belgrad
București
MAREA NEAGRĂ
PORTUGALIA
Madrid
Zaragoza
Marsilia
Nisa
MONACO
ITALIA
Firenze
SAN MARINO
MAREA ADRIATICĂ
Sarajevo
SERBIA
Dunărea
Tajo
ANDORRA
Tibru
MUNTENEGRU
Kosovo
Lisabona
BULGARIA
SPANIA
Barcelona
Corsica
Podgorica
Skopje
Sofia
Zonguldak
Roma
Istanbul
Valencia
MACEDONIA
10° V
Faro
Palma
Sardinia
MAREA
Bari
Tirana
Sevilla
Napoli
Saloniс
Ankara
I-le Baleare
ALBANIA
Bursa
Malaga
Cagliari
TIRENIANĂ
Str. Gibraltar
Gibraltar (brit.)
MAREA MEDITERANĂ
GRECIA
TURCIA
Ceuta (span.)
Melilla (span.)
Oran
Alger
MAREA IONICĂ
Izmir
Rabat
Palermo
Atena
Casablanca
Fès
Annaba
Constantine
Tunis
Sicilia
Patras
Antalya


Ukraine
Republic
of Moldavia
Hungary
ROMANIA
Black
Sea
Yugoslavia
Bulgaria


ROMANIA
National Roads Map
with Border Crossing Points Open for International Road Traffic
and NAR Traffic Control Stations
ROMANIA
National Administration
of Roads
LEGEND
b.c.p. border control point
NAR National Administration of Roads
NAR stations - road b.c.p.
NAR stations - ferry boat b.c.p.
NAR stations combined transport
Goods transport b.c.p.
People transport b.c.p.
"E" Roads network
DN
UNGARIA
UCRAINA
REPUBLICA MOLDOVA
UCRAINA
IUGOSLAVIA
BULGARIA
Black Sea
ROAD
MOCANASU FERRY BOAT
HARBOUR FERRY BOAT
CONSTANTA
CALAFAT
VIDIN
KLADOVO
BREZA PALANKA
MORAVITA
VATIN
JIMBOLIA
SRPSKA CRNJA
CENAD
KISZOMBOR
NADLAC
NADLAK
TURNU
BATTONYA
VARSAND
GYULA
SALONTA
MEHKEREK
BORS
ARTAND
NYRABRAN
VALLAJ
PETEA
CSENGERSIMA
HALMEU
DJAKOVE
TARNA MARE
CHYZA
VICOVU DE SUS
KRASNOILSK
SIRET
PORUBNOE
STANCA
COSTESTI
SCULENI
ALBITA
LEUSENI
CAHUL
GALATI
GIURGIULESTI
VAMA VECHE
DURANKULAK
NEGRU VODA
KARDAM
OSTROV
SILISTRA
OLTENITA
TUTRAKAN
ZIMNICEA
SVISTOV
GIURGIU
RUSE
BECHET
ORJAHOVO
TR. MAGURELE
NIKOPOL
E70
E85
E87
E79
E771
E68
E60
E58
E581

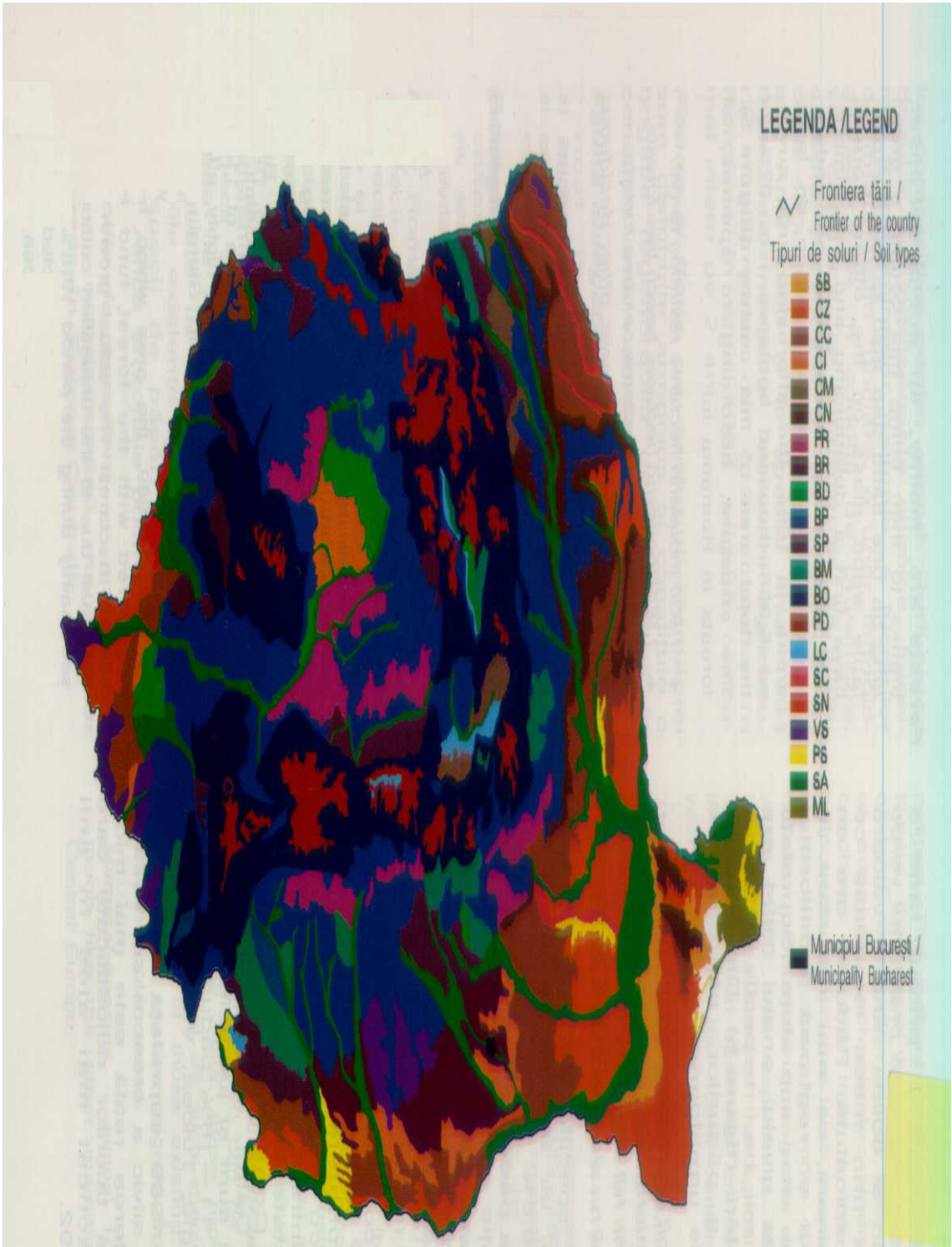
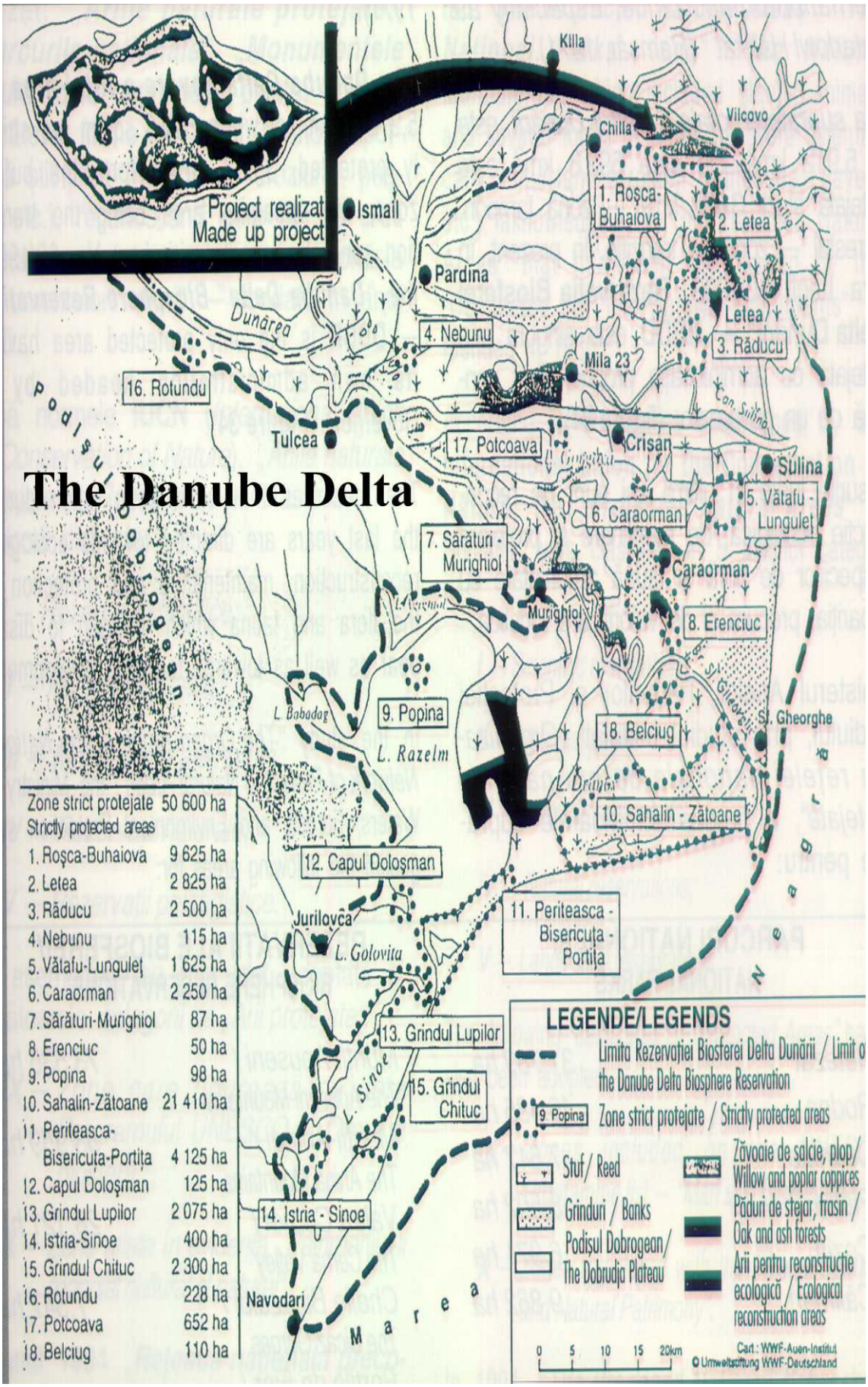


Fig. 3. Harta tipurilor de soluri dominante/ Map showing the dominant soil types
SB – sol bălan; CZ, CC, CL, CM – cernoziomuri; CN – sol cenușiu; BR – brun roșcat; SP, PD – soluri podzolice; SC – solonceac; SN – solonețe; PS – samsol; SA – sol aluvionar; ML – mlaștină /
CS – chestnut soil; chernozems; GS – grey soil; RB – reddish-brown soil; podzolized soils; SC – solontchak; SN – solonetz; PS – psamosol; AS – alluvial soil; M – marsh



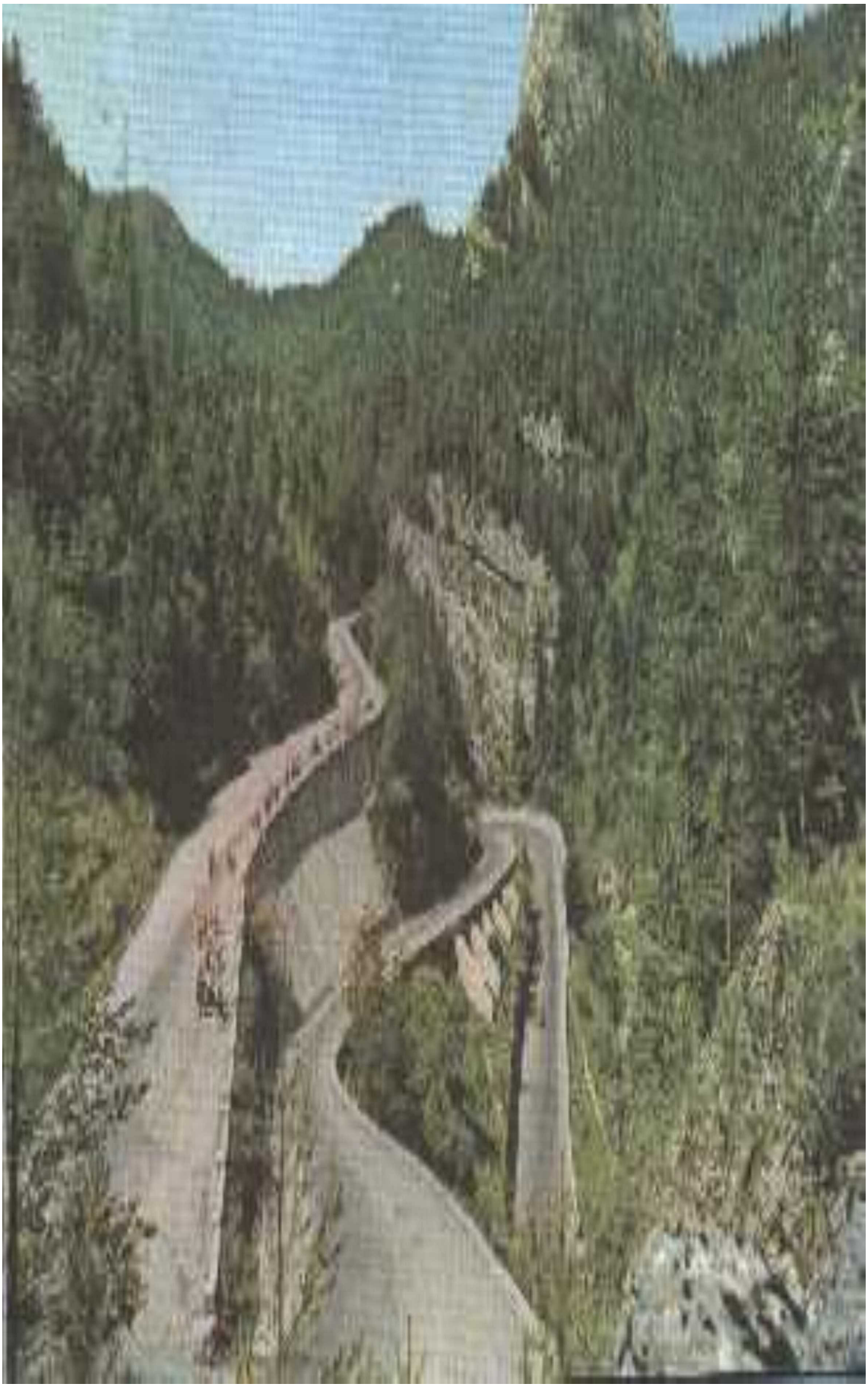
The Danube Delta

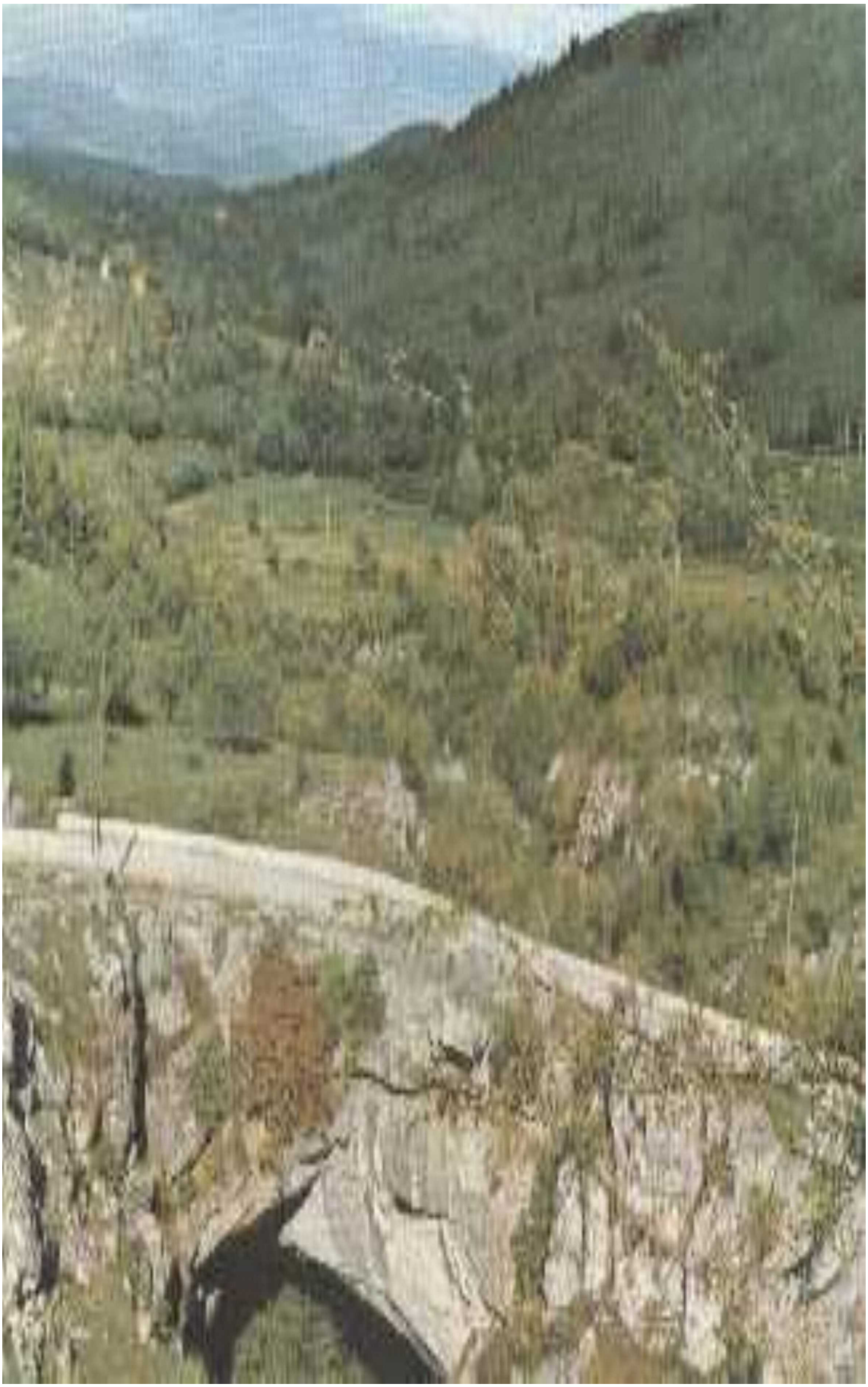
Zone strict protejate Strictly protected areas	50 600 ha
1. Roşca-Buhaiova	9 625 ha
2. Letea	2 825 ha
3. Răducu	2 500 ha
4. Nebunu	115 ha
5. Vătafu-Lunguleţ	1 625 ha
6. Caraorman	2 250 ha
7. Sărături-Murighiol	87 ha
8. Erenciuc	50 ha
9. Popina	98 ha
10. Sahalin-Zătoane	21 410 ha
11. Periteasca-Bisericuţa-Portiţa	4 125 ha
12. Capul Doloşman	125 ha
13. Grindul Lupilor	2 075 ha
14. Istria-Sinoe	400 ha
15. Grindul Chituc	2 300 ha
16. Rotundu	228 ha
17. Potcoava	652 ha
18. Belciug	110 ha

LEGENDE/LEGENDS

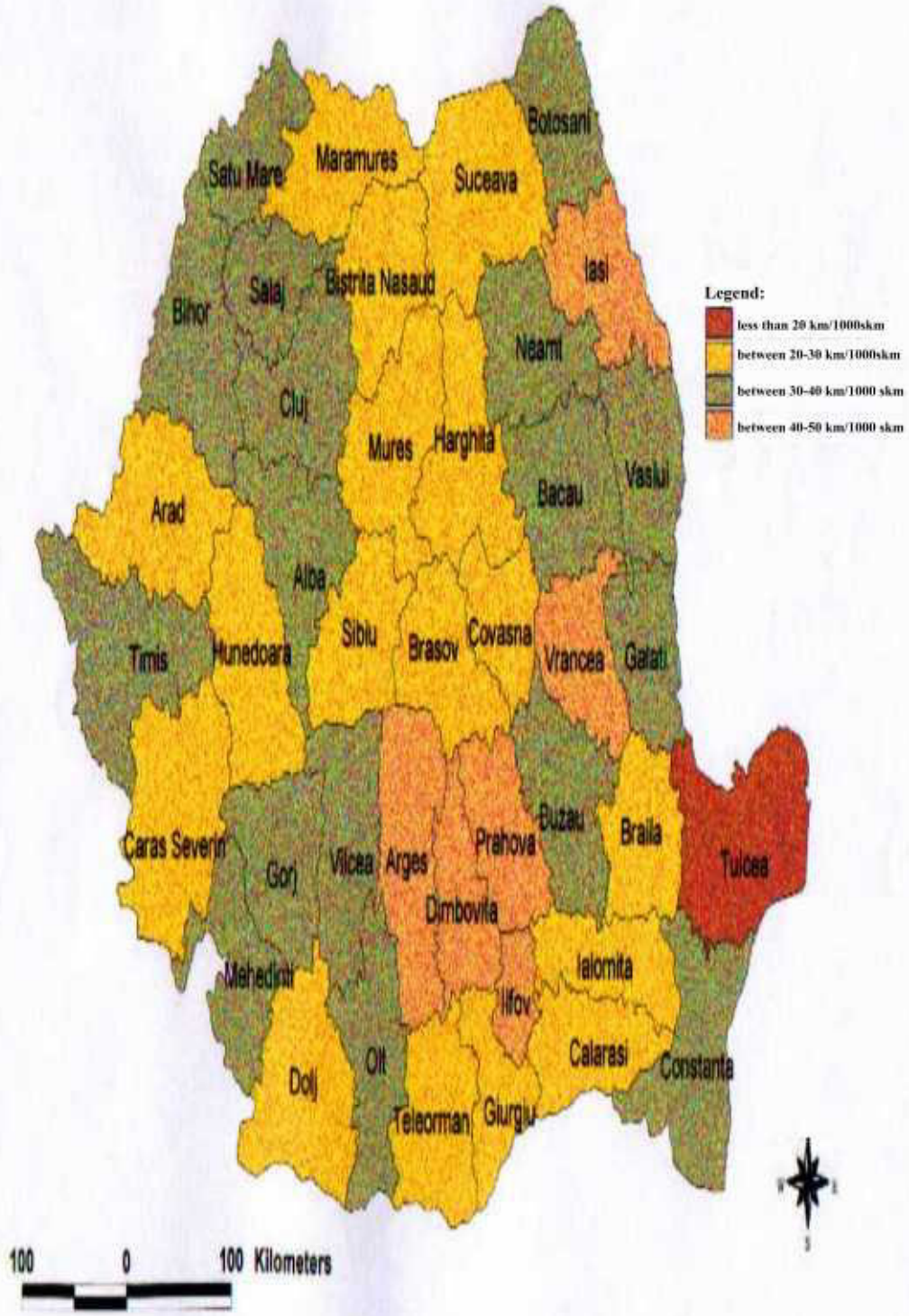
- Limita Rezervaţiei Biosferei Delta Dunării / Limit o the Danube Delta Biosphere Reservation
- 9 Popina — Zone strict protejate / Strictly protected areas
- Stuf / Reed
- Grinduri / Banks
- Podişul Dobrogean / The Dobrudja Plateau
- Zăvoaie de salcie, plop / Willow and poplar coppices
- Păduri de stejar, frasin / Oak and ash forests
- Arii pentru reconstrucţie ecologică / Ecological reconstruction areas

0 5 10 15 20km

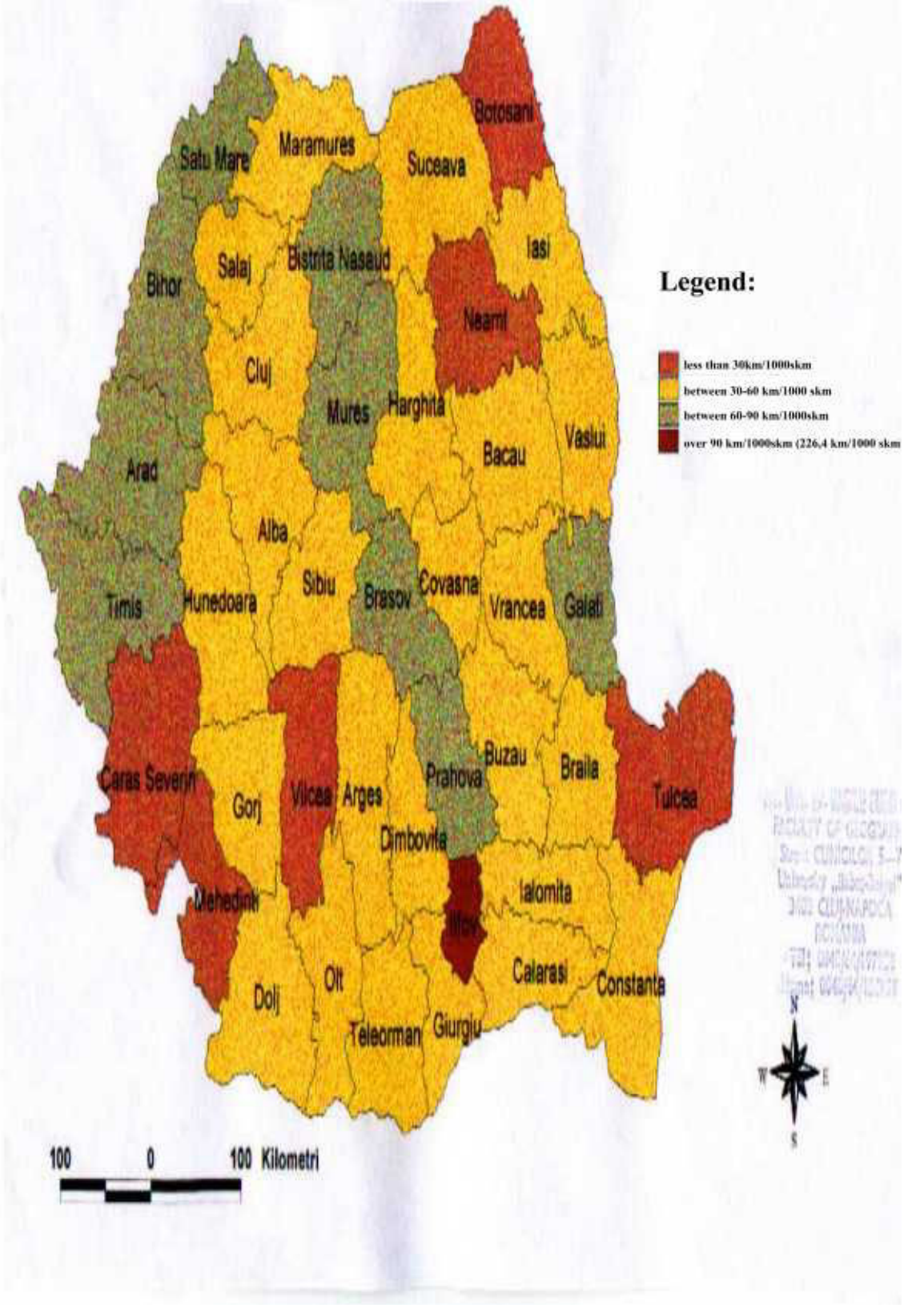


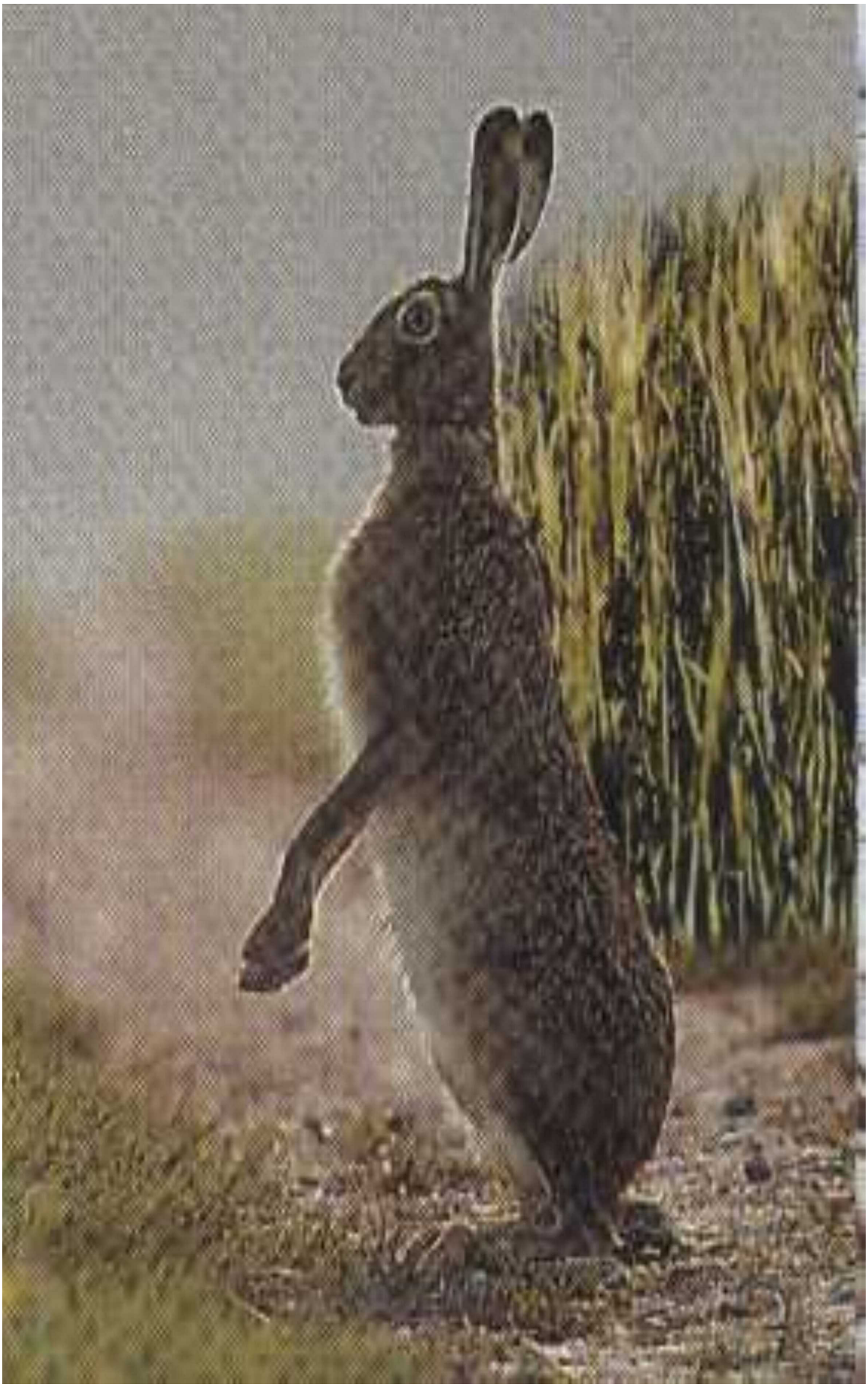


Public roads density in Romania

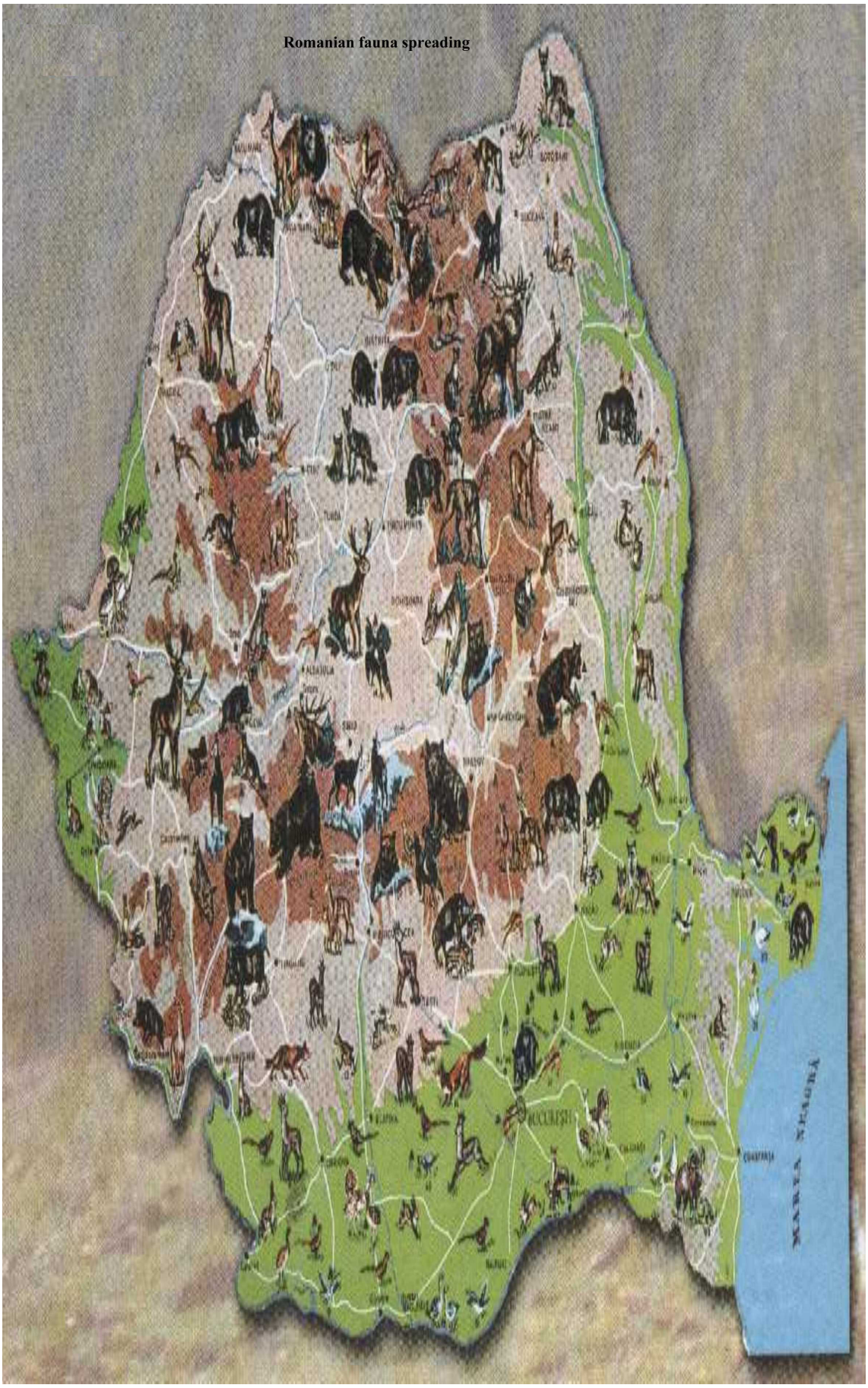


Railways Network Density

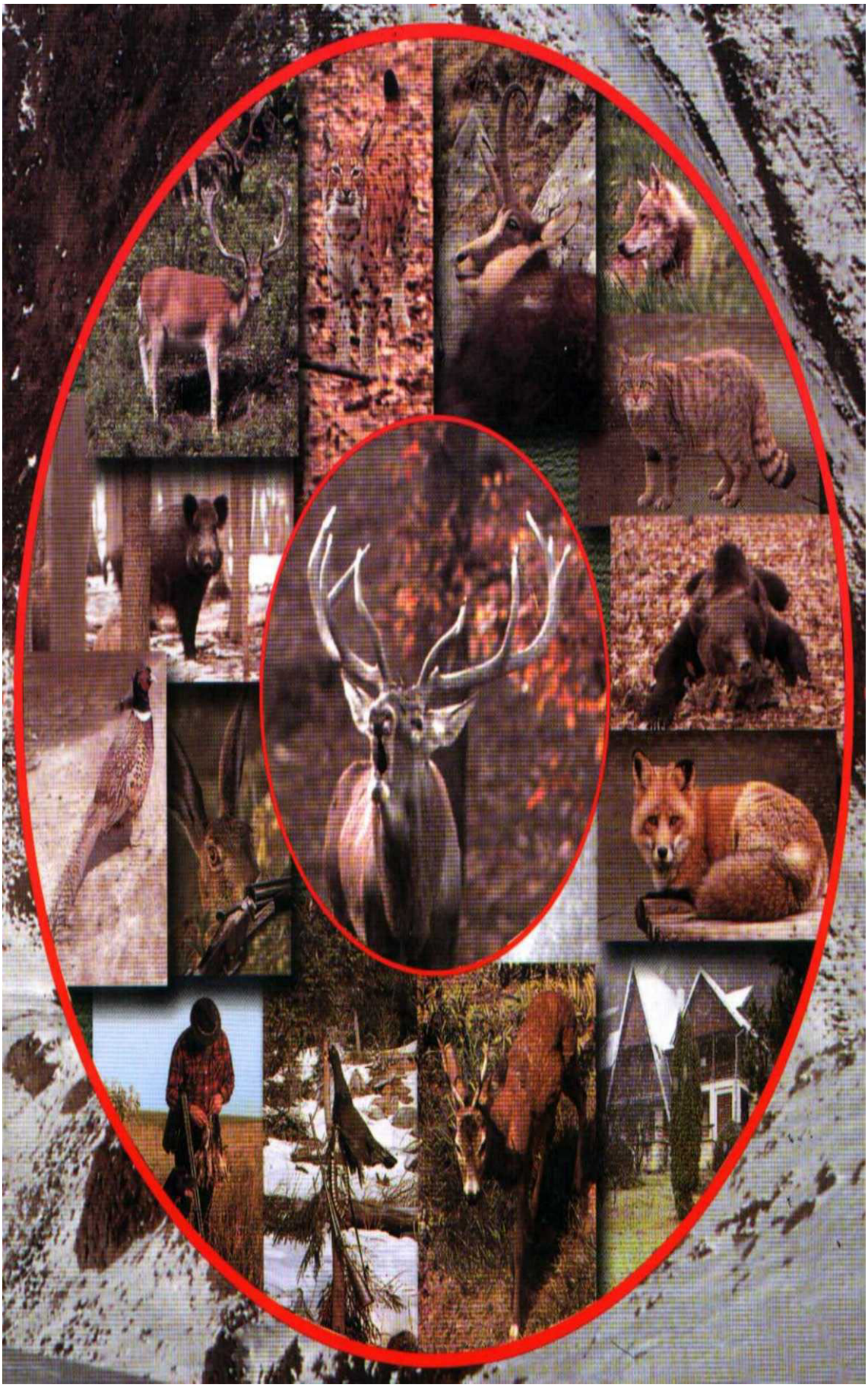


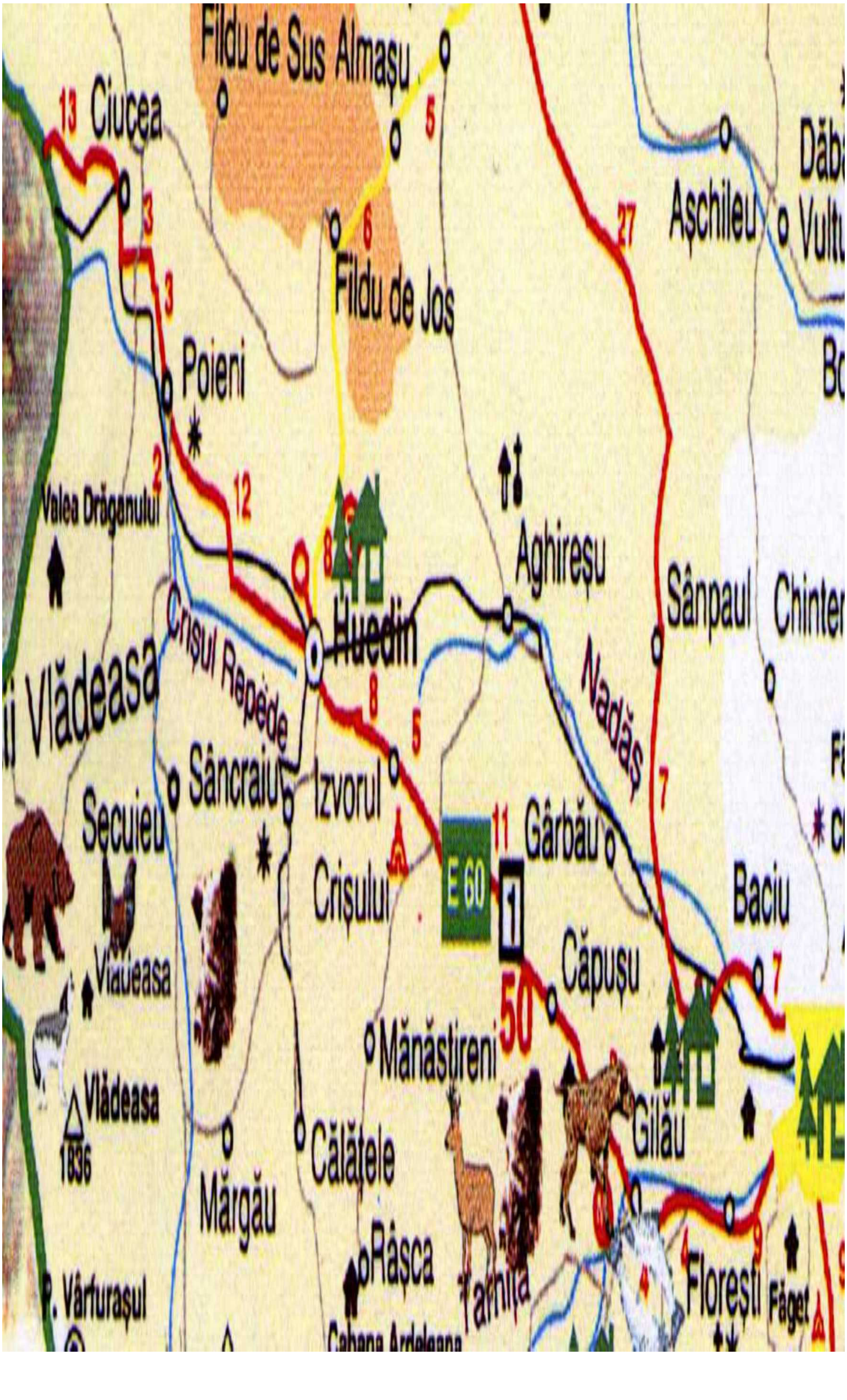


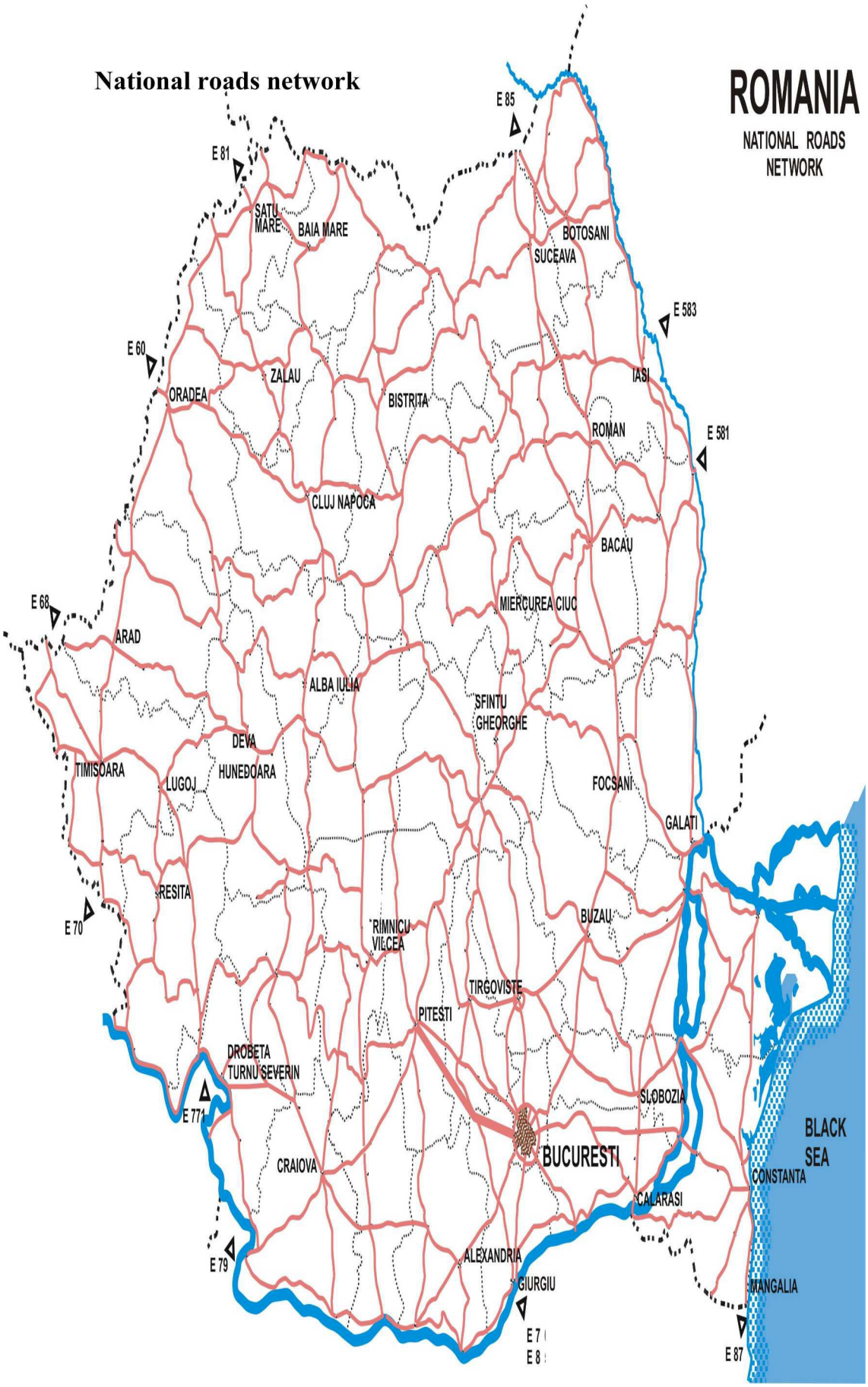
Romanian fauna spreading



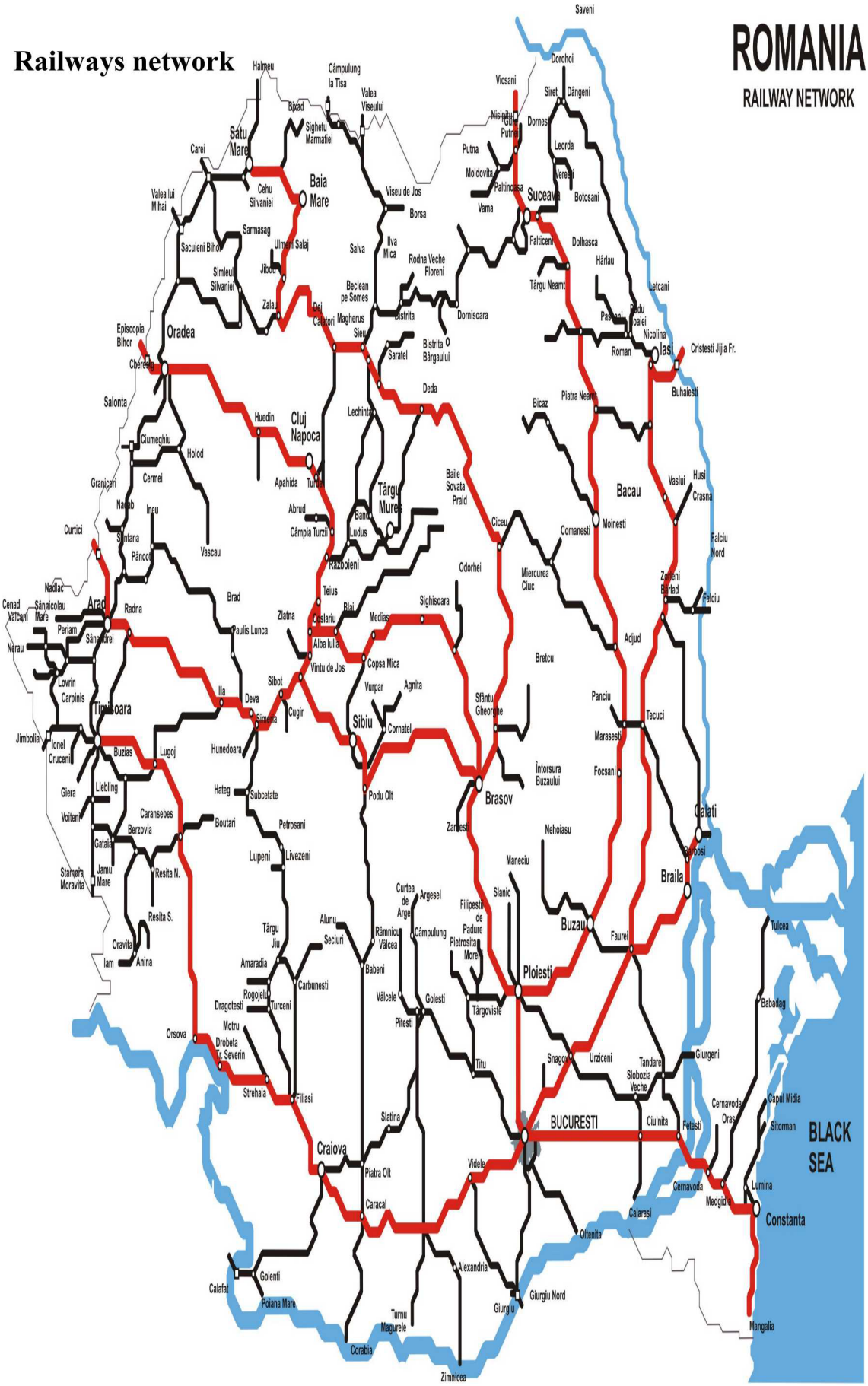

Cehu Silvaniei
Jibou
Şimleu Silvaniei
ZALĂU
Dej
Gherla
Huedin
CLUJ NAPOCA
Turda
Câmpia Turzii
Animals habitats within CLUJ county
Legend:
nursery
stag habitat
wild boar habitat
woulf habitat
trout preserve
deer habitat
bear habitat
forestry center
pheasant preserve
common dear habitat
capercaillie habitat



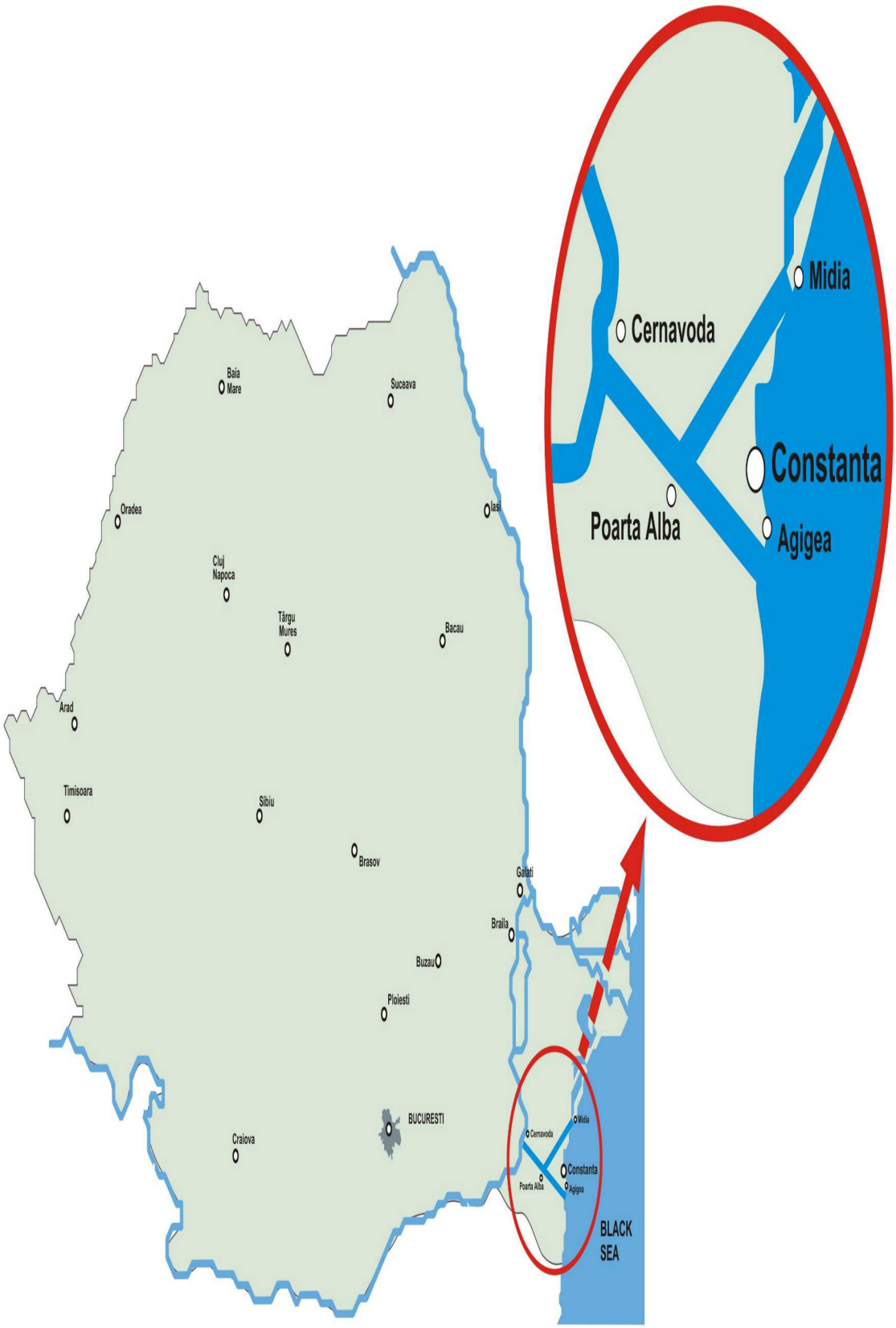

Fildu de Sus
Almașu
Ciucea
Așchileu
Fildu de Jos
Poieni
Valea Drăganului
Aghireșu
Sânpaul
Huedin
Crișul Repede
Vlădeasa
Nadăș
Sâncraiu
Izvorul Crișului
Secuieu
Gârbău
Baciu
E 60
Căpușu
Vlădeasa
Mănăstireni
Gilău
Vlădeasa
1836
Călățele
Mărgău
Râsca
Tarnița
Florești
Făget
P. Vârfurașul
Cabana Ardeleana


National roads network
ROMANIA
NATIONAL ROADS NETWORK
E 85
E 81
SATU MARE
BAIA MARE
BOTOSANI
SUCEAVA
E 583
E 60
ZALAU
IASI
ORADEA
BISTRITA
ROMAN
E 581
CLUJ NAPOCA
BACAU
E 68
MIERCUREA CIUC
ARAD
ALBA IULIA
SFINTU GHEORGHE
DEVA
TIMISOARA
HUNEDOARA
LUGOJ
FOCSANI
GALATI
RESITA
E 70
BUZAU
RIMNICU VILCEA
TIRGOVISTE
PITESTI
DROBETA TURNU SEVERIN
SLOBOZIA
E 771
BUCURESTI
BLACK SEA
CRAIOVA
CONSTANTA
CALARASI
E 79
ALEXANDRIA
GIURGIU
MANGALIA
E 87

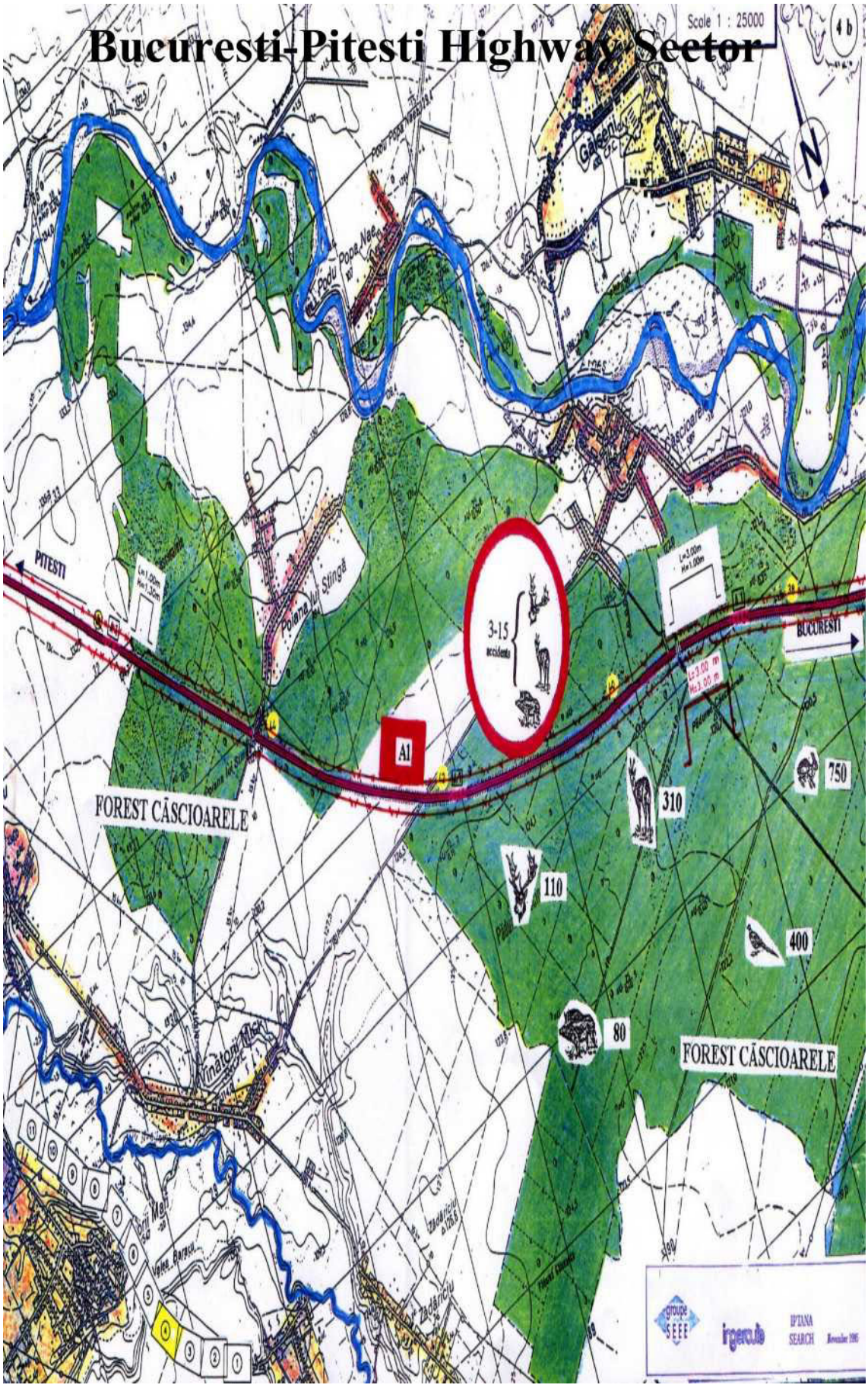
Railways network



Danube - Black Sea channel



Bucuresti-Pitesti Highway- Sector



European Road E576 sector

Local transport network development in northwesten Rom

Transport network development in Romania