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REVUE ROUMAINE DE GÉOGRAPHIE

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Etudes et communications

Comptes Rendus

ROCKS AND THE MORPHOMETRICAL DIMENSIONING OF DRAINAGE BASINS

ION ZĂVOIANU

Key-words: rocks, morphometry, drainage basins.

Le rôle des roches dans la morphométrie des bassins hydrographiques. L'auteur offre, dans l'introduction, un bref aperçu des préoccupations géographiques concernant le rôle des roches dans l'évaluation dimensionnelle des formes de relief. Ensuite, on analyse la résistance au cisaillement, définie par la loi de Coulomb et les classifications des roches, proposées par Protodiakonov et de l'ancien Comité Géologique de la Roumanie, rapportées à cette résistance. Afin de vérifier en quelle mesure est impliquée la résistance géologique dans les dimensions des éléments morphométriques des bassins de drainage, on analyse la liaison entre l'altitude moyenne des bassins hydrographiques de 5ème ordre et la superficie moyenne des bassins de premier ordre (selon le système Horton-Strahler), toutes les deux par rapport à la résistance géologique. Les bonnes corrélations obtenues prouvent le fait que la résistance géologique joue un rôle important dans l'évaluation des caractéristiques morphométriques des bassins hydrographiques.

Matters of genesis, evaluation and characteristic features of landforms have always stimulated geographical searchers to find out the factor, or factors, involved in dimensioning them, and possibly the degree of their involvement. From the multitude of physico-geographical factors, we shall dwell on rocks. The wide diversity of rocks, their effects on relief configuration and their usefulness for the society's economic life have focused the interest of at least two large groups of specialists: geographers and geologists.

The geographers' aim has been to detect, on the ground of logical explanations, the relationship between the huge diversity of landforms and the imense variety of rocks, their distinct physico-mechanical properties and resistance to the action of sub-aerial agents. At the same time, they endeavoured to decode the relief-held information imprinted in the course of time into the physico-geographical aggregates.

In 1930, Simion Mehedinți underlined in his work *Terra*, 2nd vol., the intimate connections between the composition of the lithosphere and landforms, illustrating his assertion with such rocks as granite, limestone, sandstone, clays, etc. In 1947, Nicolae Popp makes an in-depth study of the role played by rocks in the genesis of landforms. In 1951, Petre Coteț analyses the main properties of rocks (cohesion, massivity, heterogeneity and homogeneity, permeability and solubility) highlighting their importance for geomorphological research. The problem has often been resumed and treated at large in a great many fundamental works (Posea *et al.*, 1970; Naum, Grigore, 1974 etc.).

In their remarkable contributions, these authors point out the physical-mechanical and chemical properties of geological formations which, together with structure and position of the strata, are elements capable of individualising various types of relief.

Geologists, in their turn, have also dealt with quantitative aspects because they were interested mainly in the technical-economic side, of the physico-mechanical properties, with resistance to drilling perforation, and shearing stress in the first place. They devised, several classifications of rock, some of which are widely used by geographers, too, e.g. the genetic classification – magmatic, sedimentary and metamorphic rocks; scratch resistance: soft, medium-hard, hard and very hard rocks. Some authors go into greater detail, adding two more scales: weak and extremely hard, depending on the mono-axial compression of rock that goes from 1 to 200 (Todorescu, 1984). These classifications have in view primarily consolidated rocks, overlooking the quantitative classification of all rock types, unconsolidated ones included. Lauffer's classification (1958) is based on stability criteria – stable, fragile, very fragile, very friable, cohesive, and very cohesive, but ignores the quantitative parameters which actually distinguish these categories.

Proceeding from the intermediate strength of constitutive elements, Höfer & Stamatiu produced a classification of five large hardness-based rock groups (Mohs' scale) and their tear resistance to mono-axial compression.

In the geographer's view, rock resistance to the action of sub-aerial agents is a highly complex matter, because disagregation is caused by a great many factors, and current research has not the means to detect which one is most deeply involved. It has been observed that, depending on the response to the action of external forces in a portion of earthen banks, tear always occurs when shearing strength, i.e. the unitary tangential stress produced in a certain point and along a certain direction, is overcome.

Shearing strength (τf) is best expressed by Coulomb's law:

$$\tau f = s \cdot tg\varphi + c$$

where:

s = normal unitary stress exerted on the shearing plane

φ = angle of internal friction

c = rock cohesion

Viewing rock cohesion as the outcome of forces binding together the particles of a rock, or its aggregates, leads to a case of reversible and of structural cohesion. Reversible cohesion is an electric property characteristic of clay rocks. It is generated by the binding forces between mineral particles and the surrounding water film. Being water-dependent means that a higher quantity of water depletes clay cohesion, hence the well-known geomorphological consequences. This type of cohesion is also noticeable in sands, in the form of capillary cohesion occurring the moment the deposit has reached a certain humidity level. Determining it requires computing the difference between the maximum shear strength value and the value yielded by the saturated sand. It follows that capillary resistance gives sands a small shearing over strength, due to a higher moisture content (Florea, 1983).

Structural cohesion is specific of hard rocks because the natural cements binding the mineral particles during the very process of rock formation prove to be more resistant. In the case of clays, for example, structural resistance is higher in the older formations compared to the younger ones. According to Todorescu (1984, p. 496), rock resistance depends on the strength of inner grains, grain size and orientation to stress, binder strength, rock homogeneity or heterogeneity, water content, etc. In point of cohesion, rocks may be divided into two large groups:

– non-cohesive, with their shearing strength limited to the friction of mineral particles in rock (sands, gravels, boulders);

– cohesive, with their particles being maintained by the mutual attraction force between them.

Proceeding from the Coulomb-Mohs law, Protodiakonov defines shearing strength (f) by the following relations:

$f = tg\varphi$, for clastic rocks; (2)

$f = (c/s) + tg\varphi$, for cohesive-soft rocks (3)

$f = \delta/100.10^5$, for hard and semi-hard rocks (4)

where:

f = Protodiakonov's strength coefficient

φ = material friction angle

c = cohesion

s = unitary normal stress / contact surface

δ = tear resistance to mono-axial compression (N/sqm)

100.10^5 = strength coefficient (N/sqm).

Using the strength coefficient determined in this way (which varies from 0.3 with very soft rocks to 20 and over with extra-hard ones), Protodiakonov develops a ten-class and 15-category classification.

On the basis of the physico-chemical properties of rocks, age of formation and Protodiakonov's strength coefficient, Romania's Geological Committee worked out a classification, listing rocks into 6 groups and 12 categories.

In order to determine the extent to which rock has or has not a quantifiable role in setting the size of drainage basin morphometry, geographical research must make use of the findings of geological investigations. The resistance put up by the drainage basin area to the action of sub-aerial agents as a whole is by far more complex than rock strength alone. Let's recall the weathering processes –

absence of plant cover, presence of brittle and permeable rocks, intensity and frequency of torrential rain, steep slopes, landuse practices, etc. Some of the factors that can prevent denudation are the plant coverage, consolidated rock, the degree of erosion-resistance, the degree of permeability, the presence of mild slopes, etc.

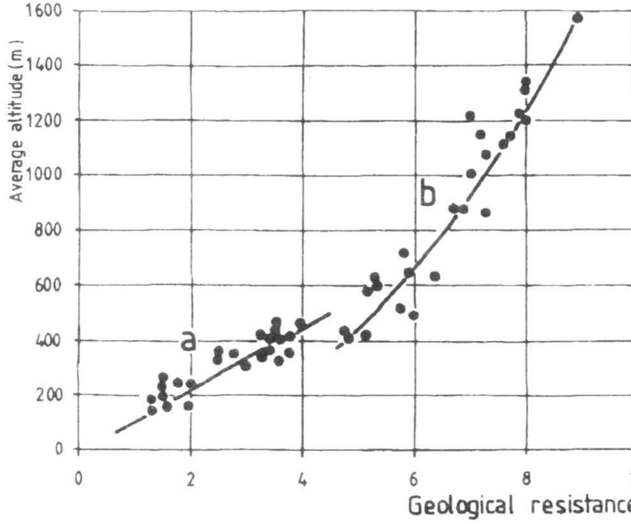
Since the present relief morphometry and configuration have been shaped over the time by the two groups of factors, it means that soil cover and weathering crust cannot cope for long with the action of solid flow and linear erosion. As elementary stream network is cutting its way into the soil profile, the latter becomes rapidly eroded down to the base rock. Therefore linear erosion resistance controls the whole erosion and transport activity of the channel network. The direct functional link between the average slope of a drainage basin's stream network and the average slope of the basin itself shows that the steeper the network slope, the sharper the slope of the basin as a whole. As a consequence, it might be assumed that the deepening of the stream network over an initially uniformly dipping area, increases stream network slope declivity, and implicitly the slope of the basin area, as a summation of slopes.

In order to estimate the extent to which the rock is or is not involved in this process of dimensioning morphometrical variables, we used the Geological Committee's classification, that groups the major rocks in this country by age and strength coefficient.

A first step was to identify the geological formations inscribed on the maps at the scale of 1:200,000, their age, the type of rock and category of strength. Next, planimetric procedures were used to obtain the area of each category of rock of a given strength. The basin area strength coefficient can be calculated by taking the mean of individual values as ponderated by the area. Establishing this coefficient for a sufficiently large number of basins has yielded a set of values that can be correlated with several drainage basin morphometrical characteristics. In this way, the direct relationships between the average slope of the stream network, and the average slope of the drainage basins, on the one hand, and geological strength, on the other, could be assessed. These relationships indicate two obvious situations: the case of non-consolidated rocks with a strength coefficient between 0.3 and 4, and the case of consolidated rocks with strength values of five (Zăvoianu, 1985).

In order to see whether geological strength between the two variables (Fig. 1a) is involved in dimensioning other morphometrical elements as well, we analysed, on the one hand, the connection between rock resistance and the average altitude of 5th- and 6th- order basins (Horton – Strahler's classification), and on the other hand, the average size of first-order basin areas, average length of afferent watercourses and geological strength coefficient.

Fig. 1 – Relationship between 5th order average basin altitude and geological resistance of nonconsolidated rocks (*a*) and consolidated rocks (*b*).



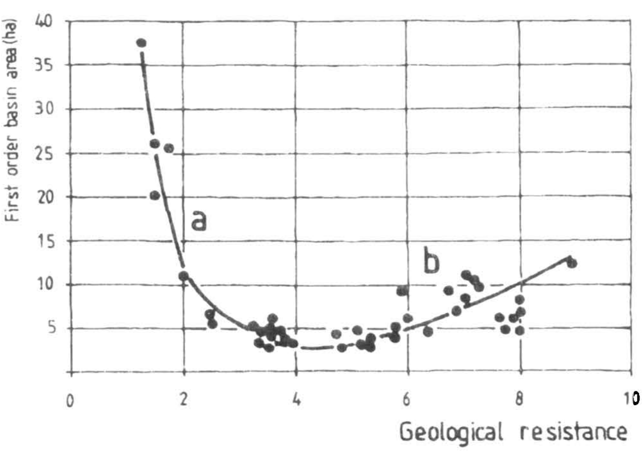
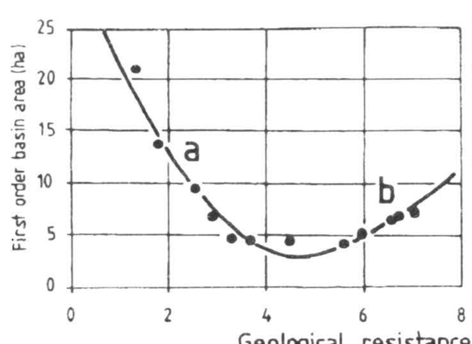


Fig. 2 – Relationship between first-order average basin area (within 5th-order basins) and geological resistance of non-consolidated rocks (*a*) and consolidated rocks (*b*).

Fig. 3 – Relationship between first-order average basin area (within 6th-order basins) and geological resistance of nonconsolidated rocks (*a*) and consolidated rocks (*b*).



The connection between average altitude and rock resistance was followed in the 5th- order basins of the Ialomiţa drainage system. The sample included 52 catchment basins situated at heights between 1,693 m (the Ialomiţa upstream its junction with the Brătei) and 150 m (the Ceptura upstream its junction with the Tohăneanca) with geological strengths of 8.96–1.3. Correlating the two variables shows a link between them, and at the same time, two characteristic situations. For basins lying in the lowlands, in the piedmont and the Subcarpathian areas (average alt. up to 500 m, geological strength coefficient below 4) the generalisation curve that is plotted expresses fairly well the connection between the two variables (Fig. 1a). With strength coefficient values over 5 and average alt. over 400 m, a second link curve, differing from the first one and showing greater value scattering, can be worked out (Fig. 1b). The latter type of correction is characteristic of basins modelled in the consolidated rocks of the Subcarpathian and mountain zones. A discontinuity interval between the two curves, i.e. between strength categories 4 and 5, can be observed. Like in other situations, it occurs at the passage from non-consolidated to consolidated rocks. With this basin order, discontinuity becomes very evident, which is not the case with higher-order basins, say 6, where it is hardly noticeable. Correlating the two variants for 6th-order basins, the link could be represented by a straight line with a fairly good correlation coefficient (0.943).

The connection between first-order basin average area and geological strength category was followed within the 5th- and 6th-order basins of the same Ialomiţa system. The first-order basin area is moulded by the aggregate of physical-geographical factors, human activity in the passageway included, each factor having a greater or smaller influence on dimensioning the area. The same elements may also set the length of elementary streams, which obviously depends on the size of the afferent area.

In order to assess the share of the geological strength coefficient in dimensioning these elements, several correlations were established for both 5th- and 6th-order basins. In this case, too, one encounters two distinct situations of the two rock types: non-consolidated and consolidated. In the case of non-consolidated rocks, the first-order basin area increases from 4–5 ha (Subcarpathian basins) to 37.5 ha (lowland basins), proportionally to the depleting geological resistance from 4 to 1.5. Lower resistance coupled with mild slope favours the increase of the first-order basin area in the piedmont and plain zones (Fig. 2a). In the case of consolidated rocks the situation is reversed, that is the first- order drainage area tends to increase proportionally to geological strength. So, if a first-order basin average area in poorly-consolidate deposits (strength category 5) is of 4–5 ha, it becomes twice as large with a strength category of 8 ha (Fig. 2b). However, the rate of basin area growth is by far smaller than strength increase. The discontinuity threshold between the strength categories 4 and 5 is obvious in this case, too.

When one works at a higher generalisation level, correlating first-order basin average area with the sixth-order basin geological strength coefficient, the relationship is still more striking. The two variables yield an inverse relation curve with non-consolidated rocks (Fig. 3a), and a direct relation curve with consolidated rocks, in which case growth is attenuated (Fig. 3b).

In conclusion geological strength plays an important part in dimensioning the morphometrical characters of drainage basins and on the channel network.

The less scattered the values, the stronger the connection between the two variables and the higher the share of geological strength; and reversely, the more scattered the values, the weaker the connection between the two variables, which is an indication that other physico-geographical factors are involved in dimensioning these elements.

The methodology of discontinuity between strength categories 4 and 5, when passing from non-consolidated to consolidated rocks, calls for a careful lest it should become linked to shearing strength determination methods, which work with three different formulae for clastic, cohesive-soft rocks, hard and semi-hard rocks.

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ON THE MATHEMATICAL MODEL OF THE DANUBE DELTA HYDROLOGIC SYSTEM

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Key-words: hydrologic model, Danube Delta, Romania, mathématique du système.

Le modèle mathématique du système hydrologique du Delta du Danube. Dans le Delta du Danube en tant que système naturel ouvert, d'une grande complexité, soumis à des interventions humaines très intenses, les processus hydrologiques qui se déroulent dans le sous-système hydri-que s'inscrivent parmi les agents naturels de la formation et de l'évolution du paysage.

Le sous-système hydrique comprend des éléments *autochtones* (la configuration morphohydrographique – bras, ruisseaux, canaux, lacs) et *allochtones* (les eaux du Danube), d'une part; des éléments statistiques (toujours la configuration morpho-hydrographique) et *dynamiques* (l'apport du Danube, agissant sur les éléments statistiques par l'écoulement liquide, solide, chimique et thermique), d'autre part.

Le modèle mathématique du sous-système hydrique comprend des données *d'entrée* (précipitations – X, débit du Danube – Y_1, apport souterrain – U_1) et de *sortie* (évaporation et évapotranspiration – Z, écoulement vers la mer –Y_2, écoulement souterrain – U_2) et s'exprime par l'équation: $\mathbf{X + Y_1 - (Z + Y_2) = +/- \Delta V}$ **où** $+/-\Delta V$ représente le volume d'eau gagné ou perdu par l'espace deltaïque dans l'intervalle analysé. Pour pouvoir établir le modèle mathématique du sous-système hydrique du delta on doit:

- connaître la capacité de stockage dans l'intérieur du delta;
- déterminer le débit d'entrée et de véhiculation dans les terrains marécageux et dans les lacs;
- identifier la vitesse de renouvellement des eaux dans les complexes lacustres par rapport aux processus d'accumulation/évacuation des nutrients et des polluants et du matériel organique produit sur place;
- prévoir le comportement écologique des écosystèmes liés à la circulation de l'eau;
- dresser plusieurs scénarios et variantes d'intervention dans la circulation des eaux en des situations critiques, ayant en vue la nécessité de conserver la biodiversité et de protéger l'environnement.

Par conséquent, le modèle hydrologique doit avoir les qualités suivantes:

- le modèle global doit inclure une structure modulaire pour les différentes complexes lacustres et pour les aires soumises à la rénaturation;
- il doit donner la possibilité de corrélation avec d'autres modèles propres au delta (par exemple le modèle biologique);
- il doit être flexible, en admettant l'introduction de nouveaux paramètres – le débit solide, chimique etc.

A discussion of the Danube Delta[1] hydrologic system, that is of water input, passage and output, means integrating it into the deltaic system as a whole, being essentially involved in shaping the physiognomy of the ecosystems.

[1] Here and in what follows, the 'Danube Delta' stands for the Danube Delta area proper, lying between the river arms, together with the Razim-Sinoie lagoon complex extending between Chilia bifurcation and the seashore, within the bounds of the Danube Delta Biosphere Reserve.

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Assumed to be an open and complex natural system, the Danube Delta has been suffering severely from human intervention to the effect of changes occurring in the canal network and between the lacustrine complexes; lateral embankments on the main arms of the river; agriculture farms, fish farms and forest plantations (all of which deprived some 30% of the area from the direct effects of the hydrological regime of the Danube).

The present pattern of the Danube Delta comprises several subsystems: hypsometric, climatic, hydrologic (hydrographic), biologic, pedologic and anthropic (human settlements and various types of management).

A classification of these subsystems into natural and man-made shows us that, the climate subsystem, through a few of its components (heat-radiation flow, precipitation, wind) could be viewed as a natural subsystem. The other subsystems (hypsometric, hydrologic, biologic, pedologic) have already been influenced to various degrees by the direct and indirect impact of human activity.

So, at present, the Delta system functions in a way under the influence of man. Therefore the issue of adjusting its hydrologic system should be addressed from this perspective.

Since the main goal is the conservation and protection of some ecosystems of the Danube Delta Biosphere Reserve, it follows that a major task is to try as far as possible and correct ecological disfunctions.

Unlike the other subsystems, the water subsystem plays a specific role within the Delta system. If the Delta did not lie at the mouths of the Danube and did not receive an inflow of materials and energy from the river's discharge (liquid, solid, chemical, caloric), to which the climate subsystem's elements specific to the temperate zone are added, then the biogeographical aspect of this area would be very much different, without any of its huge ecological diversity existing here.

Investigations have revealed the causes which have brought about the significant changes occurred in the functioning of the Delta ecosystems over the past two decades.

Analysing the interaction between the different units of the biocoenotic structures and the water factor have proved the overriding importance of the latter for the structure and functioning of biocoenoses (Cristofor *et al.*, 1985, Oltean, Nicolescu, 1985, Vădineanu *et al.*, 1985; Zinevici *et al.*, 1985; Vădineanu, Cristofor, 1986; Botnariuc, Vădineanu, 1988 etc.).

Similarly, the functional connections among the various biocoenotic components and the degree of water refreshment in lacustrine ecosystems has already been demonstrated (by multiple regression-based models) (Oltean, Gâştescu, 1985). Also, solutions for the distribution of discharge in some spatial subsystems of the hydrological system have considered (Gâştescu, 1966; Gâştescu, Driga, 1986, 1989; Gâştescu, 1993; Driga, 1994[2]).

[2] Driga, B. (1994), *Sistemul circulaţiei apei în Delta Dunării*, Doctor thesis (Mscr.), Romanian Academy, Institute of Geography, Bucureşti.

What is needed now is not so much identifying the components, but rather generalizing them into a mathematical model of the water system, correlatively with at least some elements of the mathematical models of the other subsystems.

Assuming that the huge determinant role of the Danube and of water circulation inside the Delta space has been proven and that any approach necessarily take into account the increasing impact of the human factor both as regards the direct quality of water input and the direct changes operated inside the Delta, let's proceed furthermore.

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The water subsystem consists of *autochthonous* and *allochthonous* elements, of *static* and *dynamic* aspects of their manifestation, of their functioning respectively.

Under *autochthonous* components we shall list the morphohydrographic whole of the Delta area: the main Danube arms (Chilia, Sulina and Sfântu Gheorghe), canals and backwaters linking the arms and the inner spaces, the lakes and the lacustrine complexes, as well as the sea waters in front of the Danube.

There is only one major *allochthonous* component: the Danube.

Static aspects are due to the lakes and lacustrine complexes, backwaters, channels and arms together with their morphometric dimensions. *Dynamic* aspects are the consequence of the liquid, solid, chemical and caloric discharge before the Danube enters the Delta, on arms and canals, as well as flow speed, variations of the level and variations of the whole water volume within the inner Delta.

The Danube discharge, together with its four components (water, alluvia, soluted mineral salts, caloric energy, expressed in water temperature) plays a very important role, both in point of materials and energy, the former (the liquid, and chemical discharge) being by far greater and more significant that the latter in shaping the physiognomy and functioning of the Delta system.

The multiannual means of the four Danube water components at the point where the Danube enters the Delta are the following: water volume 204.5 cu km/year; alluvia = 58.75 mill. tons/year; soluted salts = 90 mill. tons/year; caloric energy = 2,576.1 $\times$ 10^{12} kcal./year.

Some 93–95% of these values are carried directly into the sea through the three arms and only 5–7% is left to run into the inner areas through the network of backwaters and canals, or to flow directly over the banks in times of high water (10–14.3 billion cu m/year). This water volume is partially stored in lacustrine depressions and reed plots for 3–9 months/year, contributing thereby to the development of biological processes peculiar to the ecosystems of lakes and swamps.

One may safely say that, with the exception of a few areas (Chilia field, Letea and Caraorman levees), there would be no delta and deltaic evolution if the Danube's liquid and solid discharge were missing.

The mathematical model of the deltaic water system is expressed by the generalized form of the water balance equation. One part consists of inputs (I) and outputs (O). The balance between these two terms is measured by the water volume (V) stored at a given moment in relation to a previous moment. It can be written as +V or –V. Hence, the relation reads:

$$(I - O) = +/- V \qquad (1)$$

Each of the two terms of the equation is outlined by several components, namely:

– precipitation's fallen on the surface of the system (X);

– evaporation and evapo-transpiration within one and the same unit (Z);

– water inflow due to the Danube discharge (Y_1);

– discharge to the seashore through the main arms and other small waterways (canals and backwaters), or even through low levees when there water levels of the Delta are high (Y_2);

– underground contribution (U_1) and loss (U_2) are negligeable.

The above-mentioned components fit into the following relation:

$$X + Y_1 + U_1 - (Z + Y_2 + U_2) = +/- V \qquad (2)$$

At present it is possible to a certain extent for the components of the water balance equation to be expressed in quantitative terms because some of these components (X, Y_1, Y_2) have been measured for very many years now. Measurements of evaporation and evapo-transpiration (Z) have not taken that long.

Measurements of component Y_2 prove to be more relevant for the three main arms (Chilia, Sulina and Sfântu Gheorghe); they are simply estimates in the case of the canals and backwaters through which the water flows into the sea, and when we deal with the random flow over littoral levees.

In the conditions of the Delta climate, with evaporation and evapo-transpiration (Z) two or three times the precipitation value (X), the water balance becomes deficitary. Hence, the need for linking the inner Delta areas with the Danube arms to activate water circulation through them.

In the specific geographical environment of the Danube Delta, the two components yielded by the input (I) and output (O) of a certain water volume from the system, capable of securing a corresponding ecological and trophic level, acquires an overriding importance. We wish to underline the relevance of the Y_1/Y_2 ratio for the Danube Delta water balance, because the application (or extrapolation even) of some mathematical models devised for other deltas (e.g. in sub-polar or inter-tropical humid zones, where Y_2 can be controlled and sized by the X/Z ratio, might prove counterproductive in our case.

Even the Danube discharge to fall into normal quality parameters, it would still be necessary to single out those limit thresholds for the normal development of the ecosystems annual cycles.

Nowadays this matter has acquired greater urgency because the amount of nutrients and polluants has grown alarmingly.

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Before stating some of the requirements for a mathematical model of the Danube Delta hydrologic system, let us overview its main features and functions when interconnecting with other processes or subsystems of the deltaic system.

It ought to be remembered that:

– water circulation inside the Delta and the lagoon complex represents a basic factor that governs many fundamental ecological processes. These processes are ultimately reflected in the quality of living conditions, biological output and geomorphological evolution of interior basins;

– the Delta water alluvia-rich flow to the Black Sea is an essential factor in shoreline accretion and retreat;

– given that no more than 5–7% of the Danube discharge runs through the Delta, the filtering function of the internal ecosystems raises doubts as to the Danube Delta's capacity to protect the quality of the water that flows into the Black Sea; so, the essential link between the Delta-water-system-sediment-carrier function and the process of alluvia sedimentation is basically achieved in the coastal marine environment;

– the bioproductive and the morphodynamic processes in the internal Delta ecosystems develop in direct relationship with its water system. Therefore, a good knowledge of and control over the relation between the structure and functioning of the hydrologic subsystem and the above processes should underline any ecosystem conservation strategy, as well as the use of renewable resources and intervention into the structure of the water system;

– the distance from the supply source (viz, the Danube waters) and the lacustrine ecosystems (store-house zones for sediments and nutrients) is of overriding importance. These ecosystems are known to benefit from long distances and from the occurrence of filter-acting swamp ecosystems.

It follows that:

– in controlling water circulation, the solution would be to create some long internal waterways from the Delta toe, e. g. the former Sireasa canal (now closed up) for the area stretching between the Chilia and Sulina arms, and Litcov (re-opened in 1992) for the expanse between Sulina and Sfântu Gheorghe arms (the first scheme is due to Antipa, 1914);

– short canals (e. g. Mila 35, Arhipenco, Crânjală, Mila 23, Crişan-Caraorman, Filat, Uzlina) must be closed up completely or re-dimensioned because they represent a direct route for the excedent of nutrients, and moreover Danube sediments to flow into the lacustrine ecosystems, contributing (by the formation of submerged alluvia fans) to the silting of the lake ecosystems (see the case of lakes Lungu, Tătaru, Meşter and Furtuna between Chilia and Sulina arms or Gorgova, Gorgovăţ, Uzlina, Iacob, Puiu and Roşu between Sulina and Sfântu Gheorghe arms);

– a method should be devised to reduce the number and length of canals and backwaters with a two-way water circulation and increase the one-way water flow through the Delta. This could lead to ecological improvements and help identifying the thresholds on which water circulation is reversed in terms of the water level variations at Chilia bifurcation and in other crucial points for each ecosystem in part;

– an analysis is necessary of the possible solutions for organizing the Delta system internal water circulation by means of hydrotechnical constructions and managements capable of ensuring, with normal water levels, an efficient control of water circulation and acceptable evolution of the ecosystems.

Elaborating a mathematical model of the Delta hydrologic system, testing and adjusting it relies basically on a number of observations; these are insufficient so far both as length of observation period and density of the observation network are concerned.

Hence, the need for setting up a water measurement network inside the Delta area to provide necessary and sufficient data based on which the model could be worked out and readjusted. This might become a first working stage regardless of whether the present model is going to be adopted, or a new one shall be devised.

Furthermore, the water measurement network should remain operational as a groundwork for the Danube Delta water monitoring system.

As importantly would be to have some useful data reintroduced into the analysis (primarily those yielded by hydrochemical and hydrophysical assayings) which, if adequately selected, could guide the establishment of some premises for elaborating a model of the water subsystem; we are referring particularly to those points involved in connecting it with the models of other subsystems. Similarly, some hypotheses, already formulated, concerning the positive correlation between the degree of water refreshment and nutrient storage in the deltaic ecosystems, ought to be verified.

*

The state of the art in the Danube Delta is given by the X/Z ratio (precipitation fallen on the surface of the system/evaporation and evapo-transpiration in one and the same unit) scoring values between 0.25 in the reed plots and 0.35 on the lakes; the amount of nutrients (nitrates and phosphates having increased by 1.7 and 1.5 times, respectively) eutrophication has been enhanced.

In view of the above, the primary aim of the Delta hydrologic system model should be water circulation within the Delta area and the rate of water volume refreshment in the lake systems (the ones most affected by eutrophication).

The building of the model must proceed from the idea that beyond the performance *per se*, it ought to meet several concrete requirements such as:

– determine water storage capacity in various units, according to the hypsometric structure of the respective zones;

– establish the necessary discharge when entering the longitudinal canals, in order to ensure the water supply of the lakes and maintain a satisfactory circulation in the lacustrine systems;

– identify lacustrine complexes water refreshment rates in terms of the accumulation/evacuation of nutrients, pollutants and *in situ*-produced organic matter;

– forecast the ecological behaviour of ecosystems whose dynamics and evolution are strongly and directly dependent on the water system dynamics;

– simulate scenarios and variants of optimum modalities of intervention in the water system, with a view to modifying it for whatever reasons;

– interpret physical seashore changes in terms of the Danube-carried sediment. In order to meet these indispensable demands, the mathematical model needs have a few qualities in the absence of which its efficiency becomes questionable;

– the global character of the model and its elaboration for the deltaic system calls for a modular structure so that its space modules could be:

– detached and function separately;

– detached for correction, change, or exclusion in case any action of, say rehabilitation or/and depletion of the natural water regime of a zone might require a modification of the local model;

– the model is expected to be readily interconnected, toward the outside, with models of other systems (primarily with the biological subsystem);

– the model is assumed to be flexible in the interior and allow for the analysis of other components beside liquid discharge: we have in mind submodels of sediment and chemical discharges;

– the model should be concordant with the structural complexity of the water system and of its spatial subsystems, at the same time observing some very important characteristics like the following:

– reversibility of water circulation on most internal waterways (canals and backwaters);

– the frequent occurrence of multiple water input/output from spatial subsystem;

– the possibility for the water to flow in, transit and flow out 'in sheets' over the low banks or levees during high flood periods.

To sum up, we would say that a mathematical model of the water system which fails to be correlated with the mathematical models of the other subsystems lacks relevance, hence it has no ecological applicability.

Irrespective of whether it is a deterministic model (based on statistic-type equation systems) or a simulation model built on other mathematical foundations, it must have a forecasting value useful to long or short-term decision-making.

It limited to the administrative boundaries of the Danube Delta Biosphere Reservse alone, without including also the spatial subsystem of the secondary Delta of Chilia, the mathematical model of the water subsystem would remain incomplete from a spatial viewpoint, being incapable of solving the major problems raised by simulating marine coast evolution.

There is no doubt that the model best suiting the above requirements and conditions will best correspond and, perhaps, be better adjusted to the needs of the hydrologic system of the Danube Delta; on the other hand, some of the specific features of this model might call for the elaboration of a special model, in terms of local conditions, built accordingly to a sequential-type pattern in the course of its elaboration and testing. But whatever the solution, it is certain that applying the available mathematical models comparatively and testing them in the case of the Danube Delta water system would be a highly rewarding endeavour.

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THE PRE-PARATETHYS BURIED DENUDATIONAL SURFACE IN ROMANIAN TERRITORY

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Key words: palaeogeomorphology, fossil relief, denudational surface, hydrocarbon field, Romania.

La surface de dénudation enfouie de la pré-Paratéthys sur le territoire de la Roumanie. Par la surface de dénudation de la pré-Paratéthys on comprend l'ensemble des formes de relief issues pendant l'émergence de la quasi-totalité du territoire de la Roumanie, correspondant aux mouvements styriques, donc la surface recouverte aujourd'hui par les eaux de la mer Paratéthys. Le relief «cacheté» de cette surface de dénudation hétérochrone s'est formé par érosion et modelé karstique. Au Badénien supérieur mais surtout au Sarmatien et moins au Méotien se sont produits des mouvements verticaux de sens contraire, ce qui a déterminé la déformation de la surface initiale. Par conséquent, la surface de la pré-Paratéthys (Fig. 1) nous paraît déformée, l'ampleur des déformations atteignant 10 000 m. Les perturbations des isohypses sont dues aux facteurs tectoniques et à la configuration des paléoreliefs enfouis. Les cartes de détail mettent en évidence aussi d'autres aspects du relief fossilisé, comme par exemple:

-- dans la partie orientale, moldave, du pays, des segments du réseau hydrographique d'avant la transgression badénienne (Fig. 2); les étapes de la fossilisation d'une crête montagneuse (Fig. 3A, 3B) etc.

– un cuesta imposant (le promontoire Bordei Verde) dans le compartiment sud de l'avant-pays, correspondant à un plan de charriage qui sépare deux aires aux styles géomorphologiques différents (Fig. 4); une vaste zone à formes karstiques fréquentes, représentées, surtout, par des paléodolines drainées (Fig. 5A, 5B); un immense bassin hydrographique, y compris un imposant cañon, dont la longueur est de 100 km et la profondeur de jusqu'à 2 000 m. Ceci se prolonge, au sud, sur le territoire de la Bulgarie et fut dénommé la vallée du paléo-Jiu (Fig. 6), etc.;

- la bordure orientale de la dépression Panonnienne, aux nombreux golfes et crêtes enfouies, l'énergie du paléorelief y atteignant des valeurs de 3 000 – 3 500 m (Fig. 1), etc.

La surface de dénudation fossilisée s'est montrée un important objectif d'intérêt pétrolifère et gazéifère, qui polarise environ 170 champs de production découverts jusqu'à présent (Fig. 1).

The territory of Romania passed through a long-period of palaeogeographical evolution marked by a succession of glypto-genesis phases.

The denudational surfaces formed throughout that period, show a wide diversity of land forms. Episodes of emergence kept alternating with phases of sedimentation, and pre-existing reliefs were buried (fossilised). The frequency, intensity and duration of denudational processes in Romanian territory varied in time and space in keeping with the dynamic of sedimentary basins and the tectonic regime of the areas making up Romania.

Before dealing with the subject proper it is necessary to specify the following:

– A denudational cycle is the time-interval in which a region begins emerging, ending up by being covered with the waters of a sedimentation basin, whatever the temporary or local variations of the basic level at the time of emerssion;

– The palaeogeomorphological evolution must be referred to the geological units and not to the present geographical units, which do not overlap those of the remote past;

– Setting the rank and name of denudational surfaces ought to follow the principle used by the lithostratigraphical terminology, namely local (limited) areas are named after settlements, hills, or valleys, while regional or continental expanses bear the name of waters (rivers, seas);

– While field observations have revealed the existence of numerous phases of sub-aerial modelling, the mapping of a buried relief is the exclusive contribution of geophysical surveys (seismic, in the main) and drillings. Studies of buried palaeoreliefs in Romania are 40–45 years old. The number of investigations conducted over that interval is quite impressive: seismic surveys: ca 250,000 km of profile; drillings: about 30,000 wells; well logging over 50,000; complex analyses of around 300,000 rock samples and more than 2,000 geological-geophysical reports and studies. The rationale behind that huge material and intellectual effort was of an economic nature: the palaeorelief could be a favourable environment for the formation of oil and gas deposits.

The present paper gives a brief account of the expansion and characteristics of a fossilised peneplane, namely, the pre-Paratethys surface. Formed during the Styrian movements, it became buried under the Badenian and/or Sarmatian-Pliocene deposits of the Paratethys basin. To give a complete and detailed description of this palaeogeographical image means writing a several-volume work.

Beginning with the Palaeocene, the waters of the Tethys Sea started gradually retreating towards the boundaries of the present basins (Saulea, 1967); maximum land expansion was registered during the Styrian phases. This process, which vided the old Tethys Sea, brought up the land, and revigorated denudation. The freshly emerged land, together with pre-existing patches, were circumscribed to the Carparhian realm and its Foreland. The new realm of sub-aerial modelling stretched beyond the present frontiers of Romania, to the Pannonian Depression, the East of the Mediterranean Sea, the present Black Sea basin, etc. The denudational area acquired thus continental dimensions.

The process of sedimentation continued, over small areas, only in the Carpathian Foredeep and in the North of Transylvania.

The land, that had existed before the Tethys Sea, was represented by the part of the crystalline massifs of the Carpathians, of Northern Dobrogea (the North-Dobrogea Promontory included) and by some portions of the Central Dobrogean metamorphites. Presumably, they had functioned as immersed areas since the pre-Triassic times. In a contradistruction, least five fossilised denudational peneplains had formed successively at their periphery (Paraschiv, 1991). These old immersed areas represent 'perennial denudational surfaces' and not polycyclical surfaces, because the term 'polycyclic' implies that the respective palaeoreliefs had experienced some fossilised phases. The whole space of the Carpathian Foreland emerged from under the waters of the Cretaceous and/or the Eocene. At approximately the same time (up towards the end of the Savian phase), Cretaceous and Palaeocene Flysch areas began (with a few exceptions) uplifting, the pre-Paratethys denudational cycle generalising during the Burdigalian-Lower Badenian. Hence, the heterochronic character of the pre-Paratethys denudational surface, overlying variously-aged geological deposits as follows:

- in the Carpathian Mts.: metamorphic, Jurassic, Cretaceous and Palaeocene deposits;
- in the Moldavian and Moesian Platforms: Jurassic, Cretaceous and Eocene;
- in the North-Dobrogean Promontory and in Central Dobrogea: metamorphites, Palaeozoic and locally also Eocene deposits;
- in the Transylvanian Depression: Triassic, Jurassic, Cretaceous, Palaeocene and Lower Miocene;
- in the Pannonian Depression: metamorphites, Palaeozoic, Triassic, Jurassic; Cretaceous, and Lower Miocene deposits.

Therefore, the oldest formations in Romanian territory, constituting the support of the pre-Paratethys fossilised denudational surface, are the metamorphites; the youngest deposits are of a Lower Miocene age.

At the beginning of the Badenian, a much larger part of the denudational lands registered negative vertical movements. They were associated with ruptural processes that led to the formation of grabens and horsts, especially towards the Eastern margin of the Pannonian Depression. After these movements came to an end, the waters of the Paratethys Seas invaded the area, fossilising the previous landforms.

The first transgression phase, i.e. in the Lower Badenian (Langhian), covered the Carpathian Foredeep, the Transylvanian Depression, and the Orăştie basin (Voicu, 1981). The second phase, corresponding to the Upper Badenian (Kesovian), invaded the Carpathian Foreland and the Pannonian Depression, together with the Timiş, Mureş, Criş, etc. passageways. But for often local ingresses, the Paratethys realm kept extending until the end of the Pliocene.

In the beginning, the sea stretched along palaeovalleys and grabbens, subsequently flooding the interfluves and the horsts. Some crests were buried only in the Pliocene, whereas other ridges, e.g. on the Eastern margin of the Pannonian basins, have been left uncovered to this day (Făget Mts., Măgura, Şimleu Silvaniei Hills etc.). As Sea invasion here was swift and non-abrasive, pre-existent forms could be conserved and sealed off such as they had initially stood.

According to deposit age at the pre-Paratethys bottom and cover, the modelling of the area lasted between 3 and 5 million years (where the bottom is represented by Miocene sediments) and up to over 220 million years where modelling involved pre-Mesozoic horizons. In fact, the majority of the surfaces denudated prior to the Paratethys transgression would emerge from under water during the Palaeocene (particularly the Carpathian Foreland) and the Lower Miocene. Their modelling lasted from 5–30 mill. years up to 50 mill. years.

Towards the end of the Cretaceous and in the Early Palaeocene, the climate showed signs of cooling. In the Getic Depression Eocene deposits one frequently encounters *Litothamnium nummuliticum*, a species characteristic of the shallow waters of a warm sea. The Oligocene features by a wealth of *Pinaceae* and *Taxodiaceae* (Sequoia) forests, which is an indication of a warm - to - temperate climate transition. Trees with caduceus leaves are suggestive of a seasonal distinction, presumably there was a rainy, and a droughty season. The Lower Miocene flora was dominated by *Taxodiaceae*, *Cupressaceae* and *Pinaceae*. The temperate climate evolved up to and after the Badenian. The Sarmatian is supposed to have recorded seasonal variations of temperature. The Pliocene climate was temperate, semi-continental with tropical traits, especially during its lower part (Paraschiv, 1967).

According to geophysical and drilling data, the major landforms developed during those palaeoclimates were of an erosional and karstic type.

Maps of the pre-Paratethys buried denudational area isohyps have been worked out on the scale of 1:25,000 and further synthesised on the scales of 1:50,000; 1:100,000 and 1:1,000,000. Because of the scarcity of information, detailed maps for the NE of Moldavia could be drawn only at the scale of 1:50,000.

The denudational area of several other zones, eg. Southern Dobrogea, Balta Brăilei (Brăila Swamp), the inner flank of the Carpathians and a few intra-mountainous basins, could not be mapped at all because in the first two units seismic investigations are missing nearly altogether and drilling holes are few. The Carpathian Foredeep of the pre-Paratethys surface appears much broken due both to diapiric and folding movements, and to the post-Miocene denudation (Paraschiv, 1965).

Before discussing the map of the pre-Paratethys buried surface, a few remarks should be made, namely:

a) in the Upper Badenian, mostly during the Sarmatian and less so during the Pliocene, vertical movements, of different intensities and sizes took place throughout the territory of this country. As a consequence, the initial surface suffered deformations. The units of the Foreland in particular underwent fracturing, the vertical throw of the faults occasionally exceeding 1,000 m;

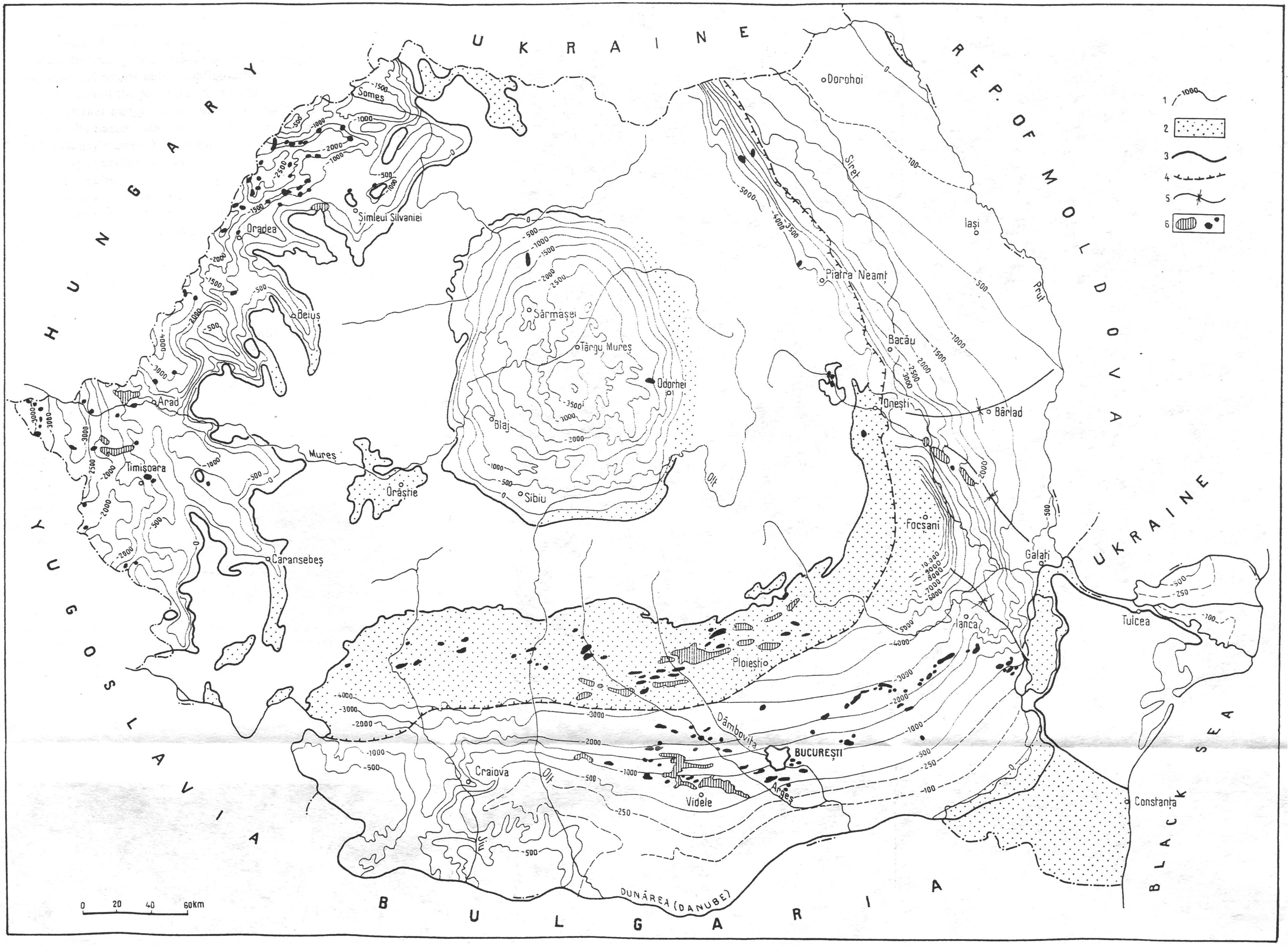

Fig. 1 – Pre-Paratethys denudational surface in Romanian territory. *1,* Isohyps; *2,* areas impossible to map it; *3,* boundaries of pre-Paratethys surface; *4,* Pericarpathian line; *5,* old depressionary areas; *6,* deposits.

b) the scale of Fig. 1 map does not allow for every morphological roughness to be represented thereon, not even the major ones. It provides but a very general image of the pre-Paratethys surface and not a detailed outline of its relief;

c) the respective map represents the present, distorted, picture of the pre-Paratethys surface and not its initial configuration.

The deformation of the pre-Paratethys surface (Fig. 1) is of the order of 10,000 m. The external margin of the pre-Badenian land corresponds to the Foreland units, to the Eastern margin of the Pannonian Depression, and to the periphery of the Transylvanian Depression. Insofar as seismometry and drilling allowed, the most spectacular subsidence (over 10,000 m) is assumed to have took place the hyper-subsided zone of Focşani.

As a general remark, the pre-Paratethys surface slopes from the periphery of sedimentary basins towards their depocentre, e.g. the Dorohoi 'peneplain' in the Moldavian Foreland sinking from East to West, and the Drăgăneşti one in the Moesian Platform from South to North. While in Transylvania subsidence is concentrical, from the periphery towards the central part of the basin, in the Pannonian Depression the pre-Paratethys surface slopes East-Westwards.

Against the background of these major characteristics one may distinguish several disturbances of isohyps which are caused both by tectonic factors and the configuration of the buried palaeoreliefs. Within the first category there fall the Bârlad Depression, the North-Dobrogea Promontory (along the Galaţi–Adjud line), Movila Miresei Depression (East of Ianca), Bordei Verde Promontory (on the Ianca – Palazu line), as well as the gulfs of the Pannonian basin on the Western margin of the Apuseni and the Banat mountains. The second category includes the palaeovalley of the Jiu River along the Băileşti-Craiova-Filiaşi line (Fig. 1).

Detailed maps on the scale of 1:25,000 reveal many other aspects of the sealed surface as follows:

In the Moldavian segment of the pre-Paratethys 'peneplain', previously named 'Dorohoi surface' (Paraschiv, 1991), the drainage network extent before the Badenian transgression (Fig. 2) could be partly reconstructed. Streams flew from NE–SW between the Northern border of the country and the parallel of Piatra Neamţ town; form East to West, between Piatra Neamţ and Oneşti, and from SE to NW between Oneşti town and the Danube. These three directions of palaeovalley drainage would suggest that the maximum subsidence area lay around the town of Bacău.

It can also be inferred that Moldavia's extra-Carpathian territory was in an advanced stage of modelling (relief index 100–120 meters). This large 'peneplain' was dominated by the Măcin Mts. (the North-Dobrogea Promontory) extending as far as the NW of Adjud town, and topping the surrounding regions by 500–600 m.

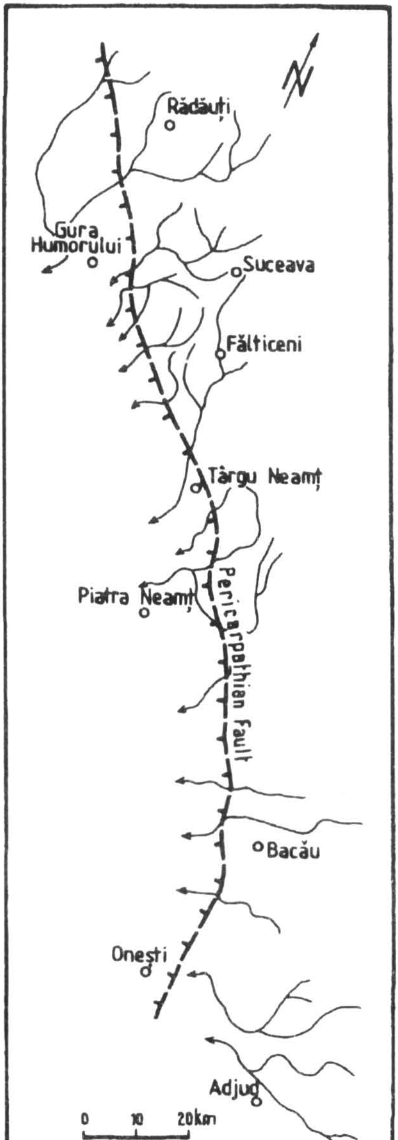

Fig. 2 – Fragments of hydrographic network in pre-Badenian in the outer-Carpathian Moldavia.

Beginning with the Badenian until the Pliocene (Paraschiv, Paraschiv *et al.* 1983) the shoreline progressively advanced Southward (Fig. 3).

An important morphological element of the Walachian segment of the pre-Paratethys surface, which previous authors had named Moesian 'peneplane' (Paraschiv, 1966) and 'Drăgăneşti surface' (Paraschiv, 1989), respectively, was the Bordei Verde cuesta (promontory) rising by some 1,000 m above the Movila Miresei Depression. The cuesta represents the front of an overthrust plane at the Palaeozoic level, along which the Moesian Platform is thrust over central Dobrogea (in the green schists area). The accident shows up as a fault (Ianca – Palazu) in Mesozoic deposits. West of this fault, the modelled surface appears as a faulted monocline, while the palaeorelief East of the fault occurs in the form of hills (Fig. 4) stamped by the folded Palaeozoic and Proterozoic structure. Relative altitudes rise to 400–500m generally (Paraschiv, Bulgaru, Bucur, 1977; Paraschiv, 1979).

Farther to the West, in the same Walachian sector of the Platform, a lot of palaeo-valleys associated with the negative landforms of the Videle-Petreşti Valleys sector (Fig. 5B) were singled out (Ursu, Langa, 1969). They correspond to a Senonian limestone substrate strongly affected by ruptural accidents. These are palaeodolines, long of a max. 25 km (carefully verified), wide of 300 m – 2,000 m, with depths of 180 m (Paraschiv, Bucur, 1975), partially drained by the tributaries of the palaeo- Argeş River. The transversal profile of the old dolines shows fairly steep slopes and an apparently rough thalweg bed (Fig. 5 B).

The Moesian Platform is a region marked by outstanding karstic phenomena in its Cretaceous, Jurassic, Triassic and Palaeozoic carbonate deposits that gave birth to lapies,

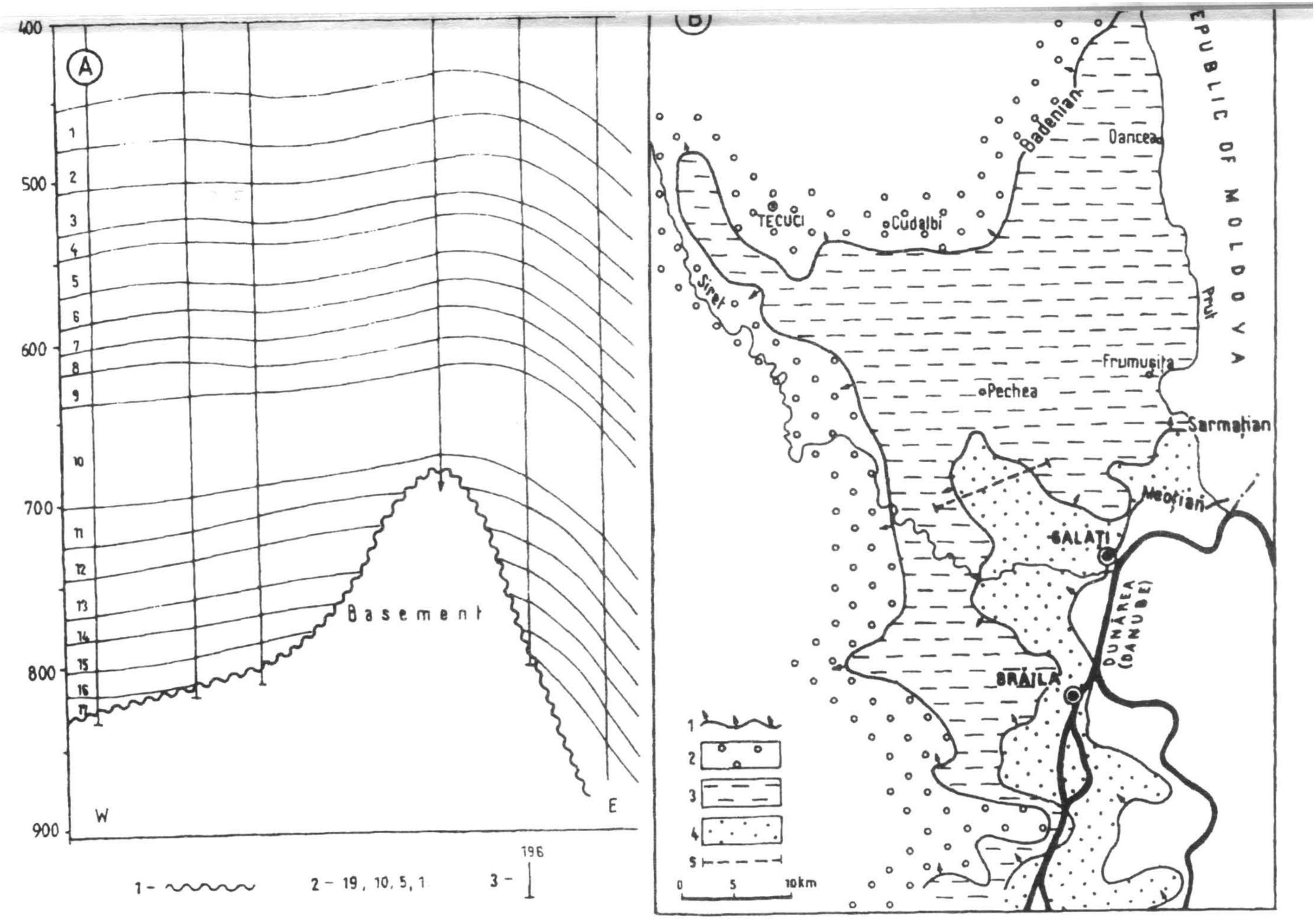

Fig. 3 – Pre-paratethys denudational area in South of **Moldavia**. **A.** Geological cross-section through Independenţa **Structure (North-Dobrogea Promontory Măcin Mts.)** *1*. Pre-Paratethys surface; *2*. succession of stratan lying atop it; *3*. wells. **B.** Burying phases of Măcin Mts. (North-Dobrogea Promontory) during the Badenian-Meotian: *1*. coastline at the end of period; fosilised surface; *2*. in the Badenian; *3*. in the Sarmatian; *4*. in the Meotian; 5. direction of cross-section in Fig. 3 A.

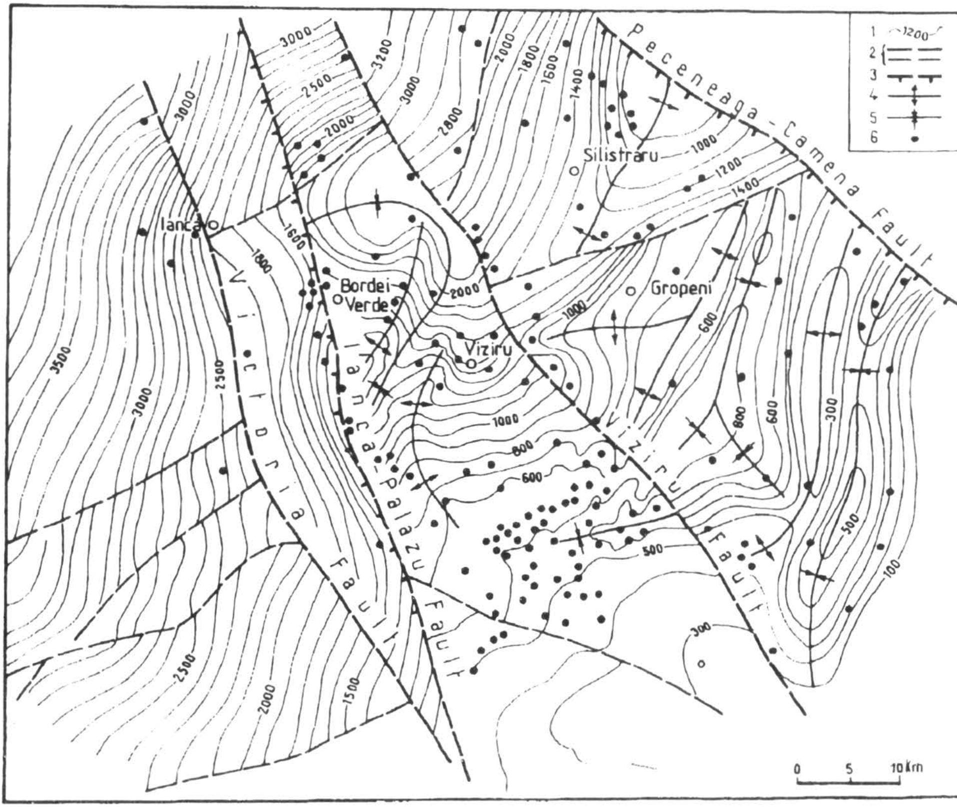

Fig. 4 – Pre-Paratethys surface in Bordei Verde paleo-cuesta area: *1*, isohyps; *2*, faults; *3*, overthrust line; *4*, anticlines; *5*, synclines; *6*, wells.

and caves even, often communicating very well among them. Such processes could develop due to the existence of a fresh water source in the close neighbourhood, viz. the Danube and of a network of faults that let liquids seep down at depths of 2,000–2,500 m.

Maximum fluvial erosion occurred in the Oltenia segment of the Foreland, and in the N–W of Bulgaria (Bokov, 1968). The great many palaeo-valleys detected here are tributary to the Palaeocene and the Lower Miocene marine basin corresponding to the Carpathian Foredeep. Most of these valleys belong to a drainage basin mentioned elsewhere by the name of Palaeo-Jiu (Paraschiv, 1989). According to the latest seismic and drilling data, the mainstream sprang on Bulgarian territory, much farther South of the Danube, running approximately in the direction of the present course of the Ogosta River.

Researches in Romania followed rigorously the course of the Jiu palaeovalley between the Danube and the peri-Carpathian fault line (Filiaşi) along a distance of some 100 km. The basin of the Jiu River is asymmetrical, more extendend Eastward, where its main tributaries the Mârşani and the Craiova develop (Fig. 6). The Palaeo-Jiu is a medium-sized river, but its valley records impressive widths. The fossilised valley depth is little more than 2,000 m in the vicinity of Filiaşi, 1,300 m around Băileşti, and only 600–800 m at the confluence with the Mârşani River.

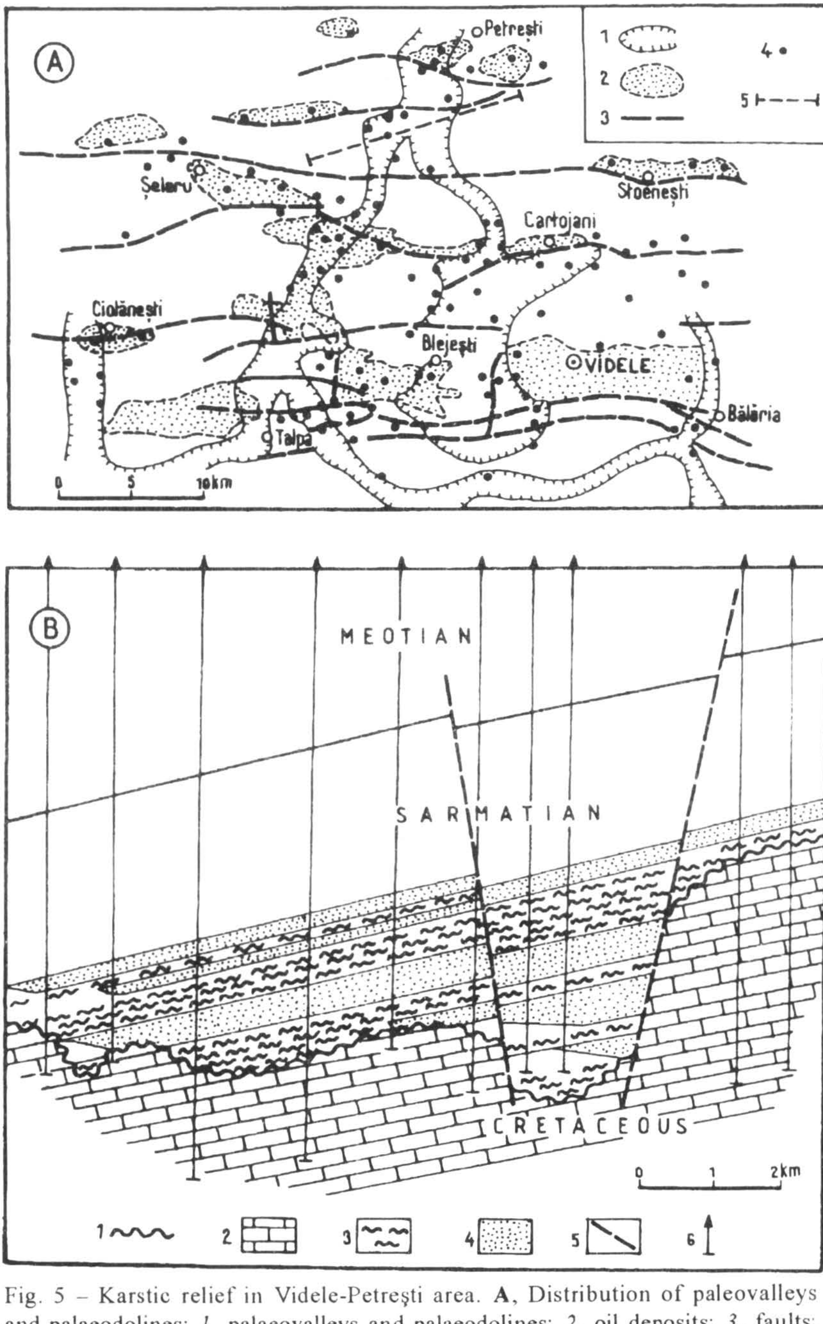

Fig. 5 – Karstic relief in Videle-Petreşti area. **A**, Distribution of paleovalleys and palaeodolines: *1*, palaeovalleys and palaeodolines; *2*, oil deposits; *3*, faults; *4*, wells; *5*, direction of geological cross-section in Fig. 5. **B**. Geological cross-section through Petreşti palaeodolines: *1*, fossilised denudational surface; *2*, carbonate deposits; *3*, clays, marls; *4*, sandstones, sands; *5*, faults; *6*, wells.

The major valley shows at least three relief steps, either terraces or lithological levels. Supposedly, tectonically distorted after emergence, they developed relative altitudes from 50 – 100 m, 300 – 400 m to 500 – 600 meters, respectively.

The youngest deposits eroded by the river are of Eocene age, Cretaceous, Jurassic, Triassic and Carboniferous deposits were added even Northward, as the valley became deeper. The silting of the Jiu palaeo-valley had begun in the Upper Badenian, continued progressively throughout the Sarmatian and Meotian to form a common cover of palaeo-valleys and watersheds in the Pontian. Therefore valleys must have formed between the Eocene (more likely the Oligocene) and the Lower Badenian. At the same time, after the Valley of the Jiu had been cut, the Northern margin of the Moesian Platform began rising stepwise, compelling the river to deepen its channel. It follows that the Jiu is a typically epigenetic valley. At the beginning of the Badenian, the Northern end of the palaeovalley was kind of a Paratethys Sea-gulf.

As mentioned previously, the Eastern margin of the Pannonian Depression was divided into many tectonic compartments, mostly horsts and grabens, subjected to syn-sedimentary movements of various intensities. That is what makes the pre-Paratethys surface look so very rough, with relative altitudes of up to 3,000–3,500 m (Fig. 1). The general aspect of the area would not suggest notable modellings. And yet, the age and spread of geological deposits at the bottom of the pre-Paratethys area (Paraschiv, Popa, 1975) would refute such a conclusion.

The greatest and most reliable number of data for the Transylvanian basin have been yielded by seismic record of the Dej tuff level. Any other information are in general limited and not very conclusive either. As deficient have proved the direct yields of the 20–30 wells that pierced throughout the Badenian. Therefore, models of pre-Badenian salt evolution in the centre of the basin are at the best speculations. What is certain is the fact that the whole of the pre-Paratethys surface is cuvette – like in shaped (Fig. 1) and that the concentrical isohyps pattern occurring against this background is indicative of some disturbances in the South and Southeast of the basin. However, a sound substantiation of these anomalies calls for additional information and further thinking.

In point of geology, fossilised denudational surfaces correspond to stratigraphical (often also angular) discordances, and are sites of interest for oil and gas reserves around the world. The greatest reserves of hydrocarbons are hosted by discordances either in the cover or bed deposits, or lining either side of the contact between the two. This is the work of palaeoreliefs which created the lithogenetic, structogenetic and hydrodynamic conditions for hydrocarbon deposit formation. Basically, discordances facilitate the flow of greater quantities of liquid.

All that has been said so far is applicable to Romania's territory, as well (Paraschiv, 1989 a, b. Paraschiv, 1991). Except for the Transylvanian basin,

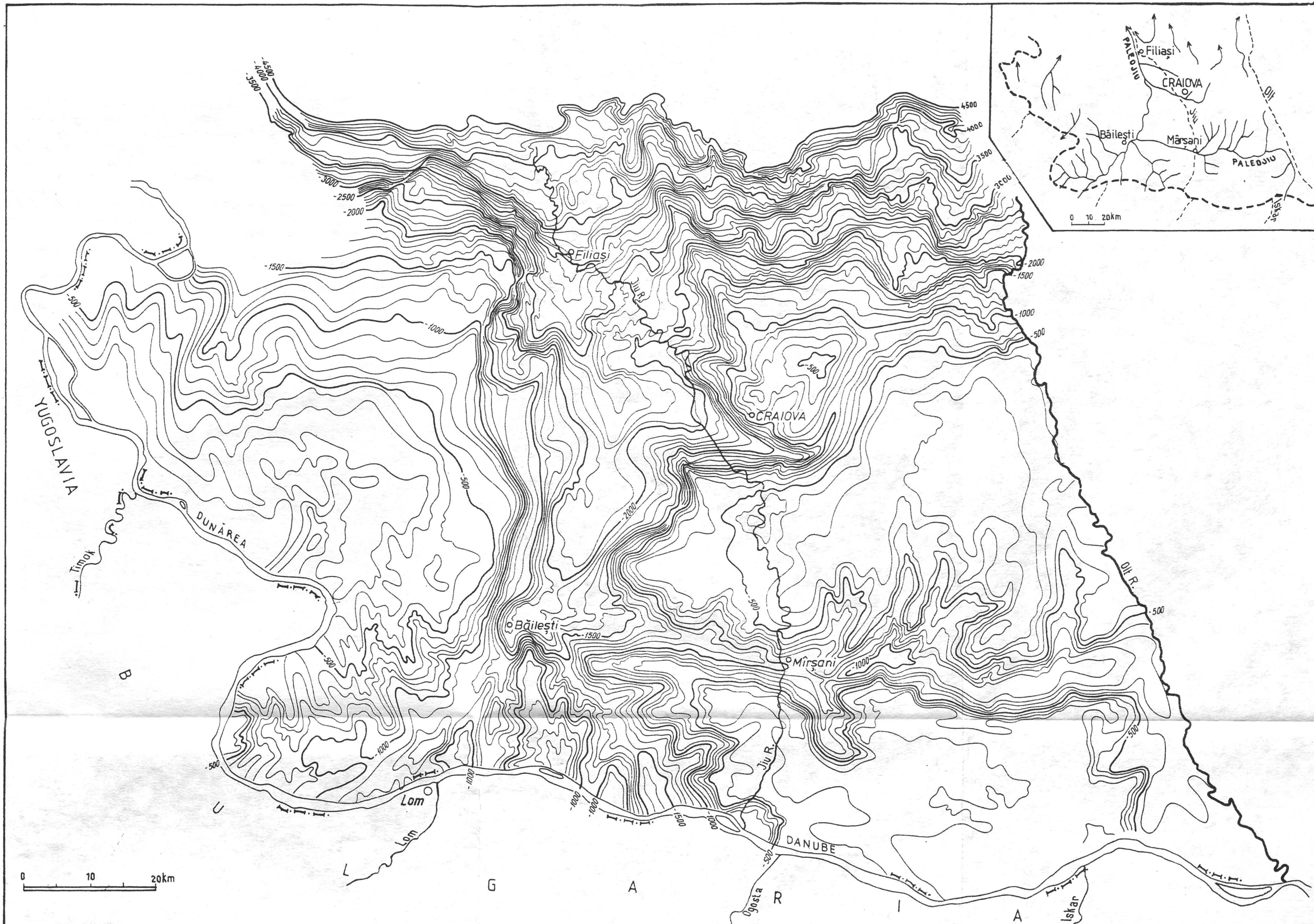

Fig. 6 – Drainage basin of the Palaeo Jiu River marked by isohyps *(A)* and rivers *(B)*.

more than fifty per cent of this country's deposits discovered until now (over 170 structures and hydrodynamic units) are grouped around the pre-Paratethys buried surface (Fig. 1).

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ROMANIA'S GEOPOLITICAL POSITION WITHIN THE PRESENT INTERNATIONAL CONTEXT[1]

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Key-words: geopolitical position, Central Europe, Romania.

La position géopolitique de la Roumanie dans le contexte international actuel. L'étude fait l'analyse des valences de la position géopolitique actuelle de la Roumanie, vue par les changements de la carte politique de l'Europe Centrale et de Sud-Est après 1989 par rapport à la situation d'entre les deux guerres. On souligne la favorabilité virtuelle, mais aussi les désavantages qui résultent de l'état actuel de forces en Europe et de la nouvelle partition régionale de cette zone.

When trying to assess a state's geopolitical position, one has to take into account its political, economic and military relations with other countries, either close neighbours or situated somewhere at zonal or world levels. Its position fluctuates in terms of the positive or negative relations established with the respective states. Romania's geostrategical and geopolitical position, therefore, has been influenced by the political and military interests of several closer or remoter powers.

Romanian geopolitics in the interwar period, little known and put to account, dealt with the position of this country within the international context (Rădulescu, 1938; Mehedinți, 1942; Tufescu, 1943; Conea, 1944, etc.). Romanian studies and geopolitics, generally, unlike German expansionistic, or Hungarian revanchist policies, is characterised by defenseness, by protection of the national territory.

Another point of interest for Romanian geopolitics was the country's European status within the context of East-West relations.

Being a Black Sea riverain country and controlling much of the Danube watercourse, Romania represents a traffic junction in all directions: from East to West, from the North to the Balkans, from and to Europe, the Middle East, the Gulf zone or the far off Asian regions retracing the old silk route. Moreover, with the Danube growing into a Transeuropean waterway, spanning the distance between the ports of Rotterdam and Constanța, the importance of this geographical space is increasing steadily. A country's centrality is subject to pressures from all directions (Conea, 1944), as proved by the whole history of the Romanian people. And the present time makes no exception. A drawback of

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such geopolitical and especially geoeconomic position is the W-E orientation of Transeuropean highways. It is the case of the Berlin–Prague–Budapest–Belgrad–Sofia–Istanbul rail and road traffic route, as well as the Berlin–Warsaw–Minsk–Moscow one running in the North of the continent. The Danube waterway is dominated by the Main–Rhine section oriented in the main towards the North Sea. On the other hand, the lower sector offers easy access westwards to the Black Sea riverain states or to the Asian countries. The benefits of this route were first underscored by Tufescu (1943).

The present geopolitical position of Romania is connected with the major changes occurred on the political map of Central and Eastern Europe. It is primarily the consequence of the post-1918 transformations. The defeat of Germany, the dissolution of the Habsburg Empire, and Russia's withdrawal within itself, as it were, have shaped the political map of this area, which by and large has remained valid to this day. A number of states acquired independence (Czechoslovakia, Austria, Hungary, Yugoslavia, Finland and the Baltic States; Poland re-emerged; Romania and Serbia recaptured their territories). This geographical space became a buffer zone between the Soviet Union and the rest of the Continent. It was rather amorphous given the diverging geopolitical priorities derived from former, opposed, military alliances. Short of Western support, Romania remained isolated, eventually falling under German hegemony at the cost of important territorial losses (the Vienna Diktat and the Ribbentrop-Molotov Pact).

The victory of the Soviets and of the Allied Powers in the Second World War brought about major changes on the political map of Eastern Europe to the benefit of Moscow. The latter englobed the Baltic States, the Eastern territories of the Polish state, pushed westwards up to the Oder-Neisse line, Basarabia and Northern Bukovina from Romania. These changes were sanctioned at the Peace Conference in Paris (1947), in the Final Helsinki Act (1975) and the New Europe Paris Charter (1990). From a geopolitical viewpoint neighbourlines for Romania has lost much of its quality, and the negative consequences are in part visible nowadays, as well.

The country's geopolitical situation experienced a radical change in the wake of the 1989–1990 events. With the retreat of the Soviet Union from Central Europe, Romania is neighbouring the Ukraine (in the North and the East), the second largest state of Europe. Since the Ribbentrop-Molotov Pact was not annulled in practice, a second Romanian state appeared on the scene – the Republic of Moldova. Apparently, this is the price paid for the withdrawal of the Soviets and their accord to the unification of Germany. In his declaration on the annulment of the consequences of this pact, the former American President, George Bush, made special reference to the independence of the Baltic States, but not a word about the territories seized from Finland, Poland, Romania and

Fig. 1 – State border changes in Central and Eastern Europe (1918–1989). *A* – After World War I; *B* – after World War II; *C* – The Austro-Hungarian Empire in 1914; *D* – The borders after 1989.

Slovakia and annexed by the USSR in 1940 and 1945. Instead, he recalled the Paris and Helsinki agreements which, as a matter of fact, were no barrier in the way of the dismemberment of Czechoslovakia and Yugoslavia.

Today, Romania's geopolitical situation on the Continent is rather similar to the pre-war one. A first particularity of a balance-of-power change is the formation of a German and Germanophile corridor (P. Cocean, 1993). As the principal political and economic power of Europe, Germany is remaking its old geopolitical routes, filling in the 'geostrategical void' left by the Soviet withdrawal. Supported by Austria it obtained the seccession of Slovenia and Croatia, a move that led to the outbreak of the Yugoslavian war. Under the EU mandate, it contributed to the dissolution of Czechoslovakia, with Czechia falling into its economic sphere of influence. This was followed by the creation of the Vyshegrad Group, which is the topical expression of the *Mitteleuropa* concept circumscribed to German-speaking zones, or to influence zones. The motivation behind this division masterminded by Z. Brzezinsky (1995), is the location of the respective states on the main E-W strategic circulation route, linking Germany geopolitically to the former Soviet Union. Apart from the pulverisation of the states of the area, Germany's eastwards advance has resulted in the development of a separation line strikingly similar to that traced by S.P. Huntington on the ground of religious criteria. This line tends to grow into a new political and economic iron curtain. The publication 'Marchés Est-Européens' shows that the countries of the Vyshegrad Group had received 84.5% of the total investments put into the Central and East-European states over the 1990–1995 period. The percentage is 18 times higher that the sums allocated to Romania and Bulgaria (Ştefan, 1997). The economic performance of the Vyshegrad Group places it in a preferential position of adherence to the Euro-Atlantic structures, leaving Romania and Bulgaria behind. Germany's priority target in Europe is Russia, with whom it entertains close political and economic ties. It is K. Haushofer's idea of an Eurasian co-dominion with Russia and Japan to bring the Anglo-Saxon domination to an end. The idea would materialise into a union between a "European technological pole," represented by Germany, and an "Eurasian pole of resources," represented by Russia. Central Europe's Nordic area is crossed by a dense network of oil-and-gas pipelines stretching out from Siberia to Germany. At the same time, Germany's intention is to turn the strategic bridgehead of Kaliningrad into the 'Free city of Königsberg'.

A second geopolitical power that had exerted an overriding influence on Romania's geopolitical situation was Russia. Ever since the rule of Peter the Great, Russia has tried to get free access to the Baltic and the Black Seas. This created the so-called 'Eastern question' in which all the great powers of Europe got involved for over two centuries until Russia succeeded to settle confortably at the mouths of Danube, to the detriment of Romania. After 1945, with Russia growing into a world power, its geopolitical importance in the Balkans and the Black Sea area grew accordingly, having a direct bearing on Romania.

With Ukraine and the Baltic States becoming independent, a buffer corridor, setting out from to the Baltic to the Black Sea, has come into existence, staving off Russia's expansion to the West. Apart from the Baltic "pockets", Bielorussia remains the only access route in that direction. From a total of 2,200 km Soviet Black Sea coast, Russia was left with some 400 km, minus the big ports of Odessa, Ilichevsk, and Sevastopol. As Ukraine emerged on the new map of Europe, the former political power centre – the Soviet Union – was divided into two poles, and their contradictions tend to establish a mutual equilibrium. Beside the traditional powers of the 20th century – Germany, France, Great Britain and Russia – a new state, nurturing similar ambitions, has come into being.

Stimulated by the Western States, Ukraine strives to become independent, mainly economically, from Russia. It is establishing close relations with the Western world and tries to join the Vyshegrad Group. It considers setting up economic ties with Turkey in the South which is a rising regional power in the basin of the Black Sea.

Ukraine's relations with Romania are based largely on the ex-Soviet custom of denying the historical status of Bessarabia and Northern Bukovina, refusing to define the situation of the Serpents Island and delimit the oil-rich Continental shelf. Its refusal to address these issues in its treaty with Romania is tantamount to blackmailing, it considering that our country's adherence to NATO is basically dependent on the conclusion of that treaty. The acceptance of Romania's membership to the Euroatlantic structures, as a groundwork for security, is and shall be dependent on the stand taken by the three powers – Germany, Russia and the Ukraine.

A special geopolitical situation has the Republic of Moldova, obliged to pendulate between the East and the West. Although the

Fig. 2 – The division of Europe (according to S.P. Huntington, 1993).

Ukraine could play a buffer role, protecting it from Russia's expansionist tendencies, Moldova is not in a position to draw closer to Romania and to Western Europe, generally, as long as the situation of the Transnistrian enclave, actually a Russian bridgehead, is not solved.

Romania possesses the shortest Black-Sea coast line – 243 km as against 345 km before the war. However, it holds a special geopolitical asset due to its control over the Danube mouths, and its location at the contact between the Euroatlantic and the Eurasian spaces. Unfortunately, Ukraine's and Turkey's hegemonistic tendencies, as well as the instability caused by the Caucasian conflicts, which tend to oust Russia from the area, prevent Romania from taking full advantage of this asset.

In Gottmann's view (1953), Romania is a 'country articulating' Europe to the Balkans. In the course of time, the evolution of this zone, in which the interests of the great powers intersected, had a bearing on Romania's geostrategic situation. The tardy dissolution of the imperial systems, which had been disputing their supremacy over South-Eastern Europe, against the background of a huge ethnical, cultural and religious diversity and of numerous national minorities, maintained a state of tension broken off only during the cold war era.

The cold-war era was marked by a complex political configuration. Greece and Turkey were NATO members; Bulgaria and Romania held membership on the Warsaw Pact. Yugoslavia upheld a non-alliance status, while Albania remained solitary.

After 1989, old resentments and antagonisms were brought to the fore by the political game of the big powers, with Yugoslavia falling into the focus. The direct participation of NATO and USA in solving the Yugoslavian conflict has brought about radical changes in the geopolitical situation of the Balkans. For the time being, the peninsula is divided into two geostrategic zones: a) one in the North including Croatia and Slovenia, drawn into the German sphere of influence, with priority orientations to the Vyshegrad Group, and outlet to the Adriatic Sea; b) the other, in the South, a zone of maximum political and economic instability, with potential situations for new conflicts to break out: the Yugoslav Federation, Macedonia, Albania and Bulgaria. Traditionally, also Greece is included in this zone. In between them lies Bosnia-Herzegovina, a nut-shell copy of former Yugoslavia, playing a buffer role between the two zones.

Apart from the global interests of USA and NATO, two blocs emerged in the region stimulated by the antagonism between two NATO – member countries: Greece and Turkey. One bloc (Albania, Bosnia and Macedonia) is pro-Turkey, the other (Yugoslavia and Bulgaria) gives prominence to Greece, Turkey's ambitions to become a regional power over her former zone of domination have come into conflict with the interests of Greece and Russia. Russia, therefore, has in view the formation of a Byzantine 'union' scheduled to include, beside Greece, also Bulgaria, Yugoslavia and Romania, together with Armenia and Georgia. On the same line goes Russia's intention to export its oil along the Novorossiisk–Burgas–Greece route, thus avoiding the difficult passage through the Bosphorus.

On the other hand, USA and Germany would like to stave off the cultural and political expansion of Islam to Europe, and eliminate Russia's strategic presence in the Balkans.

To sum up, we would say that Romania's geopolitical position today should be considered in the light of the division of Europe into four subunits with fluid frontiers among them: Western Europe, the former Soviet Empire, the Vyshegrad Group and the Balkans.

The essential problem Romania is being faced with in surmounting the East-West dilemma is to separate its historical destiny from its geographical location by integrating with Europe's Eastern and Western worlds. The basic goal is to strike a new balance with the old actors in the balance-of-power game. This time, however, the redistribution of power lends these actors a different weight.

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ȚARA (THE LAND) – A TYPICAL GEOGRAPHICAL REGION OF ROMANIA

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Key words: țară (the land), geographical region, Romania.

Țara **(le pays) – une région géographique typique de la Roumanie.** Le mot *țară* (pays) (pl. *țări*) comprend dans la langue roumaine plusieurs significations: a) terrain plat, labourable, pris en cultures, localisé notamment dans les régions collinaires; b) une unité ethnographique, à traditions, coutumes et une vie spirituelle spécifique et c) noyau d'une unité administrative-politique, qui – après s'ayant uni avec d'autres *țări* – ont formé les provinces historiques, géographiques, qui se trouvent à la base de la Roumanie, comme état national unitaire. L'auteur identifie 18 tels pays, placés des deux côtés des Carpates, dans des dépressions. Ils représentent les premières phases de l'organisation des roumains (III–VII siècles) sur les fondements de la civilisation antérieure dace et daco-romaine. Ces pays se sont développés dans un cadre naturel à ressouces variées et à maintes valences stratégiques, intensément exploitées durant le Moyen Âge. Leur population roumaine conserve une culture traditionnelle archaïque, d'une grande originalité. Ces pays engendrent, sans exception, des systèmes sociaux avec des fonctions complexes, rigoureusement articulées.

Applying the fundamental concepts of geographical regionalization, the delimitation of some functional territories on the hierarchical system is to be found at the level of today's Romanian territory, from the elementary units to structures of maximum generality. However, the growth of the entropy degree, together with the perimeters' expansion and the multiplication of systemic elements, within the landscapes adjacent to them, are obvious.

In this context, the scientific investigation of profile spotlights an important standard unity, that can be assimilated to a typical geographical region, namely *țara* (the land). The spreading of these units is illustrated in figure 1. Those eighteen "lands" are placed, with a single exception, at the outskirts of historical provinces: Crişana (Oaş, Chioar, Silvania, Beiuş and Zarand Lands), Banat (Almăj Land), Transylvania (Lăpuş, Năsăud, Moți, Hațeg, Amlaş, Făgăraş and Bârsa Lands), Bucovina (Dorna Land), Moldavia (Vrancea Land), Oltenia (Severin Land) and Muntenia (Lovişte Land).

A single "land," Maramureş, is superposed to the historical province with the same name, and Dobrogea doesn't have such geographical units.

THE NOTION OF *ȚARĂ* (LAND) AND ITS MEANING

In the Romanian language, the semantic meaning of the word *țară* ("land") is polyvalent. A first acceptation is that of mountains' antipode. It is used by

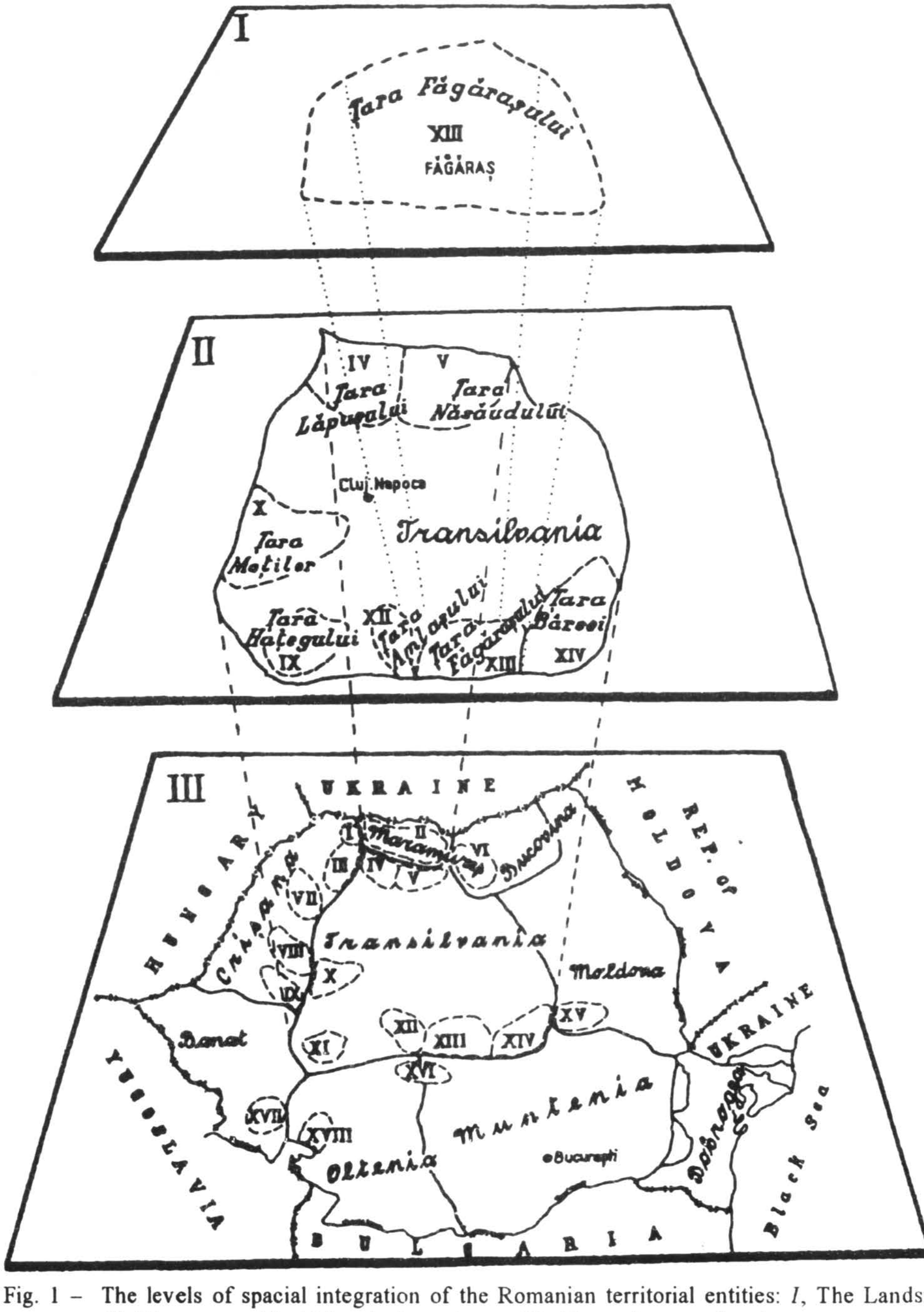

Fig. 1 – The levels of spacial integration of the Romanian territorial entities: *I*, The Lands; *II*, The geographical-historical provinces; *III*, The unitary national state.

the inhabitants of the mountainous areas to define the tilled areas of hills and fields (Conea, 1993). "Moțul left for the land..." says an old song of the people who live in Apuseni Mountains, recalling the descent of men by truck towards the lower regions to buy cereal products.

The second meaning given to the word is that of an ethnographical zone, of a cultural space. The land is not only a territory ecologically and ethnographically delimited. First of all, it is a spiritual entity, where people have the same image about the outside world, the same standards in their relationships, the same behaviour 1984. From a social point of view, the "lands" were based on structures tight correlated, by resemblance.

In the end, a connotation of the same word comes from the administrative-political prerogatives that these organization nuclei of Romanian population had during the Middle Ages (6th–13th centuries), when they fulfilled, temporarily and complementary, such functions (Maramureş, Făgăraş, Hațeg, Loviştea etc.). From the 14th century the mentioned function returned to the geographical-historical provinces, known as Moldavia Land, Romanian Land and Transylvania Land.

The regional unit called "land," with the acceptation given in this study, doesn't include the territories delimitated on ethnical criteria (Terra Blachorum, Terra Valachorum, Terra Siculorum) which are often mentioned in the historical studies, and this is because of the fact that they include a diversity of geographical territories that have, as a single functional relation, the ethnical character of the population, without making themselves up in functional entities specific to the real geographical regions. For instance, Terra Valachorum practically included all the territories inhabited by Romanian people, corresponding to a large number of individualized "lands", each of them being forms of a judicious organization of the geographical space (Surd, 1991). Also, Terra Siculorum, that is erron-eously considered a proper "land" by the same author, was an artificial administrative creation, resulted after the massive colonization of Szeklers, in 12th century, in the eastern part of Transylvania, upon an old background of autochthonous Romanian population. It was spacially grafted on some depression areas (Giurgeu, Ciuc, Odorhei, Praid), separated by mountainous summits (Gurghiu, Harghita), respectively the eastern part of Transylvania Plateau. The natural disfunctionalities were obvious, because of the divergent orientation of the vectors in the system so created. The fact that the mentioned sociosystem, that had in the Middle Ages the specific statute of a privileged nation, didn't last was proved by the massive assimilation of Szeklers by the Hungarians, who exist today in a large number in that region. Thus, from about 200 000 Szeklers in 1554, their number decreased to 817 people in 1992. Not the same thing happened with the population of the analysed "lands" that remained mostly Romanian, though the dislocation and assimilation tendencies had not been a few, on the contrary, we may say.

THE PHYSICAL-GEOGRAPHICAL CONDITIONING OF THE LANDS' INDIVIDUALIZATION

For the great majority of the lands, the peculiarity of spacial localization imposes a unique matrix, whose elements helped, by juxtaposition and tight relationships of cohabitation, defining a natural environment, favourable to the appearance and maintenance of human habitates. The vertebral column of the landscape's architecture is represented by the intra- or peri-Carpathian Depression, archetypally proped on the mountain, which influenced its origin and evolution.

The funnel shape, with a larger opening towards the plain (the gulf depressions in Apuseni Mountains, where Zarand and Beiuş Lands were established) or of a closed basin (Lovіştea, Bârsa, Dorna, Lăpuş) outlined a space of regional gravity, with the force lines axially orientated from the mountain towards the lower areas. The hydrographical discharge – as a main vector of morphogenesis – follows the mentioned direction, the same as the flows of matter and energy within the systems so configured (exploitation and commercialization of timber and agricultural products, moving of flocks to/ from the Alpine pastures, commutation phenomenon etc.).

On the other hand, the conquering tendencies, aiming to break the "lands" by force, turned into opposite movements, that had to surmount the gravitational restrictive elements, naturally established, including the obstacle, often impenetrable, of mountains. In such conditions, the valley's funnels became ideal places for retreat and riposte, for the local population, against the political, administrative, religious and cultural interferences coming from outside. As a result, the natural environment of all the lands bears in its structure many strategical valences, profitable exploited, during the history, by the local communities.

Also, the depressions are individualized in relation with the relief units settled beyond their own frame, by the varied mosaic of landscape's components, from the fertile river meadows, to the stable terraces of mountainsides and mosaic slopes of the mountains. The geosystems diversity brought about an abundance of soil's resources, followed by the complementarity of their exploitations forms. The habitates' viability is also explained through the possibility given by the natural environment to develop its polyvalent functions, which in certain historical periods, more restrictive, granted them stability, in conditions of a real autarchy.

Moţilor Land represents an exception. It is stretched on a large, mountainous area, where the habitates settled in the valleys' passages, "swarmed" on plateaus and slopes. The morphological outline is less evident, if we do not take into account the outpost formed upon Biharia summits in the West and Bedeleu in the East. The lack of connections among the habitates is only apparent, the connection being achieved here by the peculiarity of the economy (pastoral-forestry), consisting of two forms of exploitation of the soil's resources, for whom the mountains were not inertial, restrictive elements, but on the contrary, catalytic factors.

The lands' arrangement on the both sides of the Carpathians (Bârsa Land – Vrancea Land; Maramureş Land – Dorna Land; Făgăraş Land – Loviştea Land) eliminated the orographical barriers, that became permeable limits of continuity, because of the common language and the consciousness of belonging to the same nation. Thus are explained the biunivocal migrations in the working framework of some special factors (the Romanian migration from Maramureş towards Bucovina and Moldavia in 14th century, because of the Hungarian pressure; of those from Amlaş Land towards Oltenia in 14th–15th century etc.).

Therefore, we draw the conclusion that the relief's contribution to the "lands" birth is decisive. Its impact is to be noticed in their existence only in the depression territories of Carpathians and sub-Carpathians (internal and external). The plains and low plateaus (Romanian Plain, Banat-Crişana Plain, Dobrogea Plateau), with their unlimited horizon, widely opened to different influences, were not territories favourable to the individualization of some geographical regions of this kind.

THE LANDS AS INHABITATED TERRITORIES

The archaeological sites opened within the analysed "lands" areas (Năneşti and Leordina in Maramureş, Vad in Chioar; Rudăria, Dragomireana in Almăj; Bârseşti, Cândeşti in Vrancea; Cioclovina in Haţeg; Căieni in Loviştea etc.) certify their condition of *inhabited territories* even from the prehistory. The permanent dwelling is reflected by the plenty of Dacian and Dacian-Roman evidences discovered in many settlements, from all the lands we mentioned. Besides, the building of the Dacia province's capital (Ulpia Traiana Sarmizegetusa) by the Romans, in 2nd century A.D., in Haţeg Land, certifies the many facilities offered to the human habitates by that special depression.

An analysis of the Romanian territory, from the viewpoint of favourable factors' principle (in which must be obligatory included the strategical defensive function during the historical period of peoples' migration and during the creation of the first state nuclei on the Roman Empire ruins) considers the perimeter of "lands" as the most favourable one. In these inhabited spaces were preserved archaic Romanian communities, with pre-Christian customs and traditions (the death watch dances in Maramureş, Vrancea or Beiuş Land, the wedding-burial etc.). All these are anterior to the Christianity, that, it is known, penetrated the Carpathian-Danubian-Pontic territories between the 3rd–4th centuries. They give us the right to affirm that the peri- and intra-Carpathian "lands" are the most authentical spreading areas of Dacian culture, and, afterwards, of Romanian spirituality, even from its period of crystalization (2nd–7th centuries). In this respect, the similitudes with the forms of spacial organization in France, during the pre-Roman period, are more than evident (Claval, 1993).

The fact that all the people used the same linguistic stock, the Romanian one, without creating dialects (easy to proliferate within the context of political disturbances that took place in the Middle Ages and of the disnationalization pressures exercised especially in Transylvania, Crişana or Maramureş) remains an irrefulable proof of its appertaining to the same ethnogenetic space, configured before the further political divisions. In fact, even the maintaining of such compact communities wouldn't have been possible without a well strenghtened language, culture and national consciousness.

In figure 2 are illustrated the levels of typological and functional hierarchy of the territorial units. We could observe that the "lands" represent the inferior rank unit (I), that is equivalent to the basic cell in the organization of geographical territory. They are fitting in some entities of an intermediary importance (II), respectively the geographical-historical provinces which they circumscribe, delimiting them according to the neighbouring territories. The number of "lands" is maximum in Transylvania and Crişana, while they are not to be found in Dobrogea.

At their turn, the geographical-hystorical provinces brought about, through gradual political union, the unitary Romanian national state (III), by the common resources of population ethnogenesis, of culture, economy and their own political interests (in 1859 Moldavia becomes one with Romanian Land, consisting in Muntenia and Oltenia; in 1918, Romania is rounded off through referendums by Banat, Transylvania, Crişana, Maramureş, Basarabia and Bucovina. The "lands" have in Romania the role of the cells who bear the genetic code, cells that by harmonization gave birth to the organs (the geographical-historical provinces), and them, by association and functional interpenetration brought about the unique system of national state. This is why every attempt to consider the "lands" or Romanian provinces as the embryos of a possible atomization is wrong, from the very beginning, being contrary to the normal, natural evolution of the whole sociosystem.

The tight interpenetration among the village communities of the lands generated a sociosystem with complex functions, having a social, cultural, administrative or even a political nature. In this respect, the statute of relative independence they preserved for a long period, in relation with the political authorities of that period, is relevant. It must be noticed that the independence prerogatives were exerted only when those inhabited territories were attached to Turkey (for the Lands of Moldavia, Muntenia or Banat between 16th-19th centuries), to Hungaria (for the Lands of Crişana or Transylvania between 11th century – 1526), to Austria (1699–1867), respectively to Austrian-Hungaria (1867–1918). When geographical-historical provinces of Transylvania, Moldova and Romanian Land existed as independent state, the political role of the "lands" was dissolved in the stream of common interests.

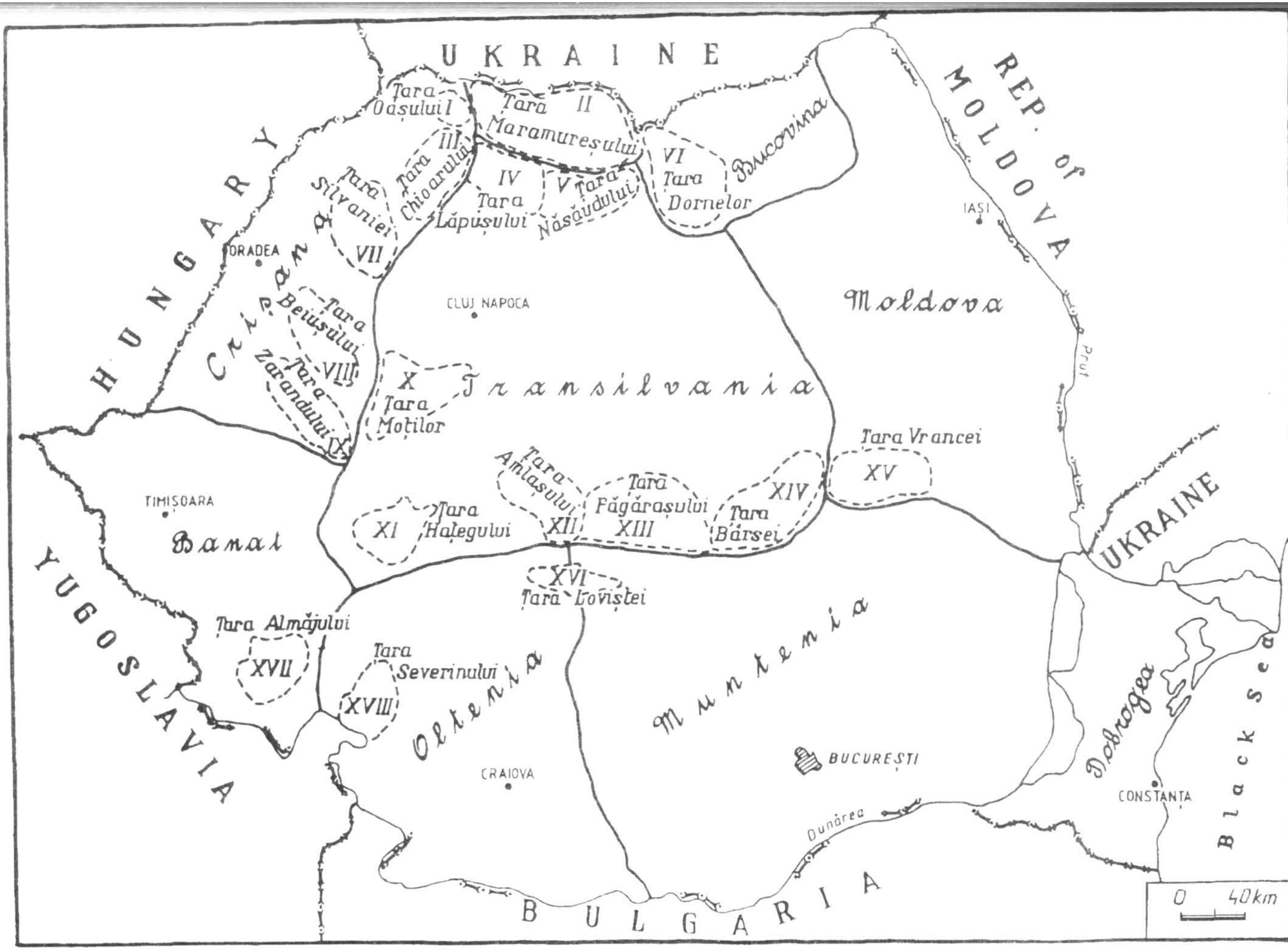

Fig. 2 – The "lands" and geographical historical provinces of Romania. *I*. Oaș Land; *II*. Maramureș Land; *III*. Chioar Land; *IV* Lăpuș Land; *V*. Năsăud Land; *VI*. Dorne Land; *VII*. Silvania Land; *VIII*. Beiuș Land; *IX*. Zarand Land; *X*. Moților Land; *XI*. Hațeg Land; *XII*. Amlaș Land; *XIII*. Făgăraș Land; *XIV*. Bârsa Land; *XV*. Vrancea Land; *XVI*. Loviștea Land; *XVII*. Almăj Land; *XVIII*. Severin Land.

The sociosystem's functions, specific to every "land", were temporarily materialized in asserting a personal culture. Having as an ideative support a true national consciousness – as a result of the affiliation to the Romanian ethnogenetic space – all the communities from these geographical regions developed a peculiar rural civilizations. It was manifested in the sphere of material life (architecture, handicraft installations, popular costumes), but also in the spiritual life (customs, traditions, popular dances, lyrical creations etc.). The architecture from Maramureş has a different style than the one in other "lands", and the popular costumes are significantly individualized in all their components for each "land". The Maramureş, Lăpuş or Năsăud Lands exhibit different types of popular costum of an absolute originality, though they are neighbours. Similarly zonal differentiations are noticed regarding the traditions and customs.

Another defining trait of the "lands" as inhabited territories is the union of the settlements' systems around some polarizing traditional centres (Negreşti-Oaş, Năsăud, Târgu Lăpuş, Beiuş, Şimleu Silvaniei, Sibiu, Braşov, Făgăraş, Câmpeni, Drobeta-Turnu Severin, Bozovici). In most cases, they were selected from the settlements having a favourable position, that were central places. The town of Braşov is an exception, being situated at the South-West outskirts of Bârsa Land, at the foot of Carpathian Mountains (with a defensive role), but also in the neighbourhood of a very travelled road between Transylvania and Romanian Land. Also Drobeta-Turnu Severin and Sighetu Marmaţiei have an peripheral position within the Severin and Maramureş Lands, being attracted by the growing importance of the Danube and Tisa, as axes for the river transport.

The most polarizing centres manifest their influence within the limits of their own regions (Beiuş, Năsăud, Lăpuş, Bozovici, Drobeta-Turnu Severin, Făgăraş, Negreşti-Oaş). However, it comes out an increase of the attraction function at a superior level, for the towns with a privileged position, (as would be Braşov, Sibiu, Baia Mare), spreading also upon some territories belonging to some other lands (Făgăraş, Lăpuş, Oaş, Chioar) or upon others that were not integrated in such entities.

If the polarizing centres mentioned above strengthened their functions in time, despite the rivalry of some other localities, we also notice the situation in which old attraction centres were replaced by new ones. First of all, we consider the town of Baia Mare, that imposed itself in relation with the old fortress of Chioar, around whom was initially formed the settlements system of the land with the same name. The ascension of Baia Mare is due to the development of mining activities in Gutâi Mountains and it have been taking place even since the 17th century.

Another example is Silvania, where the settlement with a polarizing role was initially Şimleu Silvaniei. It lost this function in the 20th century, especially after the town of Zalău received the function of a county administrative center and benefited by important capital investments for the development of a complex infrastructure.

Another example is Vrancea Land, where there was no relevant center of regional attraction. The cause must be the specificity of the village communities, that transformed every rural community in a unit of habitat that was independent economically and administratively from other settlements (Nereju, Năruja, Soveja).

The unique particularities of the "lands" as inhabited territories, being in a close genetic dependence with the natural environment's features and with the human communities who live there, give to these territories typical characters of a great interpretative resonance on the scientific and methodological grounds. The Regional Geography, as a synthesis discipline, has in the analysed "lands" a classic model of standard-units' individualization, that is the final desideration of its whole integrator approach.

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SOME TARGETS OF THE EUROPEAN TRANSPORT SYSTEM AND ROMANIA'S INTEGRATION ISSUE

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Key words: transport system, integration, Romania.

L'intégration de la Roumanie dans le système européen de transport. La stratégie d'intégration de la Roumanie dans les organismes européens, élaborée par les spécialistes des divers domains, envisage nombreuses branches économiques et sociales et correspond aux standards européens. Dans le cadre de cet effort complexe, les transports constituent un élément de grande importance. Ceux-ci jouent un rôle majeur pour le développement et l'intégration des autres branches économiques. En même temps, les transports assurent des liaisons normales et modernes entre la Roumanie et les autres pays du continent. Notre démarche se calque sur les aspects suivants: les objectifs du système européen de transport, les niveaux hiérarchiques du système roumain de transport (prévues afin de subir des changements destinés à l'intégration), les plus importants changements qui seront introduits au niveau des systèmes de transports et leurs conséquences géographiques.

Romania's strategy of integration into the European structures covers a wide range of economic and social areas, and specialists from all fields are striving to put them in line with European standards. One of the areas involved is transports, a major component of the development and prospective integration of all the other economic branches. Modern links between Romania and the other Continental countries are heavily dependent on transport routes and means.

The paper makes a brief analysis of the following items: targets of the European transport system; hierarchical levels of the Romanian transport subject to integration-targeted change; integration problems, major future changes of the transport systems and their geographical impact.

Under the Accord of Integration between Romania and the European Union, all the components of the system are to be revised, and a number of legal and administrative measures, implemented in the fields of trade, fiscality, social, technical engineering, environmental protection and information networks.

The aim of the Continental transport network is to ensure mobility of users (passengers and goods), and an adequate infrastructure for all types of transport means. At the same time, this European network should optimise existing capacities and enable the inter-operability of all its components. The European transport strategy has in view all types of transport and the integrated network is expected to cover all of the EU territory. It is scheduled to establish optimal links with countries from Central and Eastern Europe and from the Mediterranean Basin. For Romania, to fall in line with these objectives, it must operate a series of changes at all transport levels.

The major components of a transport system are the carriers, the users, and the labour force. Restructuring and integration involve only the carriers and the labour force.

The carriers are represented by transport means and the networks. A priority task is to improve the networks, upgrade the routes, supply requisite facilities along them and at junction points. As traffic is supposed to increase, the transport sector will provide more jobs, but to an ever better qualified workforce capable to operate with modern means of communication.

Major issues concerning Romania's integration into the transport system. A priority requirement is to create a framework at the level of European standards. Rules and regulations, administrative acts and fiscal policies must all provide free access of passengers and goods to the Romanian transport market. Evidently, free access is a matter of time, graduality and moreover of reciprocity. Another major impediment is the technical condition of present networks that cannot compete with the advanced ones of Europe. And very important still, is a climate of loyal competition among all types of transport and the elimination of discriminatory practices. Finally, passenger and freight traffic require more custom points, and fewer custom formalities.

These problems are scheduled to be solved under a ten-year integration programme (1995–2005) at an estimated cost of $40 billion. The largest share will get the railway transport ($ 12 billion) and the construction and modernisation of roads ($ 13 billion). All the money shall be put into capital investments, repair works, rehabilitation and development of services, and environmental protection. Financing is due from internal sources (75% state budget, Ministry of Transport, etc.), and from external donors – EU, through its specialist bodies.

Major future changes in the Romanian transport system. The current contribution of the transport sector to the GDP is 4.8% and a 5% job absorption from Romania's labour market. Whatever the type and means of transport, the sector as a whole is in a bad shape by domestic and foreign standards alike. The job offer is low and its employees, far too many, are unequally qualified and disseminated in the territory. The situation has worsened due the general economic decline and the population's lowering living standard, drastically reducing the number of passengers.

Modernising road-and-rail is aimed at connecting Romania to the Trans European traffic corridors: Berlin / Nürnberg – Prague – Bratislava – Budapest – Arad – Bucureşti – Constanţa – Thessaloniki / Istanbul; Berlin / Nürnberg –

Prague – Bratislava – Budapest – Arad – Timişoara – Craiova – Calafat / Bechet – Sofia –Thessaloniki / Istanbul; Plovdiv – Bucureşti – Chişinău – Kiev – Sankt Peterburg – Helsinki. New, permanent, links are to be set up between Romania and Bulgaria.

Another Trans European corridor is the Danube River, and the Romanian ports along its banks need updating.

The fast train lines qualifying for the Trans European Railway (TER) have already been established. What is required now is to improve their technical state and the services offer to meet European standards. The established routes are the following: Curtici – Arad – Simeria – Braşov – Bucureşti – Constanţa; Curtici – Arad – Timişoara – Craiova – Roşiori de Vede – Bucureşti; Episcopia Bihor – Oradea – Cluj Napoca – Vinţu de Jos – Sibiu – Râmnicu Vâlcea – Piteşti – Bucureşti – Giurgiu; Vadu Siret – Suceava – Bacău – Buzău – Ploieşti – Bucureşti; Galaţi – Făurei – Bucureşti. International agreements speak of five routes, of four corresponding terminals in Bucureşti, Constanţa, Craiova, and Oradea (Fig. 1). Other provisions: a RO-RO link between Constanţa and Samsun (Turkey), an extension of INTERCITY trains, of long-distance express night trains, operating on international routes, too.

Bringing the road network in line with the Trans European Motorway system (TEM) is a stagewise endeavour of construction and modernisation. The process is to be completed in three stages: 1) modernisation of the Bucureşti – Piteşti motorway, and the building of new motorways spanning the distance between Bucureşti – Constanţa and Bucharest – Giurgiu, and skirting the Bucureşti South ring; 2) construction of the Bucureşti – Braşov and Piteşti – Sibiu – Deva – Nădlac motorway; and 3) Braşov – Sighişoara – Cluj Napoca – Oradea – Borş, Bucureşti – Focşani – Bacău – Roman – Siret with ramification to Focşani – Albiţa and Paşcani – Iaşi – Ungheni, Braşov – Sibiu, and Bucharest – Craiova – Drobeta Turnu Severin – Orşova – Caransebeş – Timişoara. Custom points, in their turn, (road and rail) will be updated.

The navigable inland waterways are the fluviatile Danube (between Baziaş and Brăila), the maritime Danube (between Brăila and Sulina), the Danube – Blank Sea Canal, the Bega Canal, and prospectively the Bucharest – Danube Canal, and prospectively the Pruth River (when rendered navigable). The programme provides for the construction of container terminals in the port of Constanţa-South, Brăila, Olteniţa, Giurgiu, and Drobeta Turnu Severin, the connection of navigation information systems, new facilities for Constanţa-South port, the furthering of the free trade zones Constanţa-South, Brăila, Galaţi, Giurgiu, Drobeta Turnu Severin, the extension of Constanţa-South free trade zone to Basarabi harbour and Mihail Kogălniceanu airport.

Air transport has recorded major quality improvements, viz the modernisation and enlargement of Otopeni and Baia Mare airports, the upgrading of the infrastructure and of flight control systems at all airports, and the endowment of TAROM fleet with new types of aircraft.

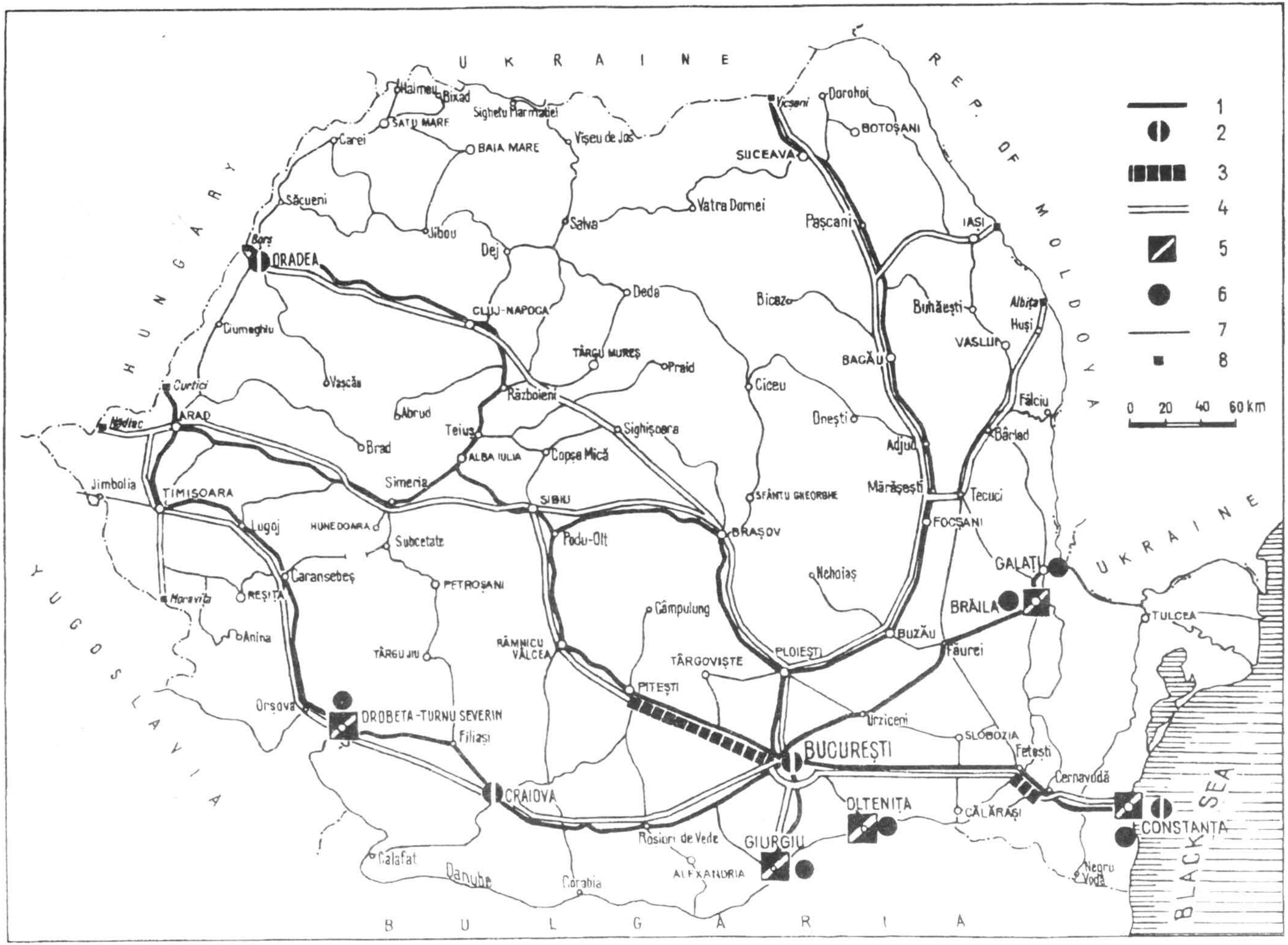

Fig. 1. – Main changes of the national system. 1, Express railways; 2, combined transport terminals; 3, present motorways; 4, future motorways, 5, container terminals; 6, free ports; 7, railways; 8, customs houses.

Changes in the transport system. Geographical impact. The stagewise completion of the above changes will certainly bear on the components of the system, benefiting users in the first place. As freight and passenger traffic will increase, road traffic on values in the year 2005 are estimated at 2.3 times the 1990 ones. Investments made in updating highways could pay off in five years' time partly from savings in additional fuel consumptions and environmental protection. International rail traffic is expected to grow by approximately three billion tonnes/km/year, and 675 million passenger/km/year. This would cash in $ 0.6 billion/year, so investments will clear off in seven years' time. With the enlargement of Constanța free-trade zone and the conclusion of the Jugoslav conflict, shipments on the Danube will reach 7,000 mill. tonnes/km/year, with revenues of $ 0.120 billion.

As the construction of new motorways will take up more grounds, land use structure and the geomorphological and hydrogeographical network will be seriously affected, yet not at county level, but rather at the level of the basic administrative units (commune or town).

Overhauling the transport system will create new jobs, but for a better qualified workforce.

The national settlement system, in its turn, will be affected, in that the oversizing of Bucharest city will continue, the polarizing role of Constanța and of other large cities, as well as, of the Danube urban ring, will increase and gain greater access. București and Constanța stand much closer on the transport hierarchical scale than on the urban scale. A third transport polarising centre – Galați – is likely to emerge. As far as the Danube urban ring is concerned, only a few towns will profit from these changes, e.g. apart from Galați, there are Drobeta Turnu Severin, Giurgiu, Brăila and partially Oltenița, provided the Bucharest-Danube Canal is commissioned. Settlements located along communication lines will diversify their functions and rank changes in the national urban hierarchy, which supposedly will widen its basis, are to be expected.

The changes entailed by the complex process of EU integration are indisputably beneficial to Romanian society as a whole. However, given the high costs involved, problems of local transport network will by necessity be postponed, aggravating already existing territorial disparities. It is not saying that a return to the old conception of forcible balanced development of all of the country's regions is the solution, but conditions should be created for the national settlement system to function normally.

The transport modernisation index (calculated at the level of the year 1995 as the arithmetical mean yielded by summating standard values for the whole length of electric train lines, the whole length of modernised roads and accessibility to air transport) reveals that there are counties in the west of Romania (Caraș-Severin, Timiș, Arad, Bihor, and Cluj) and a few ones in the eastern part (Suceava, Iaşi, Bacău, and Constanţa) with a 0.60 record. High index values, due to electric train lines and asphalted highways, register the counties of Gorj and Dolj, respectively. Bucureşti city and Ilfov county (formely Ilfov Agricultural Sector) fall into the same value group.

When motorways are commissioned, a higher modernisation record will share first the counties of Giurgiu, Ialomiţa, Constanţa, Prahova, Braşov, and Argeş, followed at a later time, by the towns and villages located along the traffic corridors. Air transport is a fast inter-regional facility, that may connect some regions to international traffic corridors, regions that have no direct access to them. The modernisation of this sector covers airports and flight control systems.

There are some geomorphologically restrictive areas for the development of fast road- and rail networks. In this case, new routes must be found, or existing ones reinforce. This asks for a huge financial, technical, and human effort. It is the case of Piteşti – Râmnicu Vâlcea rail segment, part of a fast-train traffic corridor.

But for all the modernisation of and construction drive for international traffic corridors, it should be remembered that by-links ought to be created for each and every zone to get access to them (see Law No 71/1996 which provides for the elaboration of a national territory management plan).

A better developed transport network will ultimately accelerate the exchange of mass, energy and information among all the components of the geographical space, with obvious beneficial effects for the advancement of the economy, the enlargement of commercial and tourist relations with the Continental states, making Romania more attractive for foreign investors.

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CROSS-BORDER RELATIONS IN THE GIURGIU-RUSE DANUBE SECTOR. GEOGRAPHICAL REMARKS

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Key words: boundary, cross-border relations, Giurgiu, Ruse, Romania, Bulgaria.

Considérations géographiques sur les relations transfrontalières dans le secteur danubien Giurgiu-Ruse. Après la chute des murs idéologiques en Europe, les espaces frontiers ont changé profondément leur fonction. Les conditions actuelles de collaboration et d'ouverture sont plutôt favorables à l'intensification des échanges qu'à la défunte isolation. Dans l'Europe Centre-Orientale, la fonction de barrière est abandonnée et une nouvelle phase d'intenses contacts à travers les frontières se met en place. Dans ce contexte, cette démarche tente de saisir l'évolution récente des relations transfrontalières dans le secteur Giurgiu-Ruse, dans une double perspective: d'une part celle des échanges locaux, lancés par les acteurs de décision des deux villes, d'autre part l'impact d'une croissante circulation internationale entre l'Ouest et l'Est de l'Europe dans les derniers ans. En raison de la proximité, de la taille des villes, de l'existence d'une bonne infrastructure (l'existence de l'unique pont transdanubien entre les deux pays voisins, l'existence d'une zone franche à Ruse, les projets actuels d'implantation d'une zone franche à Giurgiu, etc.), on a choisi la section Giurgiu-Ruse, considérée la plus représentative pour les relations transfrontalières développées à partir d'une paire de villes de frontière.

INTRODUCTION

The major post-1989 changes have led to a relaxation of border relations with beneficial effects on trans-frontier cooperation. Geographically speaking, this political opening appears to favour the neighbouring city-pairs on either side of the border. The forms of cooperation along the Danube line that divides Romania from Yugoslavia and Bulgaria had under communist rule covered several projects: the Iron Gate Power Station, the Machine and Heavy Equipment Manufacturing Unit in Giurgiu etc. At present, decentralisation has engendered spontaneous local relations without directives from a power centre.

The Giurgiu-Ruse city-pair is representative for a new cross-border relation type. These two cities are the largest and the best-developed urban structured along the common Danube border sector between Romania and Bulgaria. Besides, they are linked by the only trans-Danubian bridge that spans the distance between the two countries. The bridge is crossed by a railroad and a motorway, catering for international traffic. As Bucharest lies at only 60 km away from the border, the relationship between the two cities is not an ordinary one.

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For a long time now, the two cities have attracted the interest of specialists (Iacob, 1959), but most studies have avoided dealing with interrelations, preferring instead to focus on local, monographic or regional aspects within of comprehensive approaches to the Danube Valley (Ianoş, Dobraca, 1995).

The present paper is meant as a further contribution to the study of this sector with emphasis on major inter-city fluxes, their nature, evolution and motivations. The local relation is being adjusted to the requirements of the international traffic transiting the Giurgiu-Ruse city-pair. Prospective trends and opportunities in developing it are also discussed.

HISTORICAL OUTLINE

There are many factors that account for the building and development of the two cities, and not least a favourable geographical position and political imperatives. Each city has its own characteristics, the Danube itself being a divide between them. Ruse lies on a promontory of the Pre-Balkan Platform, at the contact with the Danube Valley. So, it has a better position than Giurgiu which, standing on the Danube waterplain, appears to be more vulnerable. This geographical disparity accounts for the distinct type of early fortifications erected by these two settlements to defend the Danube axis.

In Roman times, the strategic role of Ruse is marked by a stronghold (*sextanta prista*). In the Middle Ages, a fortified city was built on its foundations. The city walls provided with five defense towers used to offer protection to a prosperous population, the town itself numbering over 3,400 houses in early 17th century, that is one hundred years after the Ottoman conquest.

Opposite to it, on the place where Giurgiu stands, a small city set up by Mircea the Old (Ruling-Prince of Walachia – 1386–1418) is documented in 1395. It was conceived as a stronghold in the way of Turkish expansion. As it is, the Turkish administration introduced many common elements in the urban organisation of the two settlements. Giurgiu was turned into a Turkish rayah and stayed so until 1829 when the Adrianople Treaty led to the retrocession of the Danube rayah-ports to Walachia. Giurgiu was an important military and economic point on the Danube bank.

Militarily, it was part of an alignment of control points of the Ottoman rule, beyond which people enjoyed greater autonomy (in exchange for tribute paying). In view of it, and of the fact that the extra-Carpathian territories (the Romanian Plain) used to have a scarce population, Walachian voivodes are supposed to have shown but little interest in developing the city of Giurgiu. Economically, the city was a point of tribute collection.

At that time, Ruse was flourishing due its commercial links. A transit thoroughfare connecting central Europe to Asia Minor, the walled city was perceived as a secure halting-place in an otherwise insecure world for the caravans that criss-crossed Europe.

The undefeatable walls of Ruse were put to the test during Romania's War of Independence (1877), when unable to take the city, the millitary command decided to move the front Westwards, in the direction of Plevna.

Soon enough, Ruse became the second town of Bulgaria, by number of inhabitants, holding that rank up to the beginning of the 20[th] century. Speaking about Giurgiu/Ruse ties we must say that, until 1877, they had been almost entirely subordinated to Ottoman interests.

And yet, local fluxes in the form of population shifts and organised colonisations of scarcely populated areas, as well as shelter places in the face of political persecutions did exist. A more extended Bulgarian presence is recorded in the South of Romania.

A large part of the population of market towns like Mavrodin, Turnu Măgurele and Zimnicea were Bulgarian ethnics. Likewise, Bulgarians would set up villages along the Bucharest-Danube road. Walachian rules used to accept them, because they were skilled vegetable growers (Vărăşti, Popeşti-Leordeni, Valea Dragului etc.). While the proportion of Bulgarians and Serbs living in Giurgiu represented 20% of the city's population in 1910, the number of Romanians found in Ruse was quite insignificant.

Giurgiu will experience a relative upsurge after the Union of the Romanian Principalities (1859). In 1869, the first railroad in Romania covered the distance between Bucharest (Filaret) and Giurgiu. Oil drilling in the Prahova Subcarpathians led to establishment in Giurgiu of port-facilities for storing and exporting the oil. With Romania becoming independent of the Turks in 1877, the same as Bulgaria in 1908, a new phase in the Romanian-Bulgarian relations started.

Unfortunately, that period being marked by geopolitical events (the collapse of the Ottoman Empire) very similar to the present time (desmemberment of the Soviet communist bloc) was not beneficial for the two countries, and the strained political climate, tained by suspicion and prejudice, degenerated in open military confrontations. The peace concluded in 1878 brought Romania the province of Dobrogea, a very heterogeneous territory, with one-third of its population being of Bulgarian origin. The strained Romanian-Bulgarian relation blew up is the year 1913, when in the aftermath of several Balkan wars, Romania took possesion of the N-E part of the present territory of Bulgaria, the so-called Quadrilateral (administrated until 1940), lauching a staunch policy of colonisation.

These tensions, vailed by the post-war communist regimes, flared up again here and there after 1989. In the Iron Curtain era, the two neighbouring states were invited to undertake jointly some economic projects. These projects had surely contributed to a rapprochement between them (e.g. 1954, the *Friendship Bridge* between Giurgiu and Ruse, the Heavy Machine Building Unit).

Over the past two-three decades, the two countries adopted a different position towards Moscow. While Bulgaria was very close ideologically and economically to the Soviet Union, Romania would gradually distance itself from it, leaving the impression, to Westerners in particular, that it enjoyed relative independence. After 1989, the economic decline that hit the two countries, has sensibly reduced economic links at national level, giving prominence to local initiatives.

At the same time, dissentions over pollution sources in the Danube area, or over disaster hazards due to the obsolete technologies employed by Danube-based local units are again comming to the fore. At the root of these dissentions, often politically manipulated, lie two types of factors:

– in the first place, each state was interested in setting up along the Danube banks some large heavy industries (chemical, hydro-power and machine-building units) to profit by a cheaper raw material transport route and water supply facilities. As a result, on either side of the river there is a discrepancy between these mammoth units and settlement size;

– in the second place, we have been witnessing an upsurge of ecological propaganda, especially in Bulgaria, where "green peace" groups are very active and ecological strategies represent a compulsory ingredient of any political programme.

THE DEMOGRAPHIC AND ECONOMIC POTENTIAL OF SETTLEMENTS SHAPING THE TYPE OF FLUXES

The two cities have recorded unequal evolutions. While Ruse had been a big city since the Middle Ages, Giurgiu's population began increasing only by mid-19th century, after they have commissioned the railroad and the tanker port. Between 1831 and 1889, demographic records show a rise in the number of inhabitants from 7,000 to 15,000 persons, subsequent trends registering moderate values (30,000 in 1949). Post-war levels remained constant until 1980, when Giurgiu becomes the capital of the newly-established county. In this way, this county-seat was benefiting by a wider hinterland, its administration extending upon some settlements sited close to Bucharest (communes located at distance of 20–30 km West of Romania's capital).

Giurgiu holds rather an isolated position within the national settlement system, because it lies in a little-urbanised area. Moreover, with the expansion of Bucharest, which stands only 60 km away from Giurgiu, the chances for the latter to improve its urban development become increasingly more limited. On the other hand, Ruse holds a better rank within Bulgaria's urban system due to its early commercial boom. Its second seat in the hierarchy of Bulgarian towns has only recently been challenged by Sofia, Varna, Plovdiv and Burgas. After the Second World War, the investments in Ruse's port facilities led to a sharp population rise (Fig. 1). At present it has become the first Danubian port of Bulgaria.

In point of ethnic structure, the two cities have a predominantly national majority population, although Ruse was more cosmopolitan, just as any large port and borough. The significant Bulgarian presence in Giurgiu in the early 20[th] century is an indication of a certain trend in population shifts (Table 1).

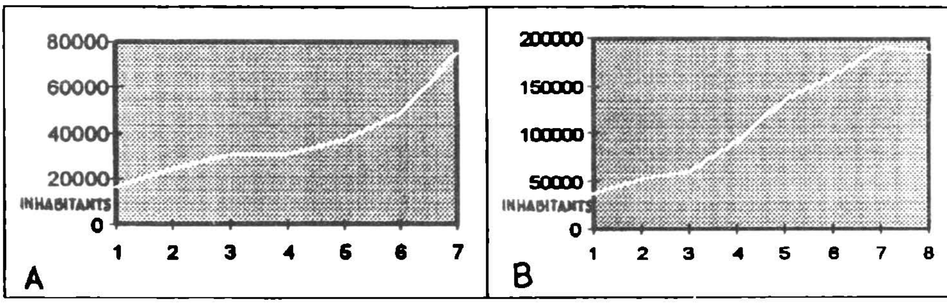

Fig. 1 – Demographic evolution in Giurgiu (A) and Ruse (B) over 1910–1992

Table 1

The ethnic structure of population

GIURGIU			RUSE		
	1910 %	1992 %		1910 %	1992 %
Total	16.016 100	74.190 100	Total	36.255 100	186.737 100
Romanians	10.298 64.3	71.275 96.17	Bulgarians	22.741 62.8	168.420 91.2
Bulgarians and Serbs	3.80 22.3	6 0.01	Turks	5.798 16	13.432 7.4
Gipsies		2.827 3.8	Gipsies	268 0.7	
Other ethnical groups	2.138 13.4	22 0.02	Armenians	1.870 5.2	
			Jews	3.851 10.6	
			Other ethnical groups	1.735 4.7	2.563 1.4

In the course of time, the economic profile of these two settlements has gradually become more similar. After 1945, commercial and port functions went hand in hand with sustained industrial development. Industry in Giurgiu goes back to the interwar period (small factories of sugar, tiles, mills etc.). In the past few decades, a heavy equipment unit and a chemical combine have been built, port facilities extended (dockyard) etc. Similar developments are notable in Ruse, too (viz. the concentration of heavy industry, and a significant tertiary sector, as well). Over the past seven years, restructuring, retechnologisation and revigoration of services, have become top priority issues. Since 1988 Ruse has a Free-Trade zone based close to the bridge. Two hundred trading companies, seven of them production firms, are awarded customs facilities. Among them, there are many Western firms (20% from the EU-member countries).

BORDER-CROSSING PERMEABILITY

Under the communist regime, border crossing was a tough issue. Frontier zones had a special, very strict regime, particularly in Romania. With very few exceptions, free circulation was prohibited. Organised trips alone were permitted. However, since people on either side of the Danube were linked also by kindship relations, a "small border traffic" regime was instituted, benefiting the inhabitants of settlements located up to 50 km from the frontier. They held a special passport which allowed a limited number of journeys/year (as a rule up to six). This facility proved very effective mainly in the 1980s, when Romania was undergoing a deep economic and alimentary crisis, but only some 6,000 people could profit by it at the time. People would cross the Danube to buy staple food, and Bulgarian-made goods could often be found in Bucharest's black market.

As from 1989, circulation restrictions have been lifted. In the first years, there were high fluxes to Turkey, in particular, suffocating Giurgiu's passage infrastructures (one-third of the travels to Bulgaria were in fact transit destinations; quite conclusive is the large number of couches registered at the Giurgiu customs point: 61,500 in 1993). Travellers did not need a visa, nor did they have to pay special dues.

In 1994, Romania introduced compulsory exit dues to any destination. They represent about 10% of the national average salary, hitting mostly the interests of small traders and sensibly depleting the travel flux. In 1996, the regulation was abrogated. At present, because of the difficult economic situation, Bulgaria is being faced with, people prefer to come to Romania, Bulgarians' choice destination being Bucharest, given the city's proximity and the reduced commercial offer of Giurgiu town.

MAIN TYPES OF RELATIONS

Whatever the intensity, continuity and type of Giurgiu/ Ruse relations and of the institutions involved, they come under the following headings:

a) *Local administrative relations*. Although the two cities are considerably close in space, their town-halls have scarcely developed any influential contacts. They have not even a twin-towns status (although Giurgiu is on such terms with Albanian and North-American towns). One of the major issues that brings administrative links closer is the environment. A joint working-group is operating since 1987, focusing on pollution level checks of the Danube waters and the atmosphere. The Bulgarians raise objections to the Giurgiu Chemical Works set up in 1983, because of polluting emissions that travelling along the Danube Valley and do not get dispersed in the higher strata of the atmosphere. The cause is Giurgiu's location at lower altitude that Ruse. A first measure was to stop the unit's chlorine production. Over the past few years, these disputes have drawn the attention of international bodies. Retechnologisation and monitoring environmental impacts are assisted by some EU-sponsored programmes (PHARE). Every three months, delegations from the two countries are organising mutual visits, and instead of continuing to hold antagonistic positions on environmental issues, they engage in more constructive cooperation projects (cultural, medical etc.). Exchanges of medical information have in view the prevention of epidemies (both human and animal) and the establishment of quaranteens whenever the case.

b) *Economic relations*. They have both a spontaneous and organised character (under the aegis of some institutions). There are few Bulgarians or joints (Bulgarian-Romanian) trading companies. According to the statistical records of the Giurgiu Chamber of Commerce, no more than five such firms exist and their turnover is low. Some initiatives have in view annual Chamber of Commerce meetings between the two cities (since 1993), the opening of a businessmen's club, the operation of the Ruse Free-Trade zone and, prospectively, the establishment of a similar one in Giurgiu, an annual farmer's fair etc.

c) *Trade contacts*. Trade contacts over the past seven years have had a fluctuating character in terms of offer and price criteria. A characteristic feature has been trading complementarity. While before 1989, food shortage in Romania proved profitable to Ruse's commercial sector, shortly after 1989, Romanian prices became more attractive for Bulgarians, because political reforms and austerity programmes in their own country started much latter. The introduction of transit dues weakened the small "business" supply sector, the market being rehabilitated only by the after its abrogation of that regulation. With Bulgaria's shaky political situation, the Romanian commercial offer becomes more attractive. That trade has a complementarity character is obvious when comparing the trading structure in the central areas of the two cities (Table 2).

Contacts have been facilitated by increasing transport facilities across the Danube (Fig. 2). A four carriage train is running daily between Giurgiu and Ruse. There are two high-capacity ferry-boats: the old one in the harbour area

Table 2

The commercial and services offer in Ruse and Giurgiu

	Number	%	Number	%
TOTAL	670	100	379	10
Commercial units:	400	60	181	48
– items of daily use	138	20	78	20
– items of periodical use	196	29	78	20
– rare and luxury products	66	10	25	6
Services (banks, restaurants, maintenance and repair shops)	225	33	159	42
Empty locations	26	4	30	7.8
New constructions	8	1	2	0.2
Renovations	11	2	7	2

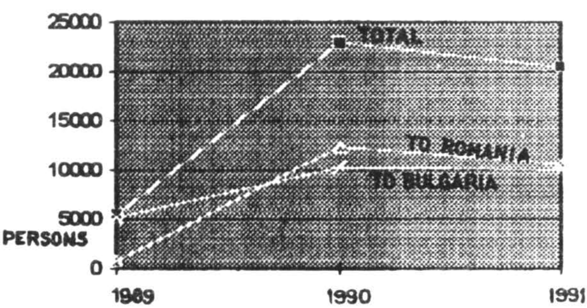

Fig. 2 – Small border traffic at the Giurgiu-Ostrovu Mocănaşu transit point.

and the recently commissioned one (1995) at the foot of the bridge over the Danube. However, there are some inconveniences too: namely, the Friendship Bridge is closed to pedestrial traffic, the second ferry point is very far from the city centre (ca 6 km), and covering the 30 km distance by train takes two hours.

d) *Cultural contacts*. This kind of contacts are incipient. A certain flow of information did exist even before 1989, when Bulgarian TV programmes were widely watched by the population from the Southern part of Romania (Bucharest included). But for a few projects and prospective attempts (broadcasts reports, mutual newspapers and visits by pupils etc.), there is nothing else.

GIURGIU/ RUSE RELATIONS AND FUTURE OPPORTUNITIES

The scope of relations and the areas involved, as it appears from the makers'appraisals is not very encouraging in point of expectancies or actual possibilities. As each city has its own interests, the problems are tackled from two different points of view.

Ruse can offer Giurgiu much in the way of economic and commercial opportunities. An important urban centre of Bulgaria (fifth in size), Ruse polarises all of the Northern part of Bulgaria. Its Free-Trade zone raises many expectations. Had language not stood in the way, the city might have contributed to extending cultural relations, given its prodigeous university and cultural life, generally.

On the other hand, Giurgiu, holds a much lower hierarchical seat, which is not particularly attractive for Ruse, it preferring to develop closer links with Bucharest that lies located quite close geographically. Recently, attempts have been made to legiferate access to medical services in Bucharest (emergencies or complications). Relations with Giurgiu are somewhat strained by located animosities in matters of environmental pollution and traffic benefits (occasionally, disagreements crop up related to the share of ferry-boat traffic dues, as was the case in 1995).

Opposing interests should be correlated with the international geopolitical situation the two were involved in. Their transit function, for example, entailing European connections, is often overshadowing local relations. The importance of these connections was highlighted by the Yugoslav crisis and embargo. Because traffic in the Yugoslav sector was disrupted, the Turkish workers returning from Germany in the summers of 1991 and 1992 had to wait at the point Giurgiu/ Ruse transit up to two days. Subsequently, in order to avoid queuing at the customs points, the Turkish Gastarbeiter flux was shifted to Italy (being ferried to Turkey from Brindisi). Confronted with serious hard currency losses, the Romanian state decided to speed up some projects to upgrade passage and traffic through Giurgiu point, putting into circulation a high-capacity ferry-boat from Ostrovu Mocănaşu (at the bridge foot). The Bucharest-Giurgiu motorway is under construction (1996) and a new customs-point to serving the extended Giurgiu Free-Trade zone was extended (1996).

We might well say that the local relation between the two cities is overshadowed by international traffic requirements in the respective sector, expected to attract most of the investments and facilities. So far now, despite vast opportunities, the two cities have been pursuing independent politics rather than cooperation relations. Rapprochements are minimal and they amount largely to mutual information and timid informal fluxes (Fig. 3).

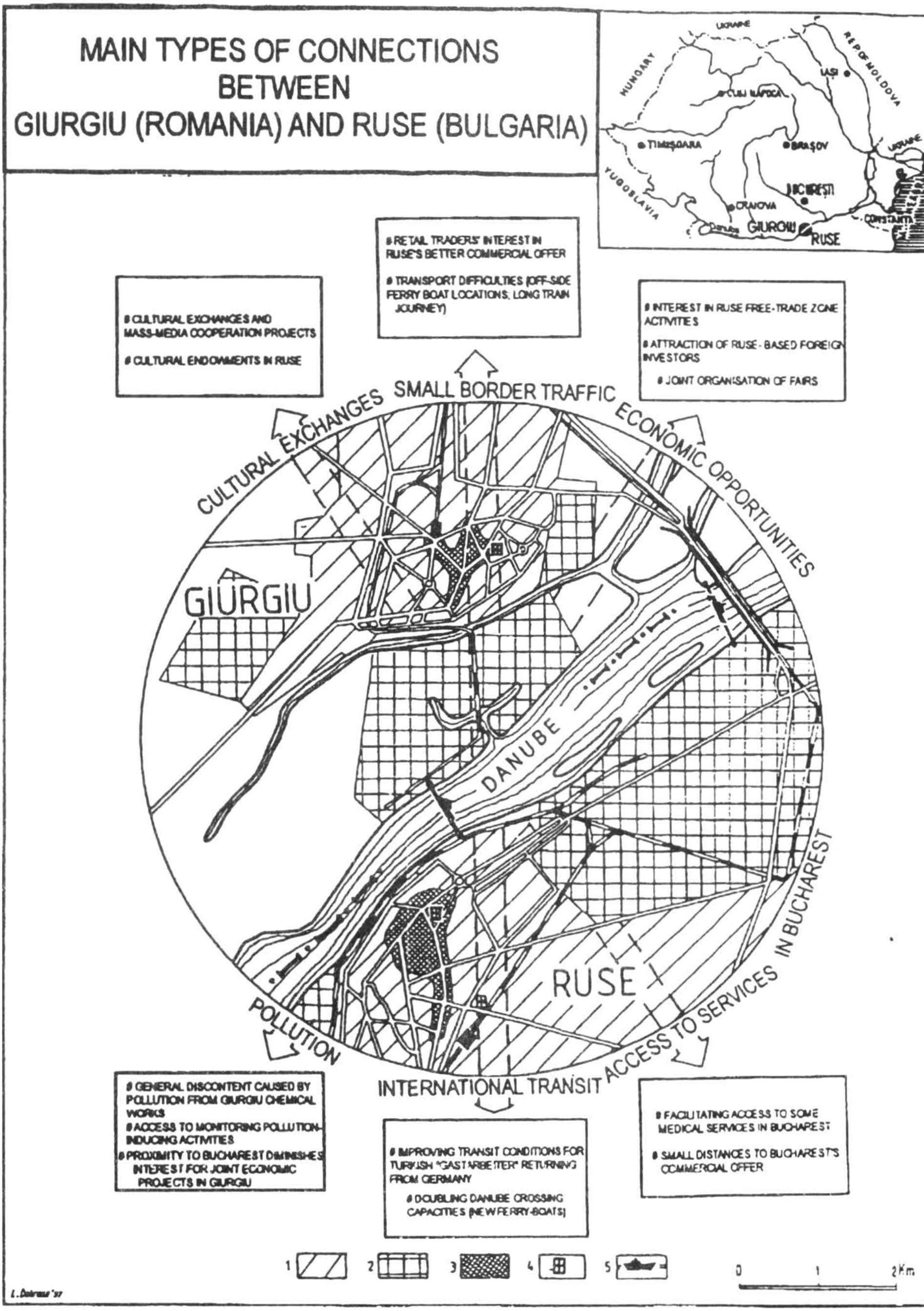

Fig. 3 – Main types of connections between Giurgiu (Romania) and Ruse (Bulgaria). *1*, Residential districts; *2*, industrial areas; *3*, commercial areas; *4*, agro-alimentary markets; *5*, ferry-boat crossings.

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PRECIPITATION – INDUCED LANDSLIDES IN THE MOLDAVIAN PLATEAU (1996/1997)

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Key-words: landslides, heavy rainfall, geomorphological hazards, Moldavian Plateau.

Les glissements de terrain déclenchés dans le Plateau de la Moldavie en 1996 et 1997 à la suite des précipitations excédentaires. Par la structure et la composition lithologique, par la cyclicité des précipitations exceptionnelles et de l'oscillation des débits de la nappe phréatique, par l'évolution de la pression anthropique, le Plateau de la Moldavie indique la prédisposition à une large répandue de ce type de glissements massifs. Parmi ceux-ci, les glissements dus à l'excès d'humidité ont la plus grande fréquence. De tels glissements se sont produits, de décembre 1996 jusqu'en mars 1997, dans presque tout le Plateau de la Moldavie, à la suite des précipitations abondantes tombées durant la période août-septembre 1996 et après la fonte de la neige accumulée entre décembre 1996 et février 1997. Le travail prend en considération ces glissements qui y ont affecté en dehors des surfaces agricoles aussi les éstablissements humains. On étudie des échantillons dans des régions critiques, récemment réactivées, par exemple les villes de Suceava et Iaşi, les villages Şcheia, Pârcovaci, Tomeşti-Vlădiceni, Duda-Epureni. Les pertes sont considérables. Plus de 250 maisons ont été affectées, environ 1000 personnes étant obligées de déménager. Des travaux de consolidation sont inutiles, un réamplacement sur le même site n'est plus possible. Dans les villes de Suceava et de Iaşi, en dehors des causes d'ordre général, on mentionne aussi la surcharge des versants par des nouvelles constructions et les défections du système de canalisation. Le processus de reprise d'activité des glissements déclenchés en décembre 1996 continue aussi dans le printemps de l'année 1997.

INTRODUCTION

The landslides reactivated in the Moldavian Plateau during the winter of 1996/1997 were a reminder that this type of mass movement is the most effective slope-modelling process and, at the same time, a category of geomorphological hazards.[1]

A geomorphological understanding of their origin in this tableland region with a hilly aspect has been made possible by studying geomorphological, geological and climatological works and by the authors' own observations made in the winter of 1996/1997, correlated with the 1996 rainfalls and referred to the multiannual means.[2]

[1] Landslides represent geomorphological hazards which, together with the other mass movements – sheet wash and gullying – are affecting the slopes of the Moldavian Tableland to the highest degree.

[2] Data supplied by the National Institute of Meteorology and Hydrology.

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The findings have shown that landslides may develop not only in the areas discussed herein, but everywhere in the tableland zone where the natural evolution of certain slope types is governed by specific geological and climatic conditions. Time-related forecasts are not easy to make, because landslide movements lie under the sign of the cyclic character of climate. However, hazard-prone areas can be outlined. The elaboration of hazard maps worldwide and in Romania, too, has shown that landslides do not always develop in areas with a high or very high degree of risk. They may occur in moderate-risk areas, or occasionally in small-risk ones.

Landslide occurrence could be accelerated by additional, unpredictable causes, of anthropic nature even, when precipitation do not reach top levels. For example, seepages from the water sewerage system supplying urban settlements (Iaşi, Suceava cities).

Landslides had focused the attention of geologists and geomorphologists beginning with the last century, having been dealt with from all points of view ever since: mechanism, role in slope evolution, distribution, association with erosion processes, and dependence on land use practices. One of the reasons for so many specialists (in natural sciences and in geographical science) being involved in studying their evolution, especially over the past few decades, is the fact that they turn out to be a natural disaster. The underlying cause is the ever increasing and extended human pressure (exploitation of resources) in areas where the natural evolution of slopes is marked by sliding processes.

THE RELIEF. GENERAL FEATURES

The Moldavian Plateau[3] (Fig. 1), is a platform unit situated outside the Carpathian Mountains and the Subcarpathians of Moldavia. Its long geological evolution was marked by tectonic movements, the intensity of which in the N–W and the S–E parts was fairly different. As the sea-waters kept retreating to the South and South-East (between the Sarmatian and the Quaternary), the emerging land was being progressively modelled by external morphogenetic factors. In this way, a variously-aged relief came into being: more evolved in the Northern and Central parts (Suceava Plateau, Moldavian Plain and partially the Central Moldavian Plateau) as against the Southern part (Tutova Hills, Fălciu Hill, Covurlui Plateau), which still preserves fragments of Pliocene or Pliocene-Quaternary plains in the interfluve areas. This distinct evolution is visible in the morphographic features, too (the N-W to S and SE orientation of interfluves

[3] 23,085 sq km represents 9.68% of Romania's surface area (Badea, Dumitrescu, 1985).

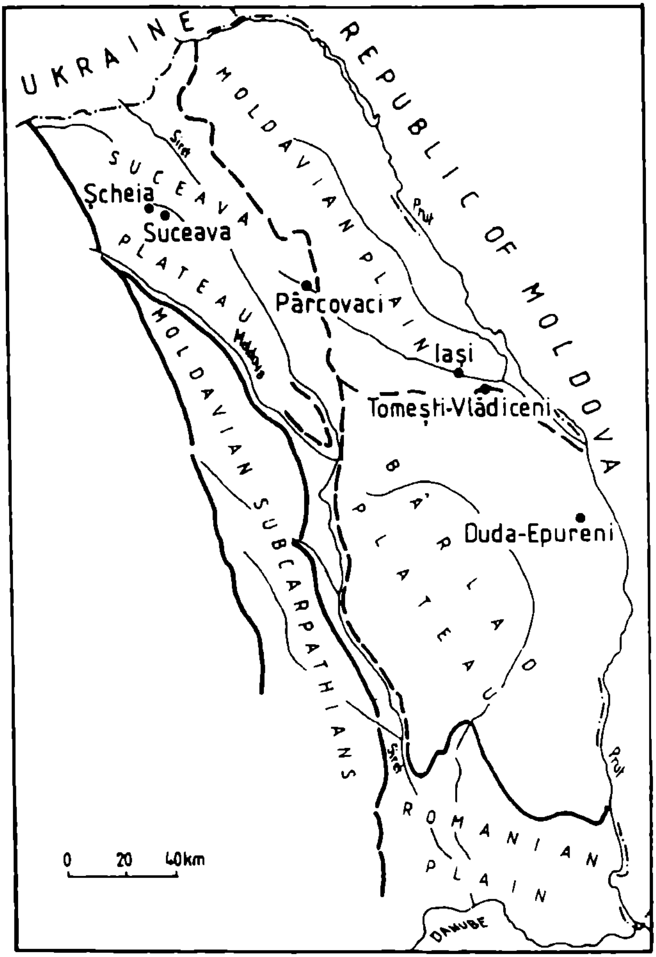

Fig. 1 – The Moldavian Plateau – Geographical situation.

and valleys) and in the evolution of slopes. The region features by moderate altitudes (250 m); density of relief fragmentation is 0.7–0.9 km/sq.km; median energy 125 m and average slope dip 10° to 15–20° (*Geografia României*, 1992). Major landforms are shaped by a monocline structure and the alternation of erosion-resistant horizons (limestones and sandstones) with marl-clay and sandy deposits. The N, N–E, or N–W-oriented scarps have facilitated the development of cuestas (the Iaşi Cuesta between Strunga and Tomeşti is nearly 50 km long). These cuestas delimit large structure-controlled surfaces (plateaus) situated at heights of 300–400 m, with S–E inclinations. It is on these surfaces that landslides associated with sheet wash and deep (linear) erosion are recorded, marking the present relief of the Moldavian Plateau. It has already been said that landslides are the major factor of the present-day relief modelling.

GEOMORPHOLOGICAL RISK FACTORS IN THE MOLDAVIAN PLATEAU

The main factors involved in landslide hazards are: precipitation, lithology, geological structure and human activity.

Variability of precipitation regime. The N–E extra-Carpathian location of the Moldavian Plateau, as well as its low altitudes favour the onset of continental masses of air coming from the N–E and N (Erhan, Precupanu, 1995). These masses of air bring with them moderate amounts of precipitation. In point of space distribution, annual means show a twofold decrease: from W to E and from N to S. While the annual means recorded in the high hilly zone of Suceava Plateau seldom exceed 600 mm (with only 579.5 mm in the depressionary corridor of Suceava city), the values recorded in the Bârlad Plateau are below 524.0 mm and under 500 mm in Huşi, a town lying in the South of the region). The foehn effect present in the Moldavian Plain (Pânzaru, Apetrei, 1995) on the Eastern slopes of the Siret Hill and the Northern slopes of the Bârlad Plateau (*Geografia României*, 1992) also contributes to depleting the quantities of precipitation (Iaşi, 530.8 mm/year).

The quantity of precipitation fallen in the Moldavian Plateau is highly variable: in 43% of cases, summated annual amounts do not exceed 400 mm, in 28% they go over 600 mm, ranging between these extremes in only 29% of the cases (Băcăuanu *et al.*, 1980).

In point of climatic cyclicity, this century has recorded years with the highest annual means of precipitation due to intense cyclonic activity and advection of moist masses of air (1990, 1912, 1933, 1940, 1941, 1950, 1966, 1969, 1970, 1975). In these years, the fallen quantities were almost twice the normal value. A few months after abundant rainfalls are recorded landslide is being reactivated. However, slides can be reactivated also by rapid water gradient changes during deficitary precipitation periods.

In the North and Central parts of the plateau highest quantities are registered in June, lowest ones in February. More than 60% of the annual precipitation fallen from April to October, a period with the highest number of rainy days, were followed by landslides towards the end of that period or immediately after (Billard *et al.*, 1992).

Rainfall is followed by the December–February snowfalls, when water accumulates on slopes in solid form. The greatest number of days with snowfall (43–47) and snow layer (75), as well as the thickest snow layer (25 cm) are registered in Suceava Plateau and in the Central-Eastern part of Bârlad Plateau. In 1996, the monthly quantities recorded at Suceava, Cotnari, Iaşi and Huşi stations topped the multiannual means (1901–1990) by almost four times in Iaşi and over two times at the other three stations[4] (Fig. 2).

[4] Summated quantities in August and September 1996: 245.7 mm (Suceava); 215 mm (Cotnari); 293.4 mm (Iaşi) and 214.8 mm (Huşi).

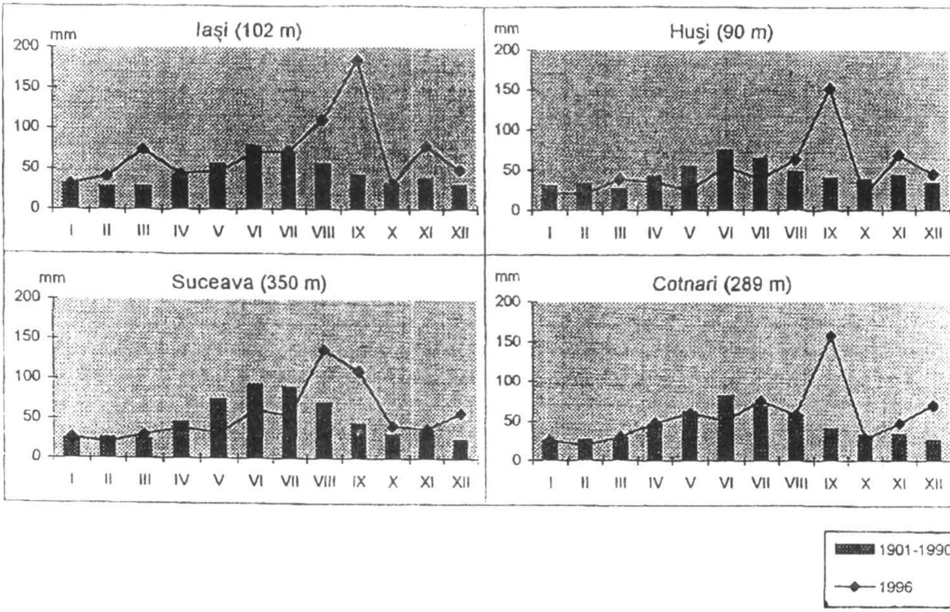

Fig. 2 – The multiannual precipitation (1901–1990) and monthly precipitation in 1996.

A particularity of precipitation variations in the year 1966 was the absence of the June maximum, characteristic of the Moldavian Plateau. It occurred in September when, like in February, minimum values are the rule. Also, the August falls topped the multiannual mean, and a second maximum developed in November and December, all of which reactivated landslides in December. The process went on due to short thawing periods followed by snow melt in January, February and March.

Consistency of surface deposits and outcropping rocks. Cohesion plays a major role in the region's slope stability. The alternation of permeable rocks with impermeable ones is a characteristic feature of the Moldavian Plateau. Rock complexes consist of a succession of marl-clay deposits with sand intercalations, "protected" in the Northern part by oolithic limestones, conglomerates and Sarmatian sandstones (Jeanrenaud, 1977). Sculptural processes, especially landslides, rock-and-soil falls and gullying led to the rapid development of cuestas; moreover, isolated outliers were dislodged, e.g. at Hârlău Pârcovaci-Cotnari, or at Vlădiceni-Tomeşti (Băcăuanu *et al.*, 1980).

In addition, wherever the Sarmatian plate was undercut fallen blocks and sharp rock fragments can be seen in the structure of deluvial covers. Wherever sands and sandy-clays are dominant ample colluvial glacis were formed at the foot of the slopes.

The Moldavian Plateau has all the tectonic-structure-controlled conditions for mass movements to set in and became reactivated. Tectonic oscillations are of small amplitude, but very extended. This created a monocline structure with mild inclination of the strata (5–8 m/km) from N, N–E to S, S–E (Băcăuanu *et al.*, 1980). The drainage network had a normal evolution, with main consequent valleys, and subsequent secondary ones (developed during the Pliocene-Quaternary). With the emergence of cuestas the network of subsequent valleys developed not only as the valley network evolved, but more especially through deluvial processes (the cuestas bordering the Moldavian Plain to the East and South). Even today, the Moldavian Plateau is affected by some positive neotectonic movements, their intensity decreasing from the North (3–4 mm/year) to the centre (2–3 mm/year) and the South (0–2 mm/year). This accounts for enhanced erosion and augmentated deluvial processes which, as a whole, cover about 60% of the Plateau area (Băcăuanu *et al.*, 1980), spreading on slopes, tablelands, summits, structure-controlled surfaces and cuestas, as well.

HUMAN ACTIVITY

It influences sliding by destabilising the slopes. This is largely the case of Suceava and Iaşi cities, where slopes are overloaded with heavy structures, with roads, heavy traffic, the construction and defective use of pipe-lines and drainage systems. The rural settlements (villages and hamlets) affected by it have a small population (Pârcovaci, Sfântu Ilie, Şcheia, Tomeşti-Vlădiceni, Duda-Epureni), homesteads spreading in the lower and median sections of the slopes, close to the commons (Gugiuman, 1959). Waters from spring lines (which occur in the upper and median section of slopes between Pârcovaci and Tomeşti) and from precipitation, having no appropriate drainage systems, stagnate in the microdepressions of the old deluvium, or seep into the ground, contributing to destabilising it. Slopes are overloaded with light structures built of wood adobe, wattle, without solid formations and seldom bolts and concrete, that are low moisture-resistant and easily degradable. Replacing forest land with pastures, orchards and cropland, coupled with the construction and reconstruction of houses on slopes already affected by previous slides, had disastrous consequences.

So, all this tectonic-structural and petrographic make-up, together with the climatic and anthropic factors, have shaped a morphogenetic system peculiar to the Moldavian Plateau, deeply marked by landslides.

On the high hillslopes (300–600 m) of the Suceava Plateau and the Central Moldavian Plateau, as well as on the cuestas cutting oolithic limestone and sandstone deposits, two generations of slides are visible:

Old slides of Pleistocene-Holocene age, marked by deep dislocations, show-up today in the form of stable-looking steps.

Recent slides, dating to historical or contemporary times, cover as a rule, the old slides without, however, being as extended. They are noticeable in surface horizons in the form of monticles, pockets, and ripples, being always reactivated by heavy rainfall. The catastrophic reactivations recorded in this century as the expression of climate cyclicity, have destroyed settlements, agricultural grounds and roads. In 1970 alone, a year with heavy precipitation throughout the area, slope denudation was particularly severe in the Subcarpathian zone of Vrancea and Vâlcea (4.7–4.8 t/ha/year), Transylvanian Plain (4.5 t/ha/an) and the central part of the Moldavian Plateau (4.4 t/ha/year) (Moţoc, 1982).

In the Moldavian Plateau, present-day modelling is associated regionally with: areas of sheet wash, deep erosion, and moderate landslide (Suceava Plateau and Moldavian Plain) and severe slide areas in the East and South of the Bârlad Plateau; areas of deep erosion, sheet wash and landslide (Tutova Hills) (Bălteanu, 1992).

Landslides reactivated during December 1966-March 1997 in the wake of heavy rainfall (August–September, 1996) has added to the underground sheet of Sângeap Hill and the mass of deluvia. So, lasting rain at the end of November and in the first decade of December (Fig. 2) and short spans of snow-melting during December–February, 1997 overcame the critical slope stability threshold, reactivating landsliding. The spread of precipitation before sliding set in was as follows: twice the multiannual mean for the respective month (July, August, and September in Iaşi and at Cotnari; August and September in Suceava and Huşi) associated with maxima of 25–73 m/24 hrs[5].

Landsliding had a wider diffusion in the Suceava Plateau (the town of Suceava, the villages of Sfântu Ilie and Şcheia), on the cuesta scarp surrounding the Moldavian Plain (Pârcovaci, Tomeşti-Vlădiceni, in the South of the Moldavian Plain (Iaşi) and the North of the Bârlad Plateau (Duda-Epureni)[6]. In terms of the limit conditions (thresholds) of the parameters involved in the stability of slopes cut in clay-sand-marly rocks, precipitation-induced sliding is wide-ranging, affecting as a rule slopes on which areas of active slides alternate with temporary stable ones.

Suggestive landslide cases are: Pârcovaci in point of dynamic and expansion; Tomeşti-Vlădiceni, of diversity of manifestation, and Suceava and Iaşi of urbanisation impact.

At Pârcovaci (fig. 3), on the right bank of the Bahlui, an old landslide became reactivated beginning with December 7/8, 1996 (Dinu, Cioacă, 1997). It had a rapid course[7] on December 7–11, moderate on December 12–22, slowing down in the following months. The dislodged mass presents monticles, microsteps

[5] This combination of precipitation is one of the major factors of denudation at the rate recorded in the Subcarpathians (0.5–10 mm), recurrence interval every 5–7 years (Bălteanu, 1992).

[6] Only catastrophic landslides are mentioned.

[7] The classification of landslide dynamic (Sharpe, 1938; Eckel, 1958; Varnes, 1978): rapid (0.3 m/min–1.5 m/day); moderate (1.5 m/day–1.5 m/month); slow (1.5 m/month–1.5 m/year).

and rotational slides, mud flows, furrows and fragmented moulds. Their incidence is higher in the median section of the slide. The fringes are covered by gullies that overlap longitudinal fissures, the future extensions of lateral scarps. Four distinct morphodynamic sections were distinguished in longitudinal profile, according to the degree of association and discontinuity thresholds. A few isolated households were destroyed, and some local roads damaged (third section). The material dislodged was compressed in the Bahlui floodplain, some homesteads and orchards were destroyed and the Bahlui was temporary blocked

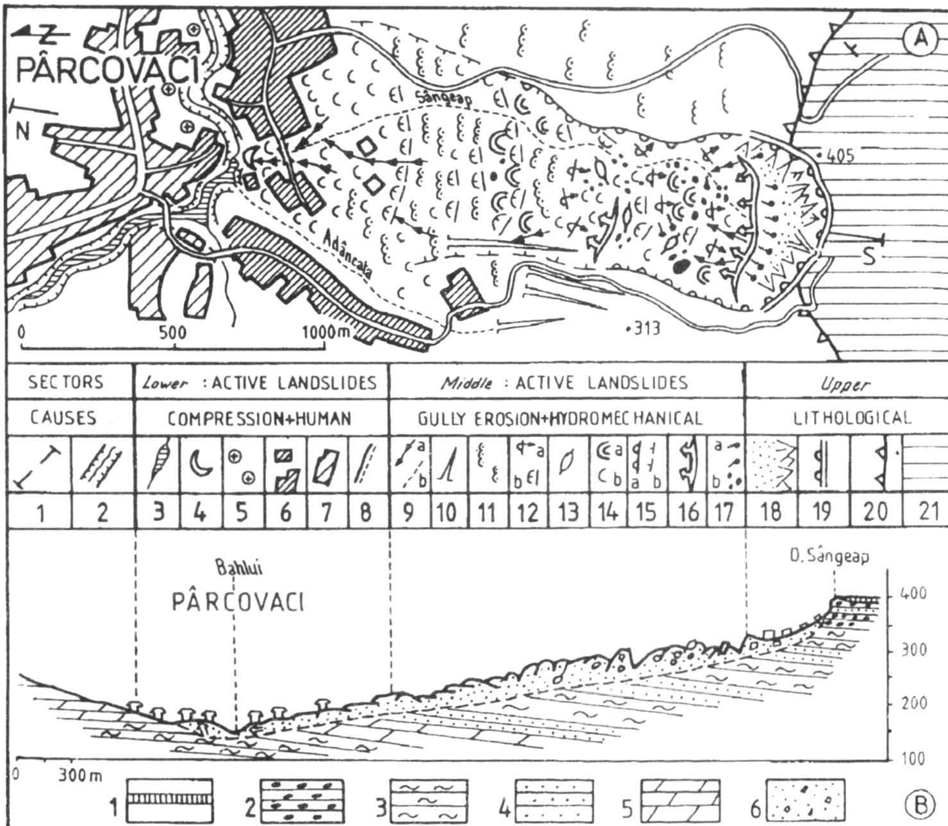

Fig. 3 – The Pârcovaci landslide: **A**, Geomorphological outline *1*, Structure-controlled area; *2*, cuestas; *3*, old scarp; *4*, rock and soil falls; *5*, sources (*a*) and lakes between sliding ripples (*b*); *6*, present scarp; *7*, active scarp (*a*), and lateral scarp in formation (*b*); *8*, deep landslides (*a*) sheet slides (*b*); *9*, monticles; *10*, rotational slides (*a*) and slide steps (*b*); *11*, slide riplles; *12*, gullies; *13*, mud flows (*a*) and torrents (*b*); *14*, tracks along which gullies are formed; *15*, settlement area; *16*, affected area; *17*, area with local swellings; *18*, end section of the slide; *19*, lake emerged behind the dam formed by the end section of slide; *20*, minor channel-bed flanked by natural banks; *21*, profile line. **B**, Landslide – profile: *1*, Repedea ooliths; *2*, Bârnova' s grey-blue clay and sand with clay; *3*, Şcheia' s sandstone and sand; *4*, gravel and sand in the alluvial plain; *5*, slide material.

due to the elevation of the minor channel bed and the cumbering of the ground on the West side of the valley (fourth section) (Dinu, Cioacă, 1987). At Tomeşti-Vlădiceni (Fig. 4), only a small part of the slopes affected by old stable slides was reactivated, but the forms of manifestation were very diverse. For example, at Tomeşti, on the Western slope of Opinca Hill, small ripples and superficial creeks appeared on the old slide, (cultivated with vine), in the first ten days of December. On the opposite slope reactivation led to a 2 m-sinking

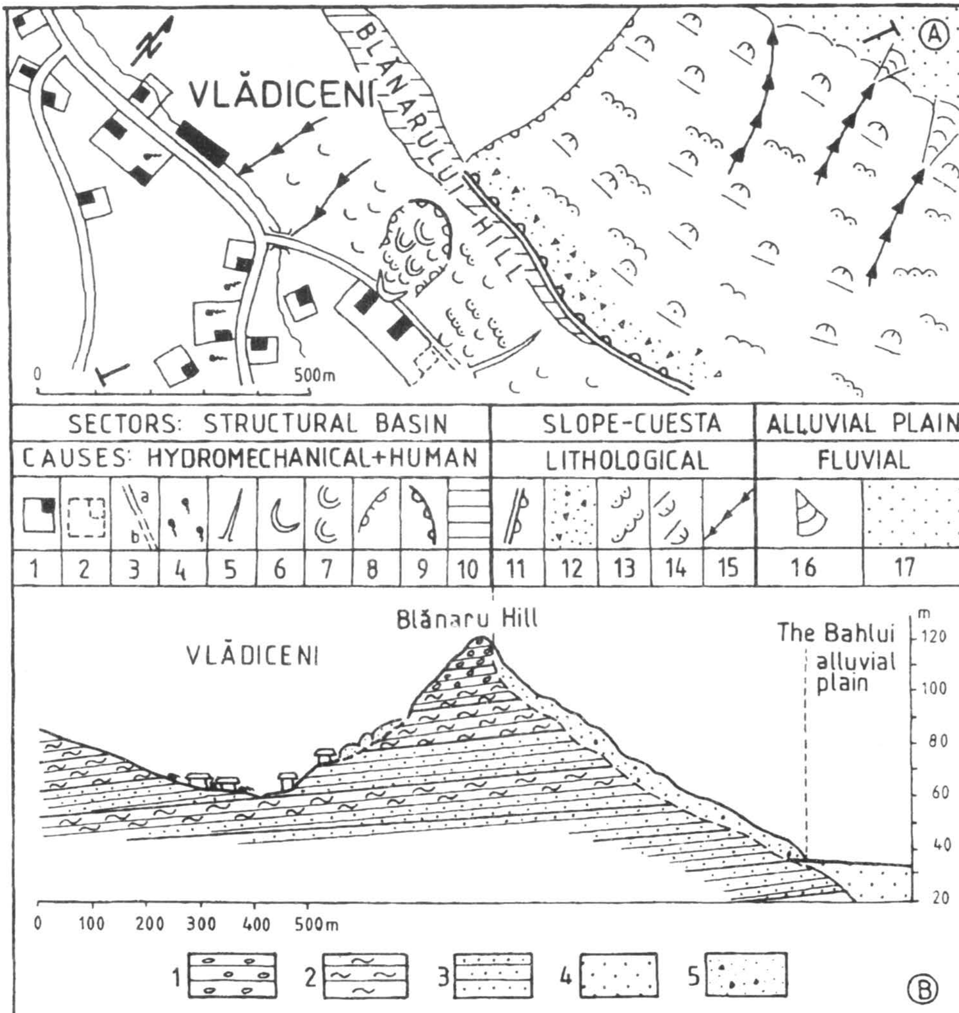

Fig. 4 – The Vlădiceni landslide: **A**, Geomorphological outline *1*, Households; *2*, abandoned households; *3*, roads (*a*); abandoned roads (*b*); *4*, sources; *5*, gullies; *6*, end section of the landslide; *7*, landslides; *8*, active lateral scarp; *9*, present scarp; *10*, structure-controlled area; *11*, old scarp; *12*, rock and soil falls; *13*, slide ripples; *14*, slide steps; *15*, mudflows; *16*, mudflow fans; *17*, alluvial plain.

which fissured the walls of two houses. In Vlădiceni village (Tomeşti commune), behind the outlier dislodged by rapid cuesta evolution, spring lines appeared at the foot of the slopes, affecting 14 homesteads and Saint Nicholas church (already ramshakled by the March 4, 1977 earthquake). On the Southern slope of Blănaru Hill, affected by old slidings, farther down the clay quarry, a lenticular slide covered the village road, stopping in the fances of two homesteads; in January, those houses showed creeks and dips caused by sinking.

Over 60% of the grounds – pastures, communes, croplands, orchards and vineyards-are damaged by slides.

Landslide in Iaşi city is a recurrent phenomenon on the edge of plateaus and terraces sheltering residential districts – Copou Hill, Sicău, Bucium, Păun, Sărărie, Blvd. Ştefan cel Mare, deteriorating old houses and patrimonial buildings (the Metropolitan House, the National Theatre, the Palace of Culture), water and gas pipes. Cetăţuia Hill and its Monastery (Cetăţuia) are also affected.

This winter, landslide in Suceava city (Fig. 5) hit the North and North-East-oriented cuesta at the junction of the Suceava with its tributary, the Şcheia. In the city itself, sliding developed on Zamca Hill cuesta (386 m) in the perimeter of Petru Rareş and Tăbăcăria streets. Reactivation involved only the 1,250 m-long cuesta cornice, producing stress-induced fissures and down-sagging on the structure-controlled surface covered with constructions. The slides that followed damaged over 60 houses. The old sliding deluvium in the median and lower parts of the slope (300–350 m alt.), with streets and buildings, was not entailed in these movements. Cuesta reactivation was due to lasting overmoisture on slopes after the heavy rains of August and September 1996, and the snow-melting of January and February, 1996. These quantities added to the pre-existent ones due to seepages from the sewerage system, maintaining a high underground water level[8]. The instability of this slope increased through the building of new houses and garages, and the trepidations produced by heavy traffic along the new artery that links the city with the E 85 highway going to Siret.

Drainage works undertaken during the past two decades proved effective only in the lower part of the sliding deluvium where they reached down to the base rock. Above the deluvium, caissons did not go that far down, and were not continued to ensure appropriate drainage, and so the landslides of winter 1997 damaged and dislodged them. Within that same interval, slides affected the villages of Sfântu Ilie Nou and Sfântu Ilie Vechi, as well as those located between Şcheia and Mihoveni on the cuestas lying at the junction of the Şcheia Brook with the Suceava River. Also the upper and the median sections of the slopes, commune grounds and the adjoining houses were destroyed.

[8] Information on the evolution of the February-March 1977 Suceava landslides were kindly supplied by C. Brânduş, from the University Ştefan cel Mare; Suceava.

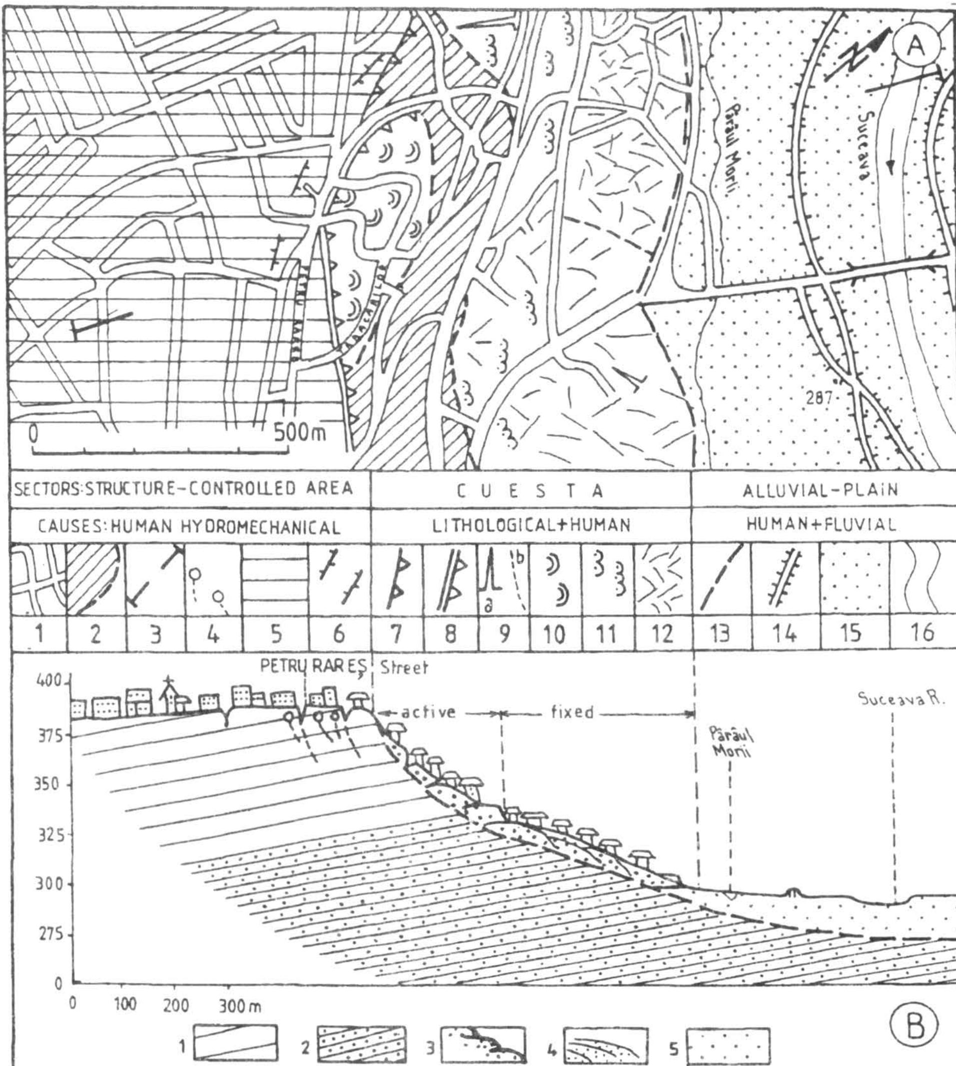

Fig. 5 – Suceava landslide: **A**, Geomorphological map. *1*, Street network; *2*, older landslide-affected area; *3*, profile line; *4*, water source from the city's sewarage system; *5*, structure-controlled surface; *6*, recent creeks; *7*, cuesta cornich; *8*, active scar; *9*, gullies (*a*), ravenes (*b*); *10*, active slides; *11*, sliding deluvia; *12*, sliding glacis; *13*, glacis line toward the floodplain; *14*, dams; *15*, floodplain; *16*, secondary channel. **B**, Slide profile: *1*, sands with clay and sandstone intercalations; *2*, Burdujeni oolithitic sandstone; *3*, mobile brittle formations; *4*, old sliding deluvium; *5*, alluvial deposits.

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APPRAISALS OF THE LANDSCAPE BALANCE – A FIRST STUDY STEP IN EVALUATING THE ENVIRONMENT CARRYING CAPACITY. TEST AREA – IALOMIŢA SUBCARPATHIANS

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Key-words: carrying capacity, landscape, landscape balance, Ialomiţa Subcarpathians.

L'évaluation de l'état d'équilibre du paysage – une étape vers l'estimation de la capacité de support de l'environnement. Région-test – les Subcarpates de Ialomiţa. Dans le cadre des démarches concernant la présentation de l'environnement dirigée vers un développement durable, le principe essentiel est l'organisation optimale des paysages. Cela implique l'adaptation des exigences de la société humaine aux possibilités réelles de l'environnement. L'article présente une opinion concernant l'évaluation de la capacité de support (*carrying capacity*), par une méthode testée dans une région de Roumanie à milieu critique.

INTRODUCTION

The more has man kept interfering with the functional capacity of natural landscapes, the more stringent the necessity to develop a monitoring system. The aim of the system is to integrate all levels of landscape organisation, with focus on structural stability. This undertaking is extremely useful to estimating the environment carrying capacity.

Estimating carrying capacity means detecting landscape vulnerability thresholds, ecological landuse limits, stress agents, and forecasting conflictual situations. With that end in view, a methodology ought to be devised in order to determine landscape ecological stability, anthropic impact, and the management of natural resources.

The present study presents a modality of expressing landscape ecological stability at regional level.

METHOD

The literature abounds in principles and methods to identify and delimit landscape units and subunits. Test area cover wider or smaller surfaces of greater or lesser complexity. So, the respective theoretical appraisals reflect at a certain point the concrete reality underlying them.

The present study covers an intensely populated area (1,100 sq km and about 220,000 inhabitants), located in the Subcarpathians of Romania (Fig. 1).

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The major element which governs the functional properties of the Ialomița Subcarpathians is the *relief*, given that its brittle rock structure (largely of Mio-Pliocene age) is subject to active tectonic and weathering processes.

Morphology as a whole shows an alternation of hills with anticlines and depressions with synclines. As a rule, altitude increases from the South (ca 400 m) to the North (ca 900 m). The *mild bioclimate* of the area has favoured the development of the *mesophile leafy forest on the nemoral belt*. Local geographical conditions have led to the emergence of three characteristic *sub-belts*: durmast woods: alternation of beech with durmast; and beech woods in the hills. With *human pressure growing*, the forest area kept shrinking to make room for pasture lands, hayfields and orchards, rural and urban settlements and even installation of some power units, as well as siderurgical and building-material industries.

In trying to assess what the landscape balance is like at present, we proceeded from a major imperative of great topicality, namely *optimum ecological environmental management* (that which Drdos and Miklos named "ecologising spatial organisation").

Identifying landscapes in terms of their ecological balance was done by means of some *synthetic indicators*. Setting the exact variables of a geosystem's balance remains a difficult task, because such variables represent links in the chain of matter and energy exchange that goes on inside the system, and are usually expressed in qualitative terms (the scale running from "very good" to "very bad") (Muică, 1994/1995).

Appraising the situation of landscapes today involved *two stages*: in a first stage the highlight fell on the relationships among "natural" components characteristic of the studied landscape pattern (abiotic). The second stage focused on the relationship between these components and the human element.

STABILITY DEGREE OF ABIOTIC ELEMENTS

The two synthetic indicators chosen here are *geodeclivity* and *density of gully-induced fragmentation*.

Geodeclivity (GD) expresses the complex relationships among lithology, structure and tectonics, "translating" the rate and intensity of their dynamic into slope shape. At the same time, GD stores also morphohydrographic and climatic information, thereby representing one of the major factors involved in ecosystem genesis and evolution. Our study uses *five declivity categories*, each one being assigned a notation depending on the class interval of analysed slopes (Table 1).

The indicator of *gully-induced fragmentation density* (DGF) points out the dynamic and direction of evolution in the functioning of the Subcarpathian geosystem, integrating information concerning the sense of tectonic movements as reflected by the headway regression of sources, degree of rock brittleness, of soil and vegetation cover and the intensity of human pressure. For research purposes, yet not overstretching the expression limit of this parameter, a *scale of five density categories* was devised, without any notation (Table 2). With the help of these two variables (GD and DGF) a *grid* expressing the *stability degree of the major natural landscape components* (Table 3) has been established. Notations were made after confronting successively what stood on the map with the information gathered on the ground.

Table 1

Geodeclivity categories

Category	Declivity	Notation
I	< 5°	Mild slopes
II	5–15°	Moderate slopes
III	15–25°	Steep slopes
IV	25–45°	Very steep slopes
V	> 45°	Sharp dipping slopes

The *five categories of abiotic components stability, acting as landscape coordonators,* are: *I – very good; II – good; III – medium; IV – weak; V – very weak.*

The *second stage* involved *mapping out these five categories*. We proceeded as follows: a 1 km² basic unit square pattern was drawn on tracing-paper. This unit was taken to best represent the complex, mosaic-like structure of the Subcarpathian landscape on the scale of 1:100,000.

Table 2

Categories of gully fragmentation density (km/km²)

Category	Declivity
I	< 0.5
II	0.5–1.0
III	1.0–1.5
IV	1.5–2.0
V	> 2.0

Table 3

Stability appraisal grid of the major Subcarpathian landscape natural components

GD(°) / DGF (Km/Km²)	< 5	5-15	15-25	25-45	> 45
< 0.5	I	II	II	III	III
0.5-1.0	II	II	III	III	IV
1.0-1.5	II	III	III	IV	IV
1.5-2.0	III	III	IV	IV	V
> 2.0	III	IV	IV	V	V

The pattern was then successively laid over the geodeclivity and gully-induced fragmentation density maps, each square area fitting thus one of Table 3 steps. In this way, we obtained the *map of stability of natural components coordinating the landscape*. The map offers a first overall image of landscape components vulnerability (Fig. 1).

LANDSCAPE BALANCE

This stage focuses on the *relationships between man and the natural components*. The synthetic indicator – *type of landuse* – is thought to express most accurately the extent to which man has changed the natural landscape. The landuse map allowed for a scale *denoting the degree to which the natural potential vegetation* (i.e. which would populate the respective territory gradually over one hundred years provided that all human activity is stopped – Muică, 1994/1995) *has been damaged*. For the sake of unity of this approach a *five category scale* was again established (Table 4). Looking at the grouping of landuse types one might wonder why simple meadows and orchards with mixed uses have not been listed on separate steps. As a matter of fact, the reality on the ground gives no indication that our listing, i.e. having the same number of steps (five) like in the previous stage, is in any way objectionable. Like in the previous case, we superposed the 1 km^2 base unit square pattern on the landuse map; making out the dominant category inside each square. The map of human pressure thus obtained attaches to *the five human pressure categories* (Table 4) the following notation: *I-very weak; II-weak; III-moderate; IV-high; V-severe*.

What followed next was to *build an appraisal grid* resorting to the two indicators yielded by the two working stages, viz *stability degree of the natural system (SDNS) and intensity of human pressure (IHP)* (Table 5). The five categories listed in the grid were again obtained by confrontation between the field reality and the map. It is not an automatically-established scale.

Superposing the SDNS and IHP maps, according to the respective grid yielded the *final map of the state of Subcarpathian landscape balance* (Fig. 2) with five categories of areas. Notations are based on field work carried out in the Ialomiţa Subcarpathians:

I – very well balanced – landuse corresponds to the environment carrying capacity; very little vulnerable (e.g. the forest ecosystem of mild, little fragmented – under 0.5 km/km^2 – slopes).

II – well balanced – landuse corresponds to the environment carrying capacity, weak degradation forms, removable in a relatively short time-span by means of low costs (energy), simple agrotechnical measures (e.g. orchard with mixed uses located on rather unstable slopes).

III – unstable balance – landuse is environmentally friendly but abiotic components being vulnerable, great care should be taken when it comes to the intensity of uses. Removing degraded forms requires low costs (energy) and simple agrotechnical measures (e.g. meadows with sparse trees and medium and weak stability of abiotic components).

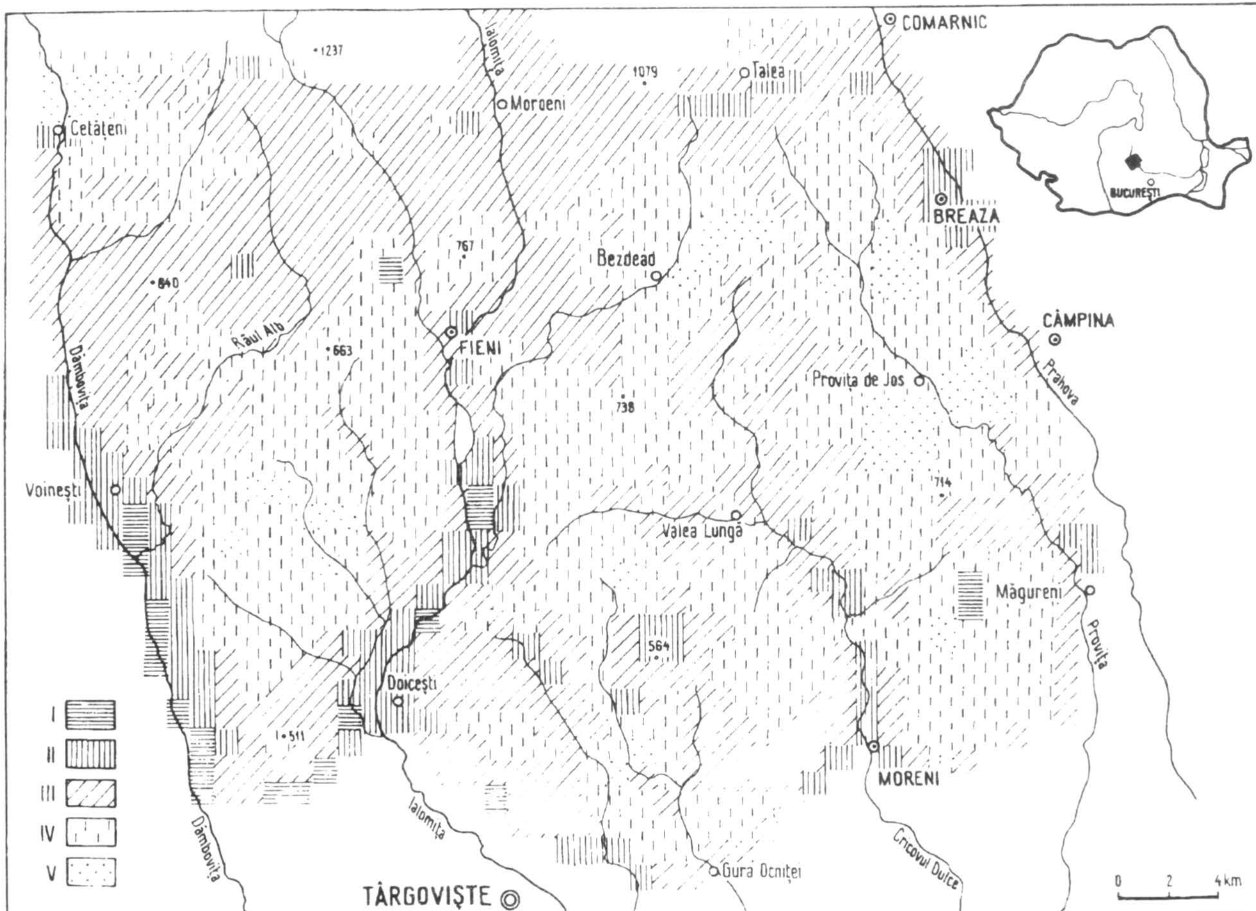

Fig. 1 – Stability degree of abiotic components.

IV – weak balance – intensity of landuse overpasses the geosystem's self-regulation capacity; very vulnerable. Extended forms of degradation in the area, costs (energy) and agrotechnical measures of melioration and respite of anthropic activity (e.g. overgrazed meadows with low and very low stability of abiotic components).

Table 4

Intensity of human pressure mirrored by potential natural vegetation changes

Category	Tipe of uses
I	Forest
II	Forest with sparse trees Bushes Forest with sparse trees and bushes
III	Meadows with sparse trees Meadows with bushes Meadows
IV	Orchards put to mixed uses
V	Orchards put to intensive uses Vineyards; arable land Settlements and roads

Table 5

Landscape balance appraisal grid

IHP \ SDNS	I	II	III	IV	V
I	I	I	II	II	III
II	I	II	II	III	IV
III	I	II	III	III	IV
IV	I	II	III	IV	V
V	II	II	III	IV	V

V – very weak balance – inappropriate landuse in terms of the environment carrying capacity; extremely vulnerable, therefore any economic exploitation should be stopped; rehabilitation requires costs (energy), melioration agro-technical measures, conservation regime (e.g. aged orchards with mixed uses, overgrazed, in conditions of very weak abiotic components stability).

In cases of landslide, the square was lowered by one step as against its normal place.

CONCLUSIONS

Using this complex analysis offers a fairly accurate picture of major landscape issues whatever the complexity of the case, as was the situation discussed herein. The smaller the territory, the more accurate the result. The same is true if categories are chosen mathematically. However, no matter the working method used or the size of the studied area, good knowledge of the reality on the ground at as many points as possible is an imperative prerequisite, ensuring the reliability of the image obtained.

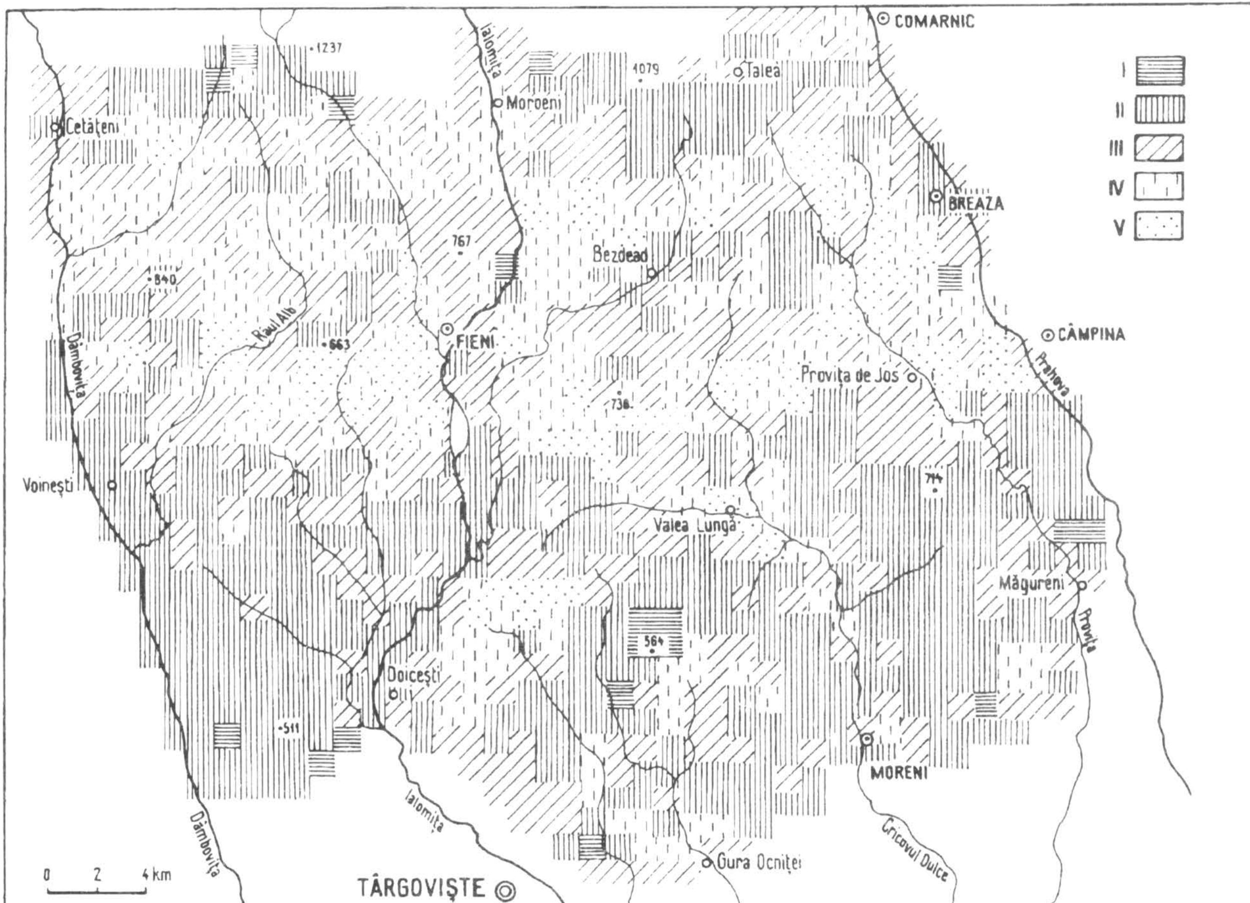

Fig. 2. State of Subcarpathian landscape.

It also offers decision-makers the necessary information for preliminary assessments, so that forthcoming projects should meet human needs yet not at the expense of the integrity of the natural environment, leaving present and future generation their benefits. In other words, sustainable development principles must be observed.

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ZOOGEOGRAPHICAL LANDMARKS IN STÂRMINA HILL (MEHEDINȚI COUNTY)

CONSTANTIN DRUGESCU

Key-words: faunistic station, zoo-history, Bălăcița (Plain).

Repères zoogéographiques sur la colline de Stârmina (département de Mehedinți). La communauté faunique de la Colline de Stârmina (la haute Plaine de Bălăcița) de sud-ouest de la Roumanie contient des zooéléments de différentes origines et répartitions, dominants étant ceux de centre de l'Europe. Excepté les espèces sous-méditerranéennes, dont la présence est normale dans cette région, un intérêt particulier présente *Salamandra salamandra*, *Bombina variegata* et *Lacerta praticola pontica* par leur position extra-aréalistique. Leur développement et leur perpétuation ici signifient des conditions de milieu tout à fait particulières, pareilles aux zones plus hautes de la Roumanie ou à celles de la région caucasienne. Sous l'aspect zoohistorique, les espèces mentionnées mettent en évidence l'existence, dans le passé, d'une corrélation entre les faunes des Carpates, respectivement celles du Caucase, avec des zones plus baisses du territoire de la Roumanie, mais qui aujourd'hui ont cessé de se manifester.

Anyone who travels on the wide highway lining the Danube Valley between Turnu Severin town and Vânju Mare settlement (in the south of Mehedinți county) will be surprised to find, only 17 km away from the point of departure, a very rough afforested area. It is the Danube-facing side of Stârmina Hill (40 – 238 m), quite a singular stretch of land in that region's relief – the high Bălăcița Plain, the habitat of *Quercus cerris* and *Q. frainetto* bushes.

Particularly impressive is the deeply fragmented terrain with steep slopes and numerous small fixed valleys and gullies. Because of high relative altitude (about 90 m), slopes are unstable, marked by landslide and strong gully erosion. The denudated material is accumulating at the slope foot of the Stârmina Hill.

But more important still are the shaded biotopes of the Stârmina Woods, especially those on the Danube-facing hillside, which shelter some bushes of *Fagus silvatica* var. *moesiaca*. It is quite a remarkable occurrence in these places populated by *Quercus* species, moreover so as they stand remote from the natural habitat of *Fagus*, and at very low altitude, too: 75 meters.

There are very many southern elements of the wooden and herbaceous vegetation. Even the main bush species – *Quercus cerris* and *Q. frainetto* have a southern distribution. Fairly widespread is *Quercus petraea* ssp. *dalechampii*. In the second belt, there grow *Fraxinus ornus* and *Carpinus orientalis*, with *Cotynus coggygria* occurring in the undergrowth (Bobârnac *et al.*, 1984).

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The meadows are populated by a few sub-Mediterranean and Mediterranean species, e.g. *Chrysopogon gryllus, Cynosurus echinatus, Trifolium incarnatus*, etc.

Vigorously developed in this forest are the Atlantic-Mediterranean elements like *Ruscus aculeatus* and *R. hypoglossum* (Cucu, Popova-Cucu, 1980).

High air humidity favours the luxuriant growth of a few creepers (*Clematis vitalba*), of ivy (*Hedera helix*) and wild vine (*Vitis silvestris*) hanging from the trees, giving the forest a tropical aspect.

There are numerous animal species of various origins and geographical disseminations. By and large, the same particularities as noticed in plants mark out the fauna, namely, the populations originating from remote areas. Unlike the presence of southern elements, which is quite normal for this region subjected to Mediterranean influences, other occurrences raise many questions.

Of areal and zoo-historical importance are the species of *Bombina variegata, Salamandra salamandra* and *Lacerta praticola pontica*.

They have a documentary space value because the stations in which they live are not specific to their original zones (Fig. 1) and lie at much lower altitudes (the first at approx. 80 m, the second at ca 75 m.) than known so far. It is the case of the south of Banat – at the mouth of Mraconia River (*Bombina variegata*) and Caraşova River (*Salamandra salamandra*). Salamandra records the highest incidence and density in the Subcarpathians and in the medium-high and lower zones of the Carpathian Mts., while *Bombina variegata* occurs mostly in the Subcarpathians (Fuhn, 1960). On the other hand, *Lacerta praticola pontica* lives at low altitudes in the south of Muntenia, in the Cerna Valley and its adjacent valleys, and in Dobrogea. Stârmina Woods represent the extreme western enclave of this species which originates from the Caucasus-Balkan zone (Fuhn, Vancea, 1961).

What factors have determined the presence of these species in the region?

In the first place, the environmental conditions and the species' ecological requirements that proved propitious to their development and reproduction.

As known, *Bombina variegata* lives on land, in the vicinity of brooks, rivers, puddles and lakes at heights of over 400 m, up to 1,500 in the moist mountain valleys.

These mountain valleys, as well as the banks of forest brooks and springs (400 m – 1,800 m) represent the habitat of *Salamandra*. But unlike *Bombina*, which is a common element of oak forests, *Salamandra* prefers the beech woods.

Lacerta, in its turn, is a meso-thermophile element. Shunning the heat, it usually inhabits the *Quercus* forests (Fuhn, 1960).

In general, the temperature and air humidity of the Stârmina Woods ecosystem meet the three living requirements of these species.

Sheltered by the high Danube bank of the Bălăciţa Plain (Roşu, 1965), the region's climate is moderately temperate with a sub-Mediterranean shade.

This is particularly evident in the cold season when temperatures are high and there is seldom deep freezing (only 80 days/year). Annual thermal evolutions register averages of 11°C, with amplitudes of only 24°C (–1°C in January and +23°C in July, with warmer and more lasting autumns –0,4°C than in the surrounding zones).

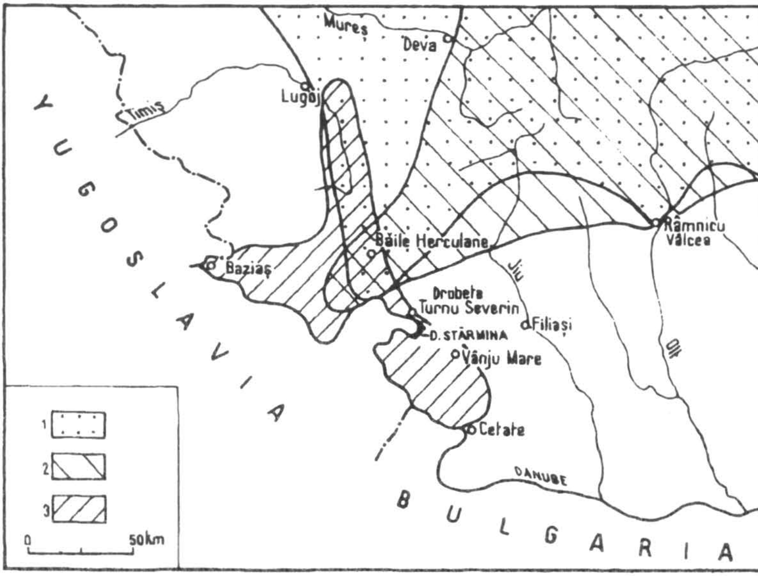

Fig. 1 – Areas of *Salamandra salamandra* (*1*), *Bombina bombina* (*2*) and *Lacerta praticola pontica* (*3*) species.

Air moisture, a major climatic element, accounts for the existence of the three species here. High moisture values (74%/year) are due to the near-by water sources, the incidence of marine air, and the precipitation (totalling 650 mm/year) relatively evenly distributed over the year (275 mm in the cold season and 375 mm in the warm season). Rain falls in autumn and winter, a characteristic of the sub-Mediterranean climate.

The biotic environmental component – the brown leached forest soil – associated with the topoclimate and vegetation also contribute to the perpetuance of these species.

What would be the time of these species' penetration into the region?

In the absence of palaeontological evidence, one has to resort to the concept reading that each species is part of a larger or smaller group of animals which moved on together, have close or similar ecological needs and a common origin even. Nikolski (1951) considered that such animal groups form faunistical complexes; Lattin (1967) maintained that they form faunistical rings. The species of a complex set up close interdependences that engender well-balanced biocoenoses, with little interspecies competition, because the respective taxa occupy different ecological pockets, well-delineated in the course of time. Therefore, it is rather difficult for allogenous species to penetrate them, and if they do, the complex is disturbed and major interspecies imbalances set in.

Listing taxa under a certain faunistical complex is based on analogies and places of origin. While the first criterion proceeds from the idea that the faunistical complex has originally been rooted in the assumption that the species of a complex were born in one and the same region, where they migrated from, the second criterion upholds that the elements of faunistical rings originate from areas in which various species took refuge during the glacial periods, subsequently extending to other zones as well.

In this light, there are very few instances in which the Pleistocene glacial refuges are formation centres of new taxa, they being rather centres of post-glacial spread, and at the most, centres which some recent species have evolved in.

In view of the above, the three species discussed herein appeared in the Stârmina Hill area concomitantly with other related elements through ecological interdependence, but in different historical periods. Thus, *Bombina bombina* came during the Boreal, when the thermal evolution of the post-glacial climate favoured its expansion as oak groves appeared on hillsides and even in some lower places, which is the case of this frog species in the Stârmina Hill.

At a later date, in the Subboreal, more thermophile elements, like *Lacerta praticola pontica*, recorded a powerful dissemination.

With the cooling of the climate (Subatlantic), mesohygrophile populations gained ground (e.g. *Salamandra salamandra*). Their temporal evolution is intertwined with the exuberant development of the beech (the beech phase nearly 3,000 years ago) when this tree began growing in the valley, down to very low altitudes (Stugren, 1982). The beech environment being suitable to *Salamandra*, the lizard followed its spread. Today, it can be found in many outposts, with similar conditions, which is the case of the Stârmina Woods.

Summing up, we would say that the unusual fauna of the Stârmina Hill proves that environmental conditions here are similar to those of remote regions, with which the fauna has no connection today.

Local development and perpetuance of the above species is a pertinent proof of the space and time evolution of the ecosystems of this Danube Valley sector and a valuable landmark of some ancient biogeographical connections that used to extend over vast areas during the post-glacial period.

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DYNAMICS OF WARMING-COOLING PROCESSES OVER ROMANIA'S TERRITORY

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Key-words: quasiequal temperatures, thermoisochrone, Romania.

Dynamique des processus d'échauffement-refroidissement sur le territoire de la Roumanie. A partir des valeurs journalières de la température, résultées des mesurages effectués à plus de 130 stations météorologiques pendant l'intervalle 1961–1990, le travail met en évidence la dynamique de l'installation des températures moyennes journalières quasi-égales et des températures moyennes extrêmes. A l'aide d'un matérial graphique adéquate, on présente l'évolution spatio-temporelle des processus d'échauffement et refroidissement, qui dépendent des conditions physico-géographiques du territoire de la Roumanie.

INTRODUCTION

This paper aims at knowing – on the one hand – how long it takes the mean daily temperature to reach quasiequal values over the whole of the territory within the warming processes, and on the other – the time lag within which the highest and the lowest mean values occur.

ADDRESSING METHOD

Aiming to reveal the space-time evolution of the warming process depending on latitude, the landmark was taken to be the highest daily mean temperature, recorded at Avrămeni station situated in the northernmost position in the territory. Noting the landmark temperature value (20.8°C), it was conventionally accepted that the callendar dates had to be sought for, when temperatures reached over the territory close values, ranging within 1.0°C i.e. 20.0...20.9°C.

To know the general course of the thermal potential in the territory during the warming process, callendar dates were charted when the daily mean temperatures climaxed.

The dynamics of the cooling process over the territory is viewed resemblantly. However in the latter situation, the occurrence dates of the lowest mean values – the landmark for starting to monitor the phenomenon – were chosen to be those in the south of the country, where the phenomenon, propagating from the north and from the mountain summits manifests the latest.

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Thus, the lowest daily values (ranging between –3.1° and –3.9°C) were recorded in the south-west of Romania, i.e. in front of the Carpathian-Balkan fit, where mean temperatures of –3.3°C at Calafat and –3.6°C at Băileşti are recorded on January 13.

The method used to draw the map for the time-evolution of the setting of the highest mean values was also applied to the map ascertaining the dynamics of the space-time variation of the lowest temperature daily means.

To round of the picture the evolution dynamics of warming and cooling processes over the Romanian territory by use of some specific profiles – drawn on the repartition maps in figures 1 and 4 – graphs were built up to indicate the installation "speed" of daily mean temperatures with equivalent values, established according to the stated criteria, depending on the distance (latitude) in the extra-Carpathian area and on altitudes along a profile unfolded between Omu Peak (2507 m) and the Danube floodplain.

WARMING PROCESS DYNAMICS

Due to Romania's central position within the European continent and the large inverted "S" shape of the Carpathian-Balkan mountain chain, it is easy to remark that the extra-Carpathian area shows important climate differences as compared to the intra-Carpathian one.

Analysing the configuration featured by the thermoisochrones, it is noteworthy that the maximum temperature daily means (20.8°C) in the extreme north of the country (Avrămeni) are recorded on August 8.

In the extreme south (over a narrow area stretching between Calafat and Giurgiu), temperatures reach values close to 20.8°C (20.3...20.9°C) much earlier i.e. on June 6 at Turnu Măgurele and June 10 at the other stations (Fig. 1). It follows that it takes about two months (63 days) for the air to reach the same thermal potential in the north as in the south.

While in the south of the country the above described phenomenon is a natural process, in Dobrudja it is the result of exceeding the moment of thermal equilibrium achieved between the marine sink and the network of aquatic surfaces within the slowly warming Delta on the one hand – and the continental area, a more important heat contributor – on the other hand.

The hill areas in the south and west of the country but mostly the Moldavian Plateau hampers the warming process till around July 10, after which it relaxes, fastly expanding in Trotuş, Bistriţa and Moldova Valleys and penetrating over most of Transylvania.

After the date, except for the north-eastern extremity and the mountain area, mean daily temperatures are reached over the whole of the Romanian

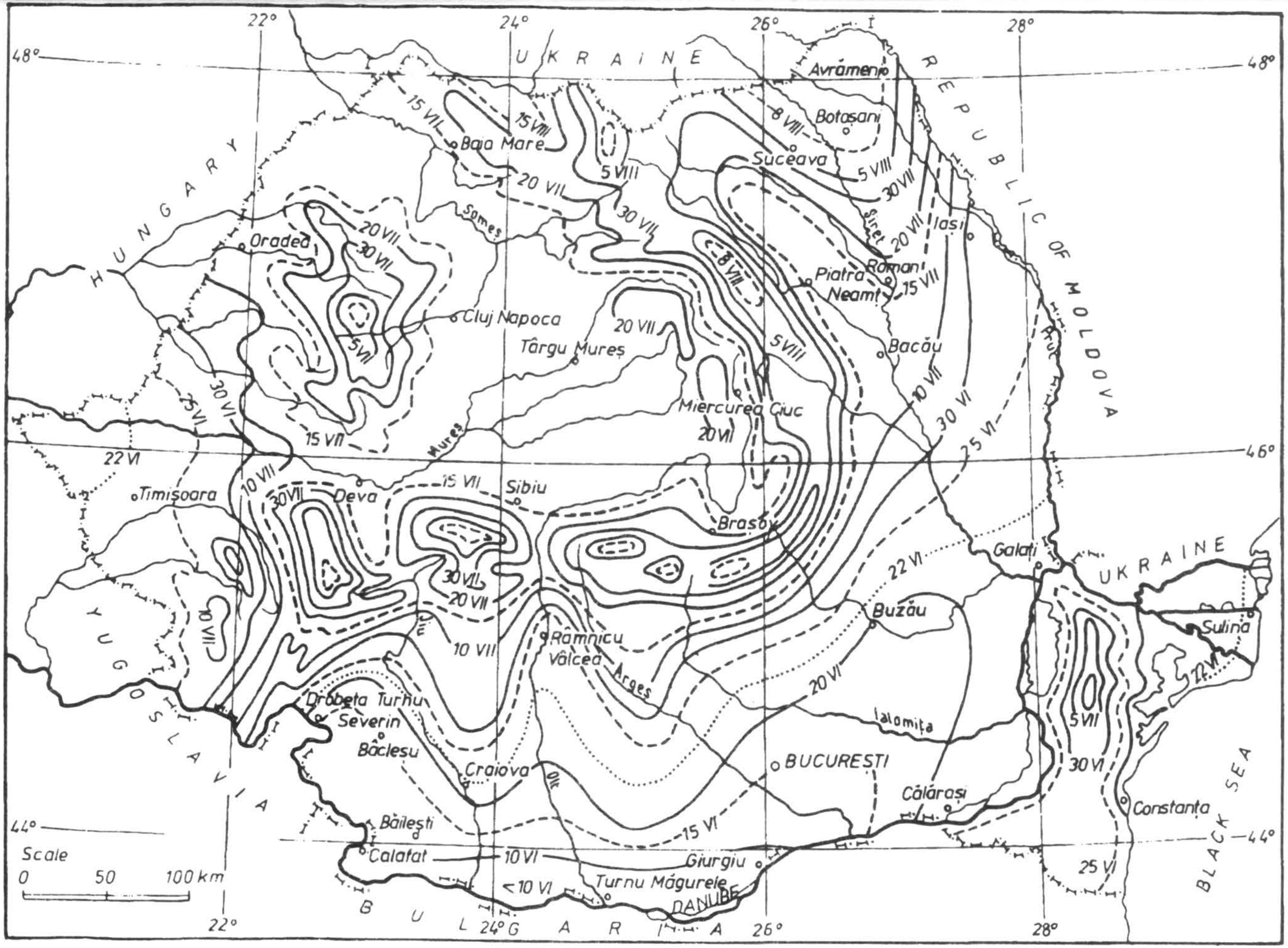

Fig. 1 – Setting-in dynamics of the highest mean daily temperatures at equivalent values during the warming process over Romania's territory.

territory equivalent to those recorded at least one month before (June 6–10) in the southern border. Temperatures keep rising in the north-eastern extremity of the country the same as in the mountain areas – until August 8.

The analysis of the dynamics of quasiequal mean daily temperatures setting-in made on the basis of the thermoisochrones rendered in Figure 1 shows that the solar radiation contribution holds a key importance highlighted by both the latitude space-time variation and by the altitude one.

Temperatures rise gradually, depending on latitude inside the north-to-south open extra-Carpathian area simultaneously with those rising depending on altitude until August 8 – the limit date. This ascertains that the effect of the latitude range of the Romanian territory (≈5°) is equivalent of that of the mountain chain altitude (≈2400 m).

In the extra-Carpathian area, but mostly in the inter-Carpathian depressions the highest mean temperatures, i.e. the maximum yearly mean temperatures are below the thermal range taken into account (20.0...20.9°C) occur earlier. They set-in around July 15.

In order to monitor the "speed" of some equivalent temperatures setting-in during the warming process in the extra-Carpathian area, depending on the distance between Turnu Măgurele and Avrămeni (≈660 km) and also depending on the altitude in the southern slope of the Southern Carpathians – between Turnu Măgurele and Omu Peak, two profiles were drawn on the background of the map shown by Figure 1 which cross the thermoisochrones through the maximum modulation areas.

The analysis of the curves displayed in Figure 2 shows that between June 10–15 over the almost flat surface in the south of the country, the warming process advances east to Turnu Măgurele by about 200 km. In the same interval, the thermoisochrone reaches altitudes lower than 100 m.a.s.l. At the end of June (30.VI) the area with the same temperature advances towards Moldavia to about 420 km, while in the slopes it exceeds a little the altitude of 350 m.a.s.l.

For the equivalent of the almost 550 km against Turnu Măgurele within the extra-Carpathian area towards northern Moldavia, in the southern slopes of the Southern Carpathians, the July 25 thermoisochrone points at altitudes of about 1000 m.a.s.l. while to the distance of aproximately 580 km indicated by the August 5 thermoisochrone location there corresponds an altitude of almost 1900 m.a.s.l.

As the warming process gradually displaces parallely towards extreme northern Moldava and towards the mountain summits the curves point at the warming process dynamics draw together, so that at distances of about 600 km and altitudes ranging between 2200–2300 m they merge into one another (Fig. 2).

The fact that evolution of the warming process reveals the equivalence of latitude effect and relief altitude ascertains the exceptional physiographical structural balance of Romania.

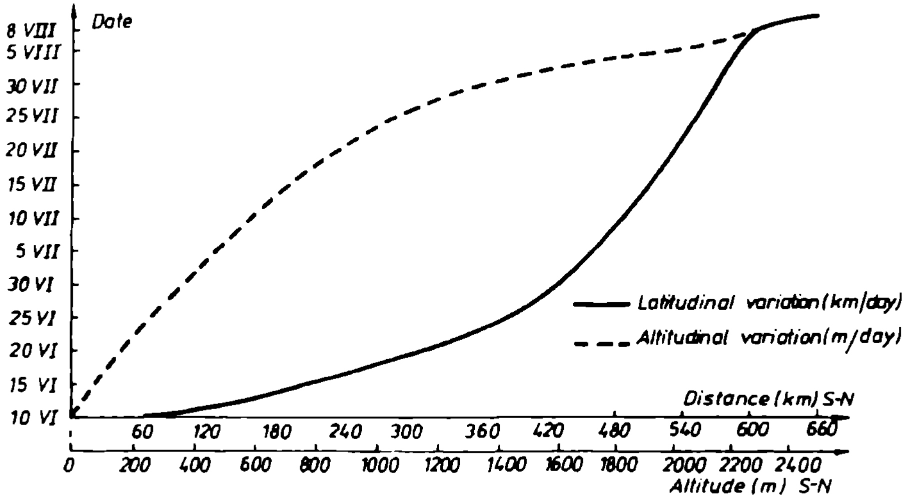

Fig. 2 – Setting-in dynamics of the highest mean daily temperatures at equivalent values during the warming process.

If our country had had other geographic co-ordinates or if one of the components (latitude/altitude) had been different in size, that balance would have been impossible.

Eliminating the hypothesis accepted for the achieved analysis on the space-time dynamics of equivalent temperatures according to which the air temperature would maintain in the south of the country until reaching the same values in the north, the dynamics of the real process is touched, as it develops in the warm period of the year.

According to the distribution shown by the thermoisochrones in Figure 3 the temperature rising process discontinues around July 15 in the higher parts of Dobrudja, on the outer side of Eastern and Curvature Carpathians in the extreme south-west of the country and in Transylvania Plateau.

The reasons are different for the early cessation of the temperature rise in these area. The phenomenon is esentially due to the fact that the radiative potential, decreasing after summer solstice at a certain moment of the year becomes unable to give its heat contribution to thermal accumulations at active surface level. The solar energy intercepted at daytime can no longer ensure the retrieval of losses owed to night radiation in poised radiative balance circumstances.

In the rest of the territory, the mountain area included, where the balance is positive, the cooler active subjacent surface is still able to continue transforming the heat resulted from solar energy transform. Owing to this, the warming process goes on until July 15 in the south of the country, delaying in exchange evermore towards north-eastern Moldavia and the heights of the

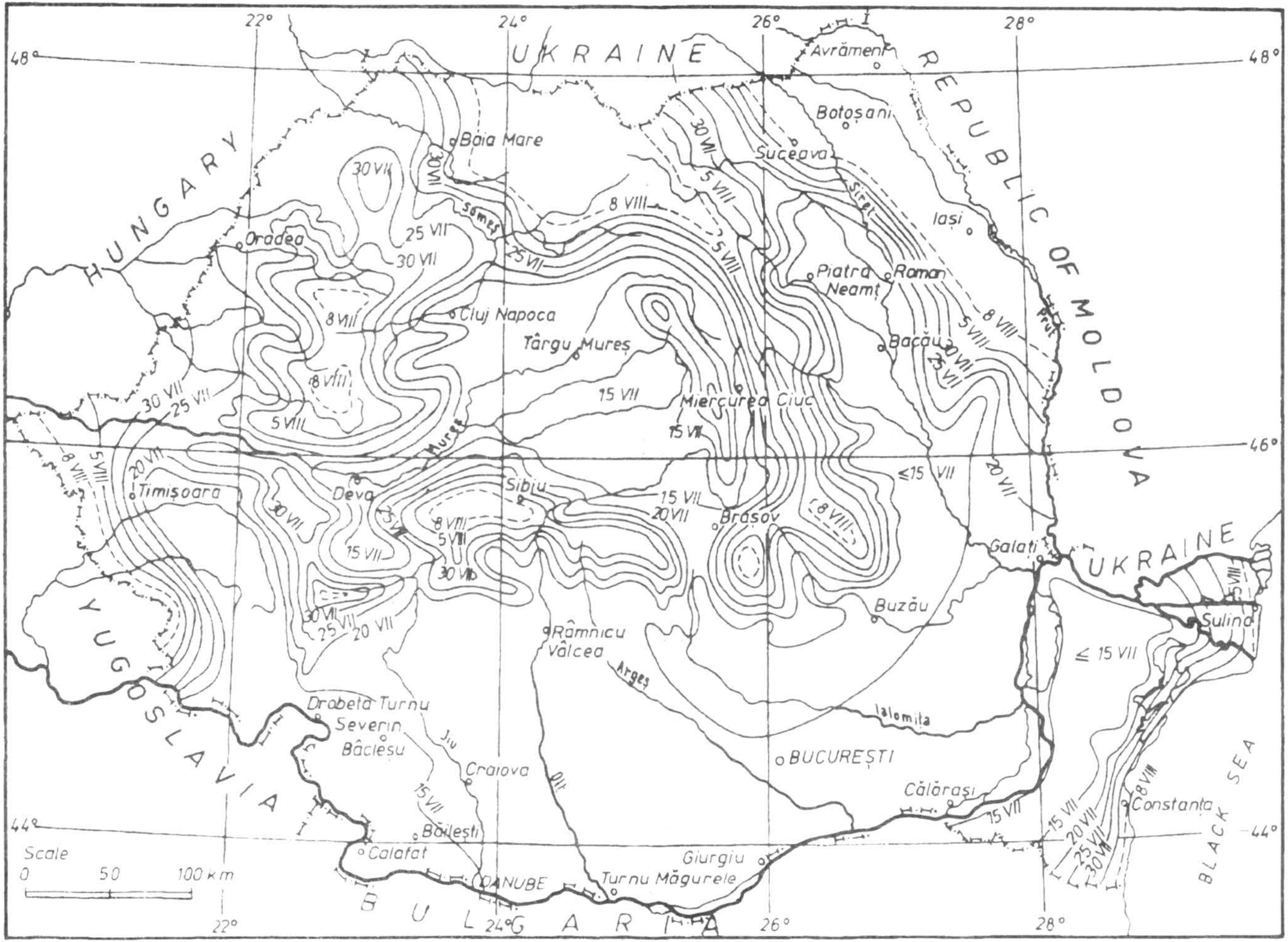

Fig. 3 Setting-in dynamics of the highest mean daily temperatures during the warming process over Romania's territory.

mountain summits, where it lasts until August 8. In eastern Dobrudja and along the coast the warming delay is caused by the inertia of the Black Sea and the Danube Delta water cooling.

COOLING PROCESSES DYNAMICS

Towards the end of summer. when the radiative balance becomes negative after having passed through the equilibrium area, temperature values gradually tend to decrease. This process will peak in the core of the winter season.

On the grounds of the stated criteria, in order to analyse the dynamics of the cooling process the reference point was taken to be the calendrical date when the lowest mean temperatures were recorded in the extreme south of the country. Given the situation, the data base was stormed to pick the first callen-dar date when temperatures were recorded over the territory ranging between –3.0°...3.9°C in the south of the country.

The analysis of the thermoisochrones drawn in Figure 4 proves in a natural way that the settlement of quasiequal temperatures taking such values has the earliest occurrence in the high summits of the Southern Carpathians in the Bucegi Massif at Omul Peak and also in the summits of Făgăraş Mountain where such temperatures occur on November 10. With the advance towards the occurrence period of the mean annual temperatures (January) the thermoisochrones encompass ever lower areas. Thus the December 10 thermoisochrone delimitates the chains of the Eastern and Southern Carpathians going as far as Olt Defile, whereas the December 30 thermoisochrone delimitates the Southern Carpathians west of Olt Defile.

In a time interval of just 10 days (December 30 – January 10), a huge part of the country's surface situated in the extra- and intra-Carpathian low areas is entirely covered by mean temperatures ranging between –3.0° and –3.9°C. There results that while in the mountain summits winter sets-in in the first decade of November, in the low parts of the country the characteristic features of the winter season become stable at the end of December and in the first half of January.

To get acquainted with the dynamics of the cooling phenomenon propagation as a function of latitude and altitude, on the grounds of the map in Figure 4, space-time variation graphs were drawn as shown in Figure 5.

Thus, the profile rendering the variation "speed" of equivalent temperatures – which depends on the latitude in the extra-Carpathian area, starts from the extreme north-eastern Moldavia, while the profile for the variation "speed" depending on the altitude starts at the level of Omul Peak station (2507 m.a.s.l.). The two curves merge in a terminal point in the south of the country, at Turnu Măgurele.

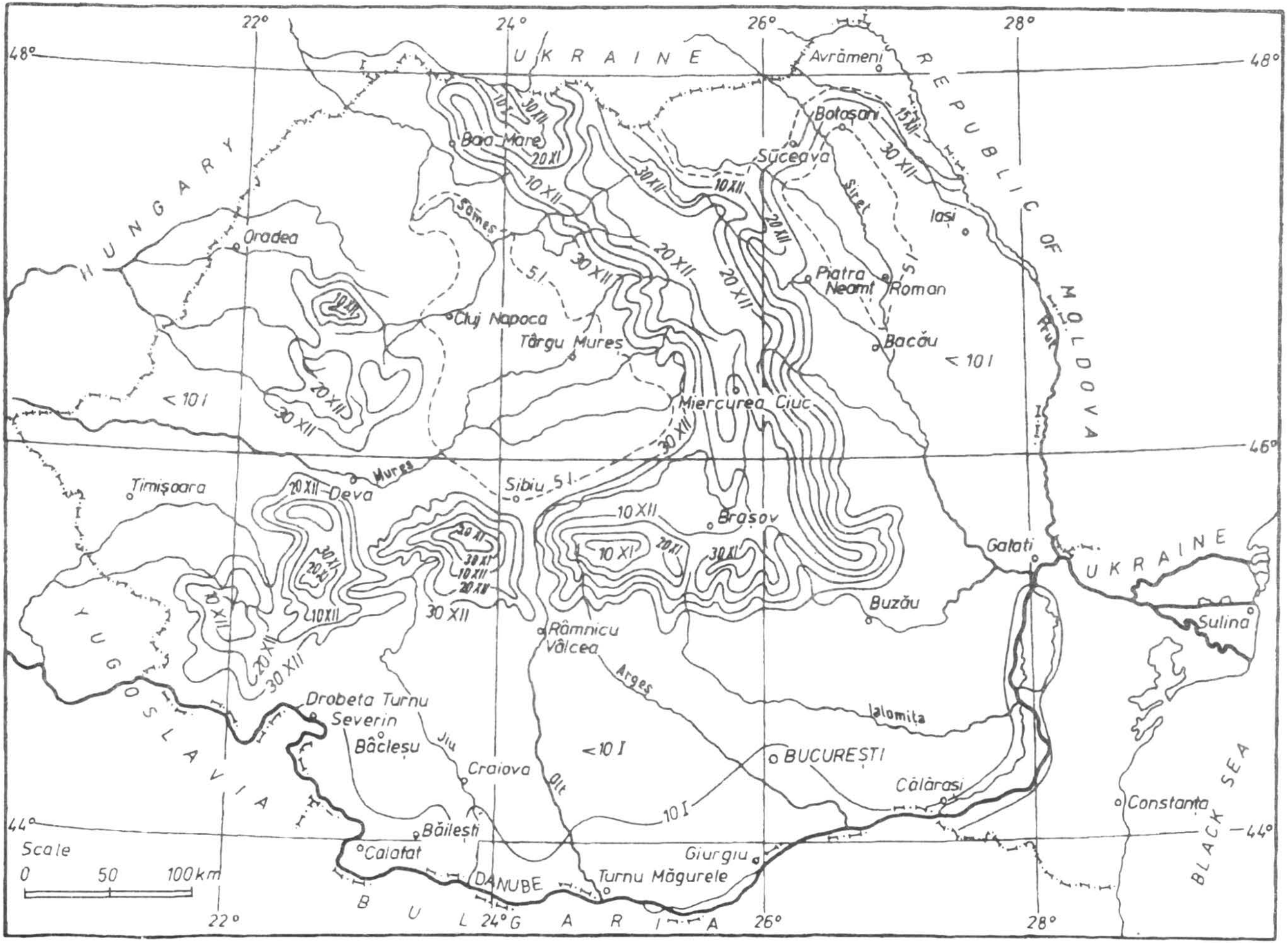

Fig. 4 – Setting-in dynamics of the lowest mean daily temperatures at equivalent values during the cooling process over Romania's territory.

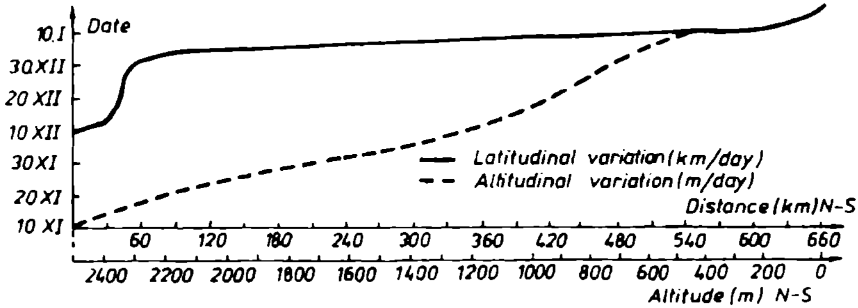

Fig. 5 – Setting-in dynamics of the lowest mean daily temperatures at equivalent values during the cooling process.

These show in the first place the time lag between the occurrence of equivalent temperatures in the mountain summits (November 10) and in the north of the country where they are recorded no sooner than on December 14.

It is noteworthy that southwards of Omul Peak, below 400 m.a.s.l. and at distances longer than 550 km from Avrămeni, the curves merge naturally, since quasiequal temperatures occur at approximately the same callendar dates – around January 10.

To get awareness of the real dynamics of the cooling process over the territory a map was drawn as shown in Figure 6 which displays the callendar dates when the lowest mean daily temperatures are recorded. From analysing this map a delimitation becomes noticeable of the intra-Carpathian area and the mountain occupied land from the rest of the territory, through the January 10 thermoisochrone.

In the south of the country, in the middle and inferior reaches of Siret river and upstream Mureş and Olt rivers, the cooling process still goes on after January 10. In most of the extra-Carpathian area the air cools after a relative hampering of the phenomenon upstream Siret river and along its slopes – downstream Roman and in the hill area in the southern border of the Southern Carpathians the air goes on cooling.

The January 14 thermoisochrone delimitates the largest area within the south of the country where the lowest mean temperatures occur on January 14 and immediately after. The strongest inertia in displacing the warmer air above the south of the country is recorded in the highest part of Bălăciţa Piedmont, at Bâcleşu station where the displacement of the hotter air lasts until January 16–18.

It is easy to see that, mostly in the extra-Carpathian area, coolings are mainly caused by the atmosphere dynamics, being owed to cold air invasions triggered by the Siberian anticyclone. This becomes obvious if the phenomenon is monitored in its progression first towards the south of the country, then towards western Oltenia where at the altitude of Bâcleşu station (309 m.a.s.l.) the lowest mean temperatures are recorded four days later than in the surrounding areas.

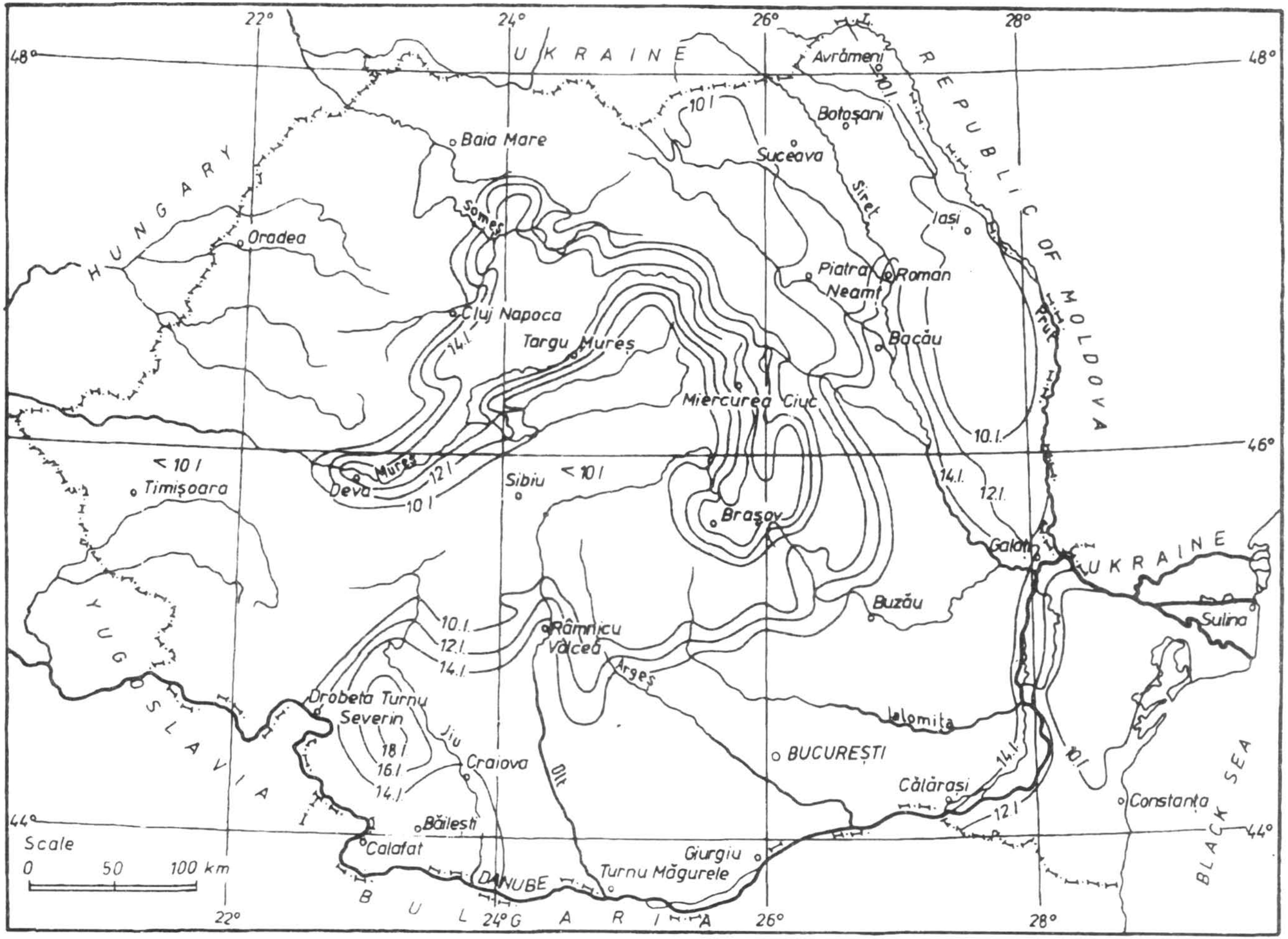

Fig. 6 – Setting-in dynamics of the lowest mean daily temperatures during the cooling process over Romania's territory.

The delay of the cooling process taking place within the intra-Carpathian depressions situated in the upstream basins of Olt and Mureş rivers taken place on the background of the generalized cooling which envelops the west and north-west of the country along with the whole of the Carpathian chain whereas in the extra-Carpathian area the delay of the cooling processes is caused by the advection of continental air masses, in the intra-Carpathian area they are due to the continuation of air temperature decrease following nocturnal radiative cooling and to the gravity stratification of the cold air. This phenomenon prolonges the interval required by mean daily temperatures to touch their lowest values until January 14.

Between the earliest dates of their occurrence (January 8) and the latest (January 19) there is a time – difference of no more than 11 days.

The former is recorded under the circumstances of Mediterranean air influence, felt in the summits of Ţarcu, Retezat and Godeanu massifs at about 2000 m.a.s.l. after having crossed the Dinaric Alps, and the latter at the already mentioned Bâcleşu station. Yet, it must be pointed at the fact that in most of the Romanian territory the interval when the lowest mean temperatures are recorded lasts only 5 days, i.e. January 9 through 14.

CONCLUSIONS

• The dynamics of the warming-cooling process discloses on the one hand the effect of Romania's location within the European continent, and on the other hand at the effect of a remarkable balance between its expansion in the latitude and the altitude of the major relief.

• The annual evolution of the warming-cooling processes indicates that the space-time variation dynamics of the warming processes is mainly governed by the solar radiation energetic contribution, whereas the dynamics of the cooling processes is mainly due to the atmospheric circulation.

• The space distribution of the Carpathian-Balkan chain as a large inverted "S" has a decisive role in the development of the warming – cooling processes over the Romanian territory, while the other relief stages facilitate or hamper their space-time development, depending on their altitude and disposition.

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Bucureşti*

THE DISTRIBUTION OF THE RADIATION BALANCE COMPONENTS ON VARIOUSLY ORIENTED AND SLOPED SURFACES IN THE TRANSYLVANIAN PLAIN

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Key-words: radiation balance, topoclimate, Transylvanian Plain.

La répartition des éléments composants du bilan radiatif sur des surfaces à inclinaisons et orientations variées dans la Plaine de la Transylvanie. L'ouvrage donne la distribution des sommes annuelles des éléments composants du bilan radiatif sur des surfaces à orientations et inclinaisons variées, dans la Plaine de la Transylvanie (voir les tableaux 1.2 et la figure 1), déterminées par calcul. Les résultats obtenus mettent en évidence la différenciation prononcée des valeurs sur les versants, par comparaison à la surface horizontale.

METHODOLOGICAL CONSIDERATIONS

The main issue we go in for in this paper is the way the slopes having various orientations and degrees of inclination receive solar, terrestrial and atmospheric radiation. Knowledge of these issues is highly important since they reflect more accurately the geographical reality, i.e. the dominant presence of the sloped surfaces. On the contrary, the usual climatic charts render the distribution of radiation fluxes on levelled surfaces, ignoring the influence of slope, geographical orientation and land fragmentation on them, as it is known. It is this latterly mentioned condition that is highly characteristic of this area and that causes a large variety of amounts of radiation to be possible. Hence, this results in a large differentiation of the processes going on in the geographical realm: soil heating and cooling, evapotranspiration, soil humidity balance, underground water refilling from snowcover etc. It is quite difficult to assess the amount of radiation received by the slopes, the only possibility, apart from the remote sensing procedures, being the indirect approach through calculation.

To this purpose we set out from the computed values for four characteristic gauged stations (Cluj-Napoca, Turda, Bistriţa, Târgu Mureş), then being sub-sequently compared with the measurements at the Cluj-Napoca station (Table 1). We also employed for comparison the global radiation map of Romania (Neacşa, 1969, 1972).

The amount of global radiation on levelled surface was computed using Angström's equation:

$$Q = Q_{max}[k+(1-k)s/s_{max}] \tag{1}$$

where: Q_{max} is the maximum possible amount of incoming solar radiation flux;
k is the cloud shine coefficient (k=0,35);
s is the actual duration of sunshine;
s_{max} is the maximum possible duration of sunshine.

Table 1

Yearly Sums (kcal/cm^2 year) of the Net Radiation Components on Flat Surface

Meteorological Station	Height (m)	Net Radiation Components					
		Q	A	Q(1–A)	R_s	R_e	R
Cluj-Napoca (real data: 1960–1964)	363	120	20	96	24	46	50
Cluj-Napoca (computed)	363	119	26	87	30	46	41
Bistrița (idem)	358	118	26	88	30	47	41
Turda (idem)	424	120	24	92	28	50	42
Târgu Mureş (idem)	309	119	25	89	30	48	41

Q = Global Radiation (kcal/cm^2. year); A = Average Albedo (%); Q(1–A) = Absorbed Radiation (kcal/cm^2. year); R_s = Reflected Radiation (kcal/cm^2. year); R_e= Effective Radiation (kcal/cm^2. year); R = Net Radiation (kcal/cm^2. year).

The sunshine fraction (s divided by s_{max}) was computed ad hoc using data from the above mentioned gauged stations. Computational results show us they are close to measurement data, which proves the accuracy of the methodology we have followed.

Next we needed to compute the radiation balance (the net radiation):

$$R = Q(1-A) - R_e \quad (2)$$

where: A is the average albedo;
R_e is the effective radiative flux.

The average albedo was obtained on an estimative basis, according to the specific albedo values of crop, pasture, forest, water body, snowcover, keeping in view the seasonal evolution of the landscape physiognomy. The estimated values have a guiding character, no doubt. Anyway, we reflect better the geographical reality, whereas the field measurements performed at those stations express a standard meteorological situation, that of the tended turf field.

It needs saying that the only way to get accurate real values for the average albedo of an area is through remote sensing techniques. This issue, though of utmost significance for climate studies and research, is thorny as local scale actual data still have a scattered character.

The effective radiative flux was obtained using the equation:

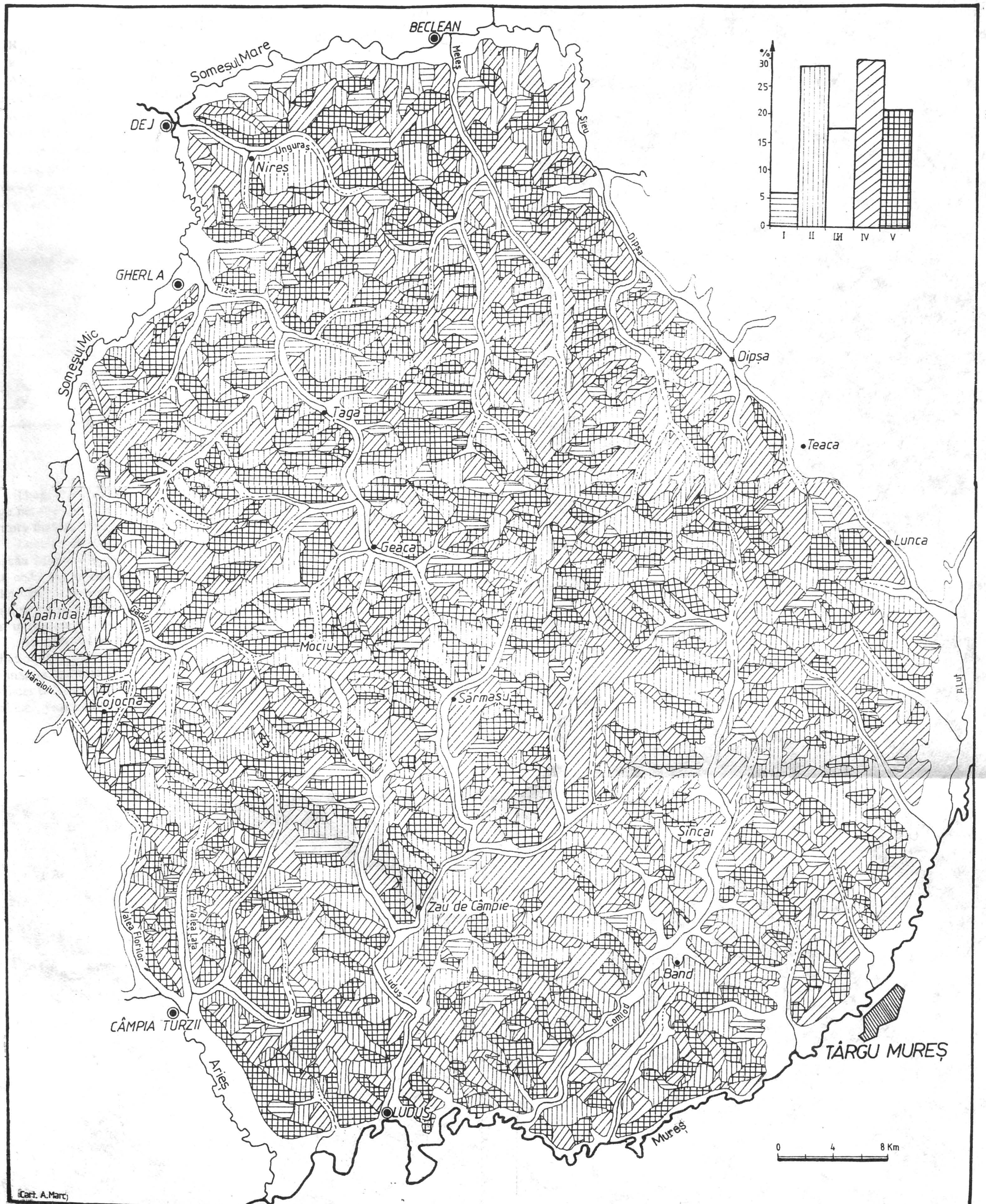

Fig. 1 – The Distribution of the Net Radiation Components in the Transylvanian Plain.
Vignette: Frequency Histogram of Various Categories of Slopes (Table 2).

$$R_e = R_{e(n=o)}\,(1-kn^2) + \Delta R_e \qquad (3)$$

where: $R_{e(n=o)}$ stands for the effective radiation under cloudless conditions;
k is the brightness coefficient of the sky;
ΔR_e is the correction for the effective radiation imposed by the thermal difference between air and the radiative surface.

Next we established from the diagram (Fărcaş, 1981, 1988) the yearly quantity of incoming radiation fluxes for various surfaces (Table 2; Fig. 1). Being void of certain computational elements, the other components of the net radiation (the absorbed, reflected, effective radiation fluxes) for various surfaces of sundry orientations and degrees of inclination have been only estimated from the global radiation amounts on levelled surfaces.

Table 2

Yearly Sums (kcal/cm^2. year) of the Net Radiation Components in the Transylvanian Plain by Categories of Slopes and Orientation

Category	Area (% of total)	Net Radiation Components				
		Q	Q(1–A)	R_s	R_e	R
I	5.0	82–107	60–77	22–28	32–40	28–37
II	28.1	108–117	78–84	28–30	41–44	37–40
III	16.9	118–120	85–87	30–31	45–46	30–42
IV	29.3	121–130	88–94	31–34	47–50	43–44
V	20.7	131–146	95–106	34–38	51–56	44–50

DISCUSSIONS AND CONCLUSIONS

The global radiation fluxes on levelled surfaces in the Transylvanian Plain range between 118 and 120 kcal/cm^2. year. It is only at the margins of this territory that the global radiation amounts go down under 115 kcal/cm^2. year.

Locally, in the Mureş floodplain on the south-eastern margins of the Trascău Mountains the global radiation amounts may exceed 120 kcal/cm^2. year, under the influence of the mountainous shelter effects and of the descending foehn-like air movement. Anyway, the effect of this descending air movement can also be seen in the duration of sunshine, which exceeds 2,000 hours per year in this area.

As opposed to this relatively homogeneous distribution of the global radiation flux, the actual picture of the process, strongly dependent upon slope inclination and orientation, is completely different. The horizontal or levelled surfaces to be seen on the floodplains and terraces can get as much as 118–120 kcal/cm^2. year and they hold 17% of the territory under discussion.

On the shady slopes of 5–25°, having north-eastern, north-western and northern orientations, the amounts of global radiation reach 80–118 kcal/cm². year. They hold in all 33% of the whole territory.

On the contrary, the shiny slopes of 3–13°, having southern orientation, and of 3–23°, having south-eastern and south-western orientations, can receive up to 146 kcal/cm². year of incoming global radiation. These surfaces represent 50% of the entire territory. For the sake of comparison we mention the fact that the highest radiation amplitude shady slopes versus shiny slopes computed for the Transylvanian Plain is similar to an horizontal shift north-south of nearly 2,000 km.

The net radiation on flat surface at the gauged stations over here reaches about 40–42 kcal/cm². year in the case of computed data and 50–51 kcal/cm². year if measurements were employed. The yearly computed sums range between 28–40 kcal/cm². year on the northern, north-eastern and north-western slopes and 43–50 kcal/cm². year on the southern, south-eastern and south-western ones.

As to the other components of the radiation balance, these are almost two times stronger on the southern slopes than on their counterpart.

As a conclusion we have to remind that some of the processed data are just orientative, due to lack of observations and to empiric methods of calculation. In future it is necesary to clarify these aspects and to extend the research upon the caloric component of the balance, as to their depending processes.

Even in the condition of less precise calculated data, we have the possibility to make an image close to reality the transfer of heat and humidity in the geosphere or regarding its transformations.

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THERMAL REGIME TENDENCIES OF WINTERS IN BUCHAREST – A CLIMATE VARIABILITY INDEX

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Key-words: climate variability, climatic index, standardized index, snow-covered soil, Bucharest.

Tendances du régime thermique des hivers à Bucarest, comme indicateur de la variabilité climatique. En se basant sur les températures moyennes de la saison d'hiver, à la station météorologique Bucarest-Filaret, on a analysé les hivers de l'intervalle 1857–1995. On a utilisé une grille avec 11 classes d'encadrement des hivers selon la valeur de la température moyenne de la saison et de la déviation standard. Pour une meilleure caractérisation de la saison d'hiver, on a aussi analysé la durée de l'intervalle pendant lequel le sol a été couvert de neige. Les résultats menent à la conclusion que les hivers en Bucarest seront plus chaudes et la durée de l'intervalle à couche de neige décroîtra.

THERMAL REGIME-TENDENCIES

A characteristic for placing Romania within a temperate continental climate is also the natural succession of the four seasons. Of these, the winter season has maintained in the attention of climatologists because of its large space-time variation and severity degree.

The paper analyses winters as a function of the available observational data. As for Bucharest, observational climatological data are available from Filaret meteorological station spanning over 139 years, starting with the 1857/1858 winter until the winter of 1995/1996. Winter was considered to be the three month-period: December, January, February (also named "climatological winter").

Processing the huge data set was impossible without the computer. In this sense, a file was created with mean monthly temperature values, computed from readings of the mean daily temperatures at the four climatological terms (01, 07, 13, 19 hrs. LT). The mean temperature for the winter season was computed from the mean values of the winter months. The INSTAT programs set was used for the computation of all the parameters necessary to evaluate winters thermally. It is obvious that a winter cannot be characterized only through thermal regime, other climatic parameters being also necessary, such as: the snowlayer duration, the snowdepth, the number of days with temperatures below certain thresholds (0°C<, <–5°C, <–10°C).

Also, one winter may exceed the three months of the season either installing earlier than December or lasting beyond the last month of the season – February. On the grounds of the mean temperatures of the winters in the 1857–1995 interval, their time variability is displayed along with the trend (Fig. 1).

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When analysing the thermal regime of the winters in Bucharest, a large year-to-year variation becomes noticeable. The mean multiannual temperature over 139 years is –1.06°C, with a standard deviation of 2.04°C. During this long period, the mean temperatures of the winters ranged between –5.9°C in 1953/54 and 3.4°C in 1862/63.

The coldest month in this long string of monthly values was January 1942, with a mean of –10.3°C, while the warmest – February 1863 which recorded +10.1°C.

Among the most severe winters, those in the intervals 1880–1900, 1921–1930 and 1939–1942 (fig. 1) are worth mentioning.

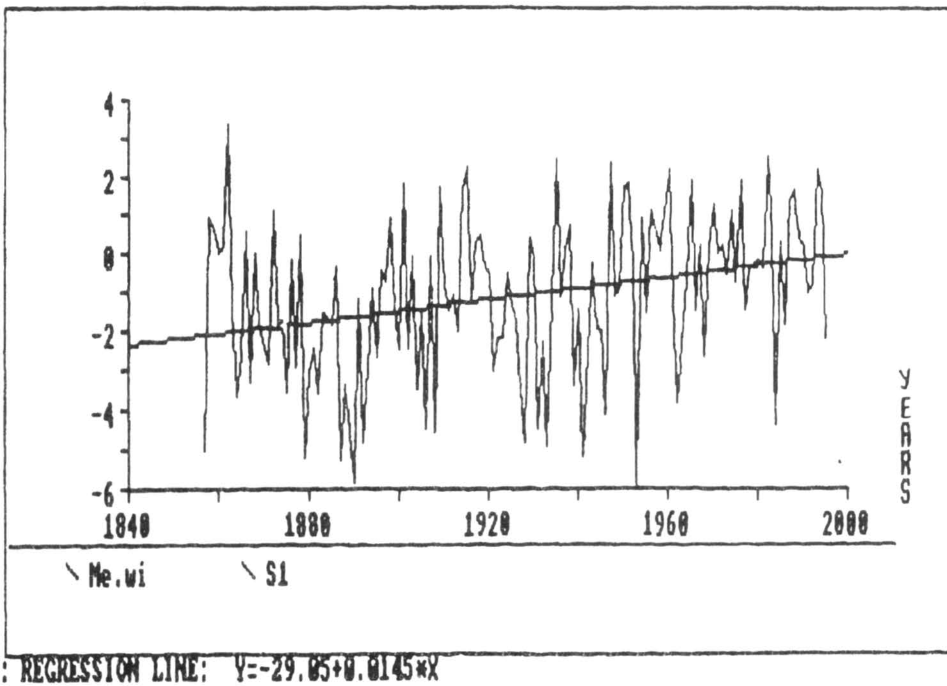

Fig. 1 – Variation and Evolution Tendency of Winters Mean Temperature for the Period 1857–1995.

The most severe winter throughout the 139 years with climatological observations in Bucharest was that of 1953/54, its mean temperature being –5.9°C, resulted from mean monthly temperatures of –1.1°C in December 1953, –7.5°C in January 1954 and –9.0°C in February 1954.

No occurrence periodicity could be detected from analysing the winters in the studied interval.

The regression line for the variability of winters was computed as (1):

$$y = -29.05 + 0.0145x \qquad (1)$$

The tendency is obvious for the increase of mean air temperatures of the winters, showing values of the regression line of –2.02 in 1857/58 and only –0.15 in 1995/96. Year-to-year significant variations occur on the background of the mentioned temperature rise tendency. For instance, only in the last half of the 20th century, several extremely severe winters occurred (1953/54, 1962/63, 1984/85). The last winter in the monitored string (1995/96) is not among the most severe, with a mean seasonal temperature not lower than –2.2°C (–1.3°C in December 1995, –2.5°C in January 1996 and –2.7°C in February 1996). Yet this winter was remarkable through the longest snow-cover duration on record (Fig. 3).

THE INTERVAL WITH SNOW-COVERED SOIL

To better characterize winters the snow-covered soil duration was also used. Since until 1895 tables did not mention the days when the soil was snow-covered, such data could be used only beginning with the winter 1896/1897.

The first day with snow cover was taken from tables no matter if it occurred in the winter season properly (December to February) and the same was done for the last day with snow cover. On the average the first day with snow cover throughout the analysed interval is December 1, while the last – March 15. During the mentioned interval (1896–1995) the earliest date with snow cover on record was October 25 in both 1922 and 1946, while the latest – April 19, in 1954. No agreement was noticed between cold winters and the longest duration with snow cover. As concerns the first day with snow cover, there is a slight delaying tendency. i.e. its displacement towards the first decade of December, while the last day with snow cover tends to occur earlier. i.e. towards the beginning of March (Fig. 2a, b). These two variations point at a shortening tendency of the snow cover duration (Fig. 3).

CLASSIFICATION OF WINTERS IN THE BUCHAREST AREA

The almost normal statistical distribution allows the use of σ standard deviation (which characterizes data focusing around average values) as an index to anomalies.

To thermally classify the winter seasons, the mean temperature (t_i) of each was used, together with the mean multiannual temperature of the winters (E) from the 1857–1995 interval. The 11 thermal severity classes for winter seasons were worked-out on the basis of the standard deviation, with 1/25 from the winters' mean multiannual temperatures for each consecutive class (Table 1).

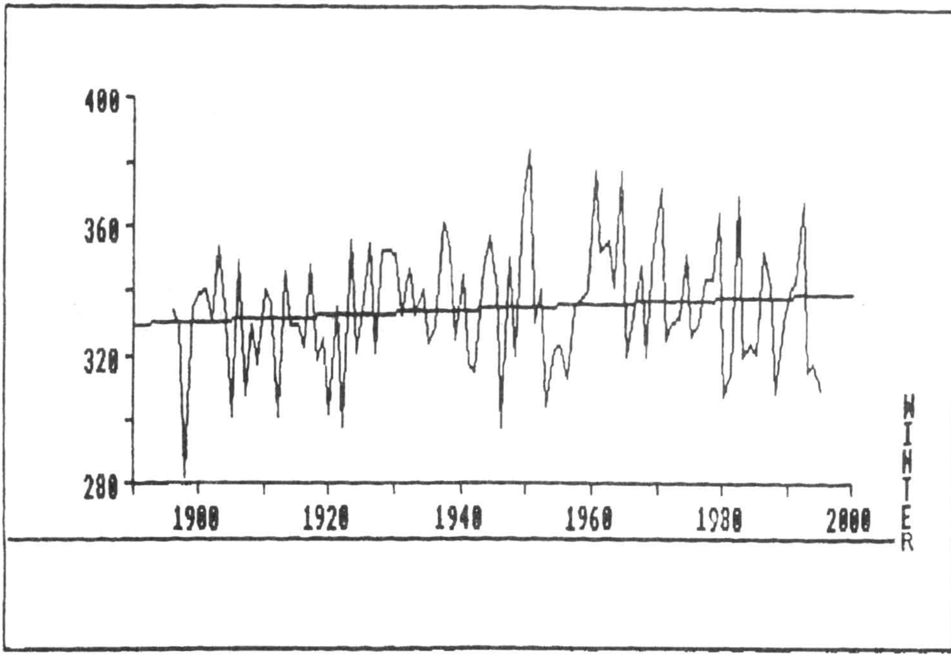

Fig. 2a – Time Evolution of the Earliest Day with Snow Cover.

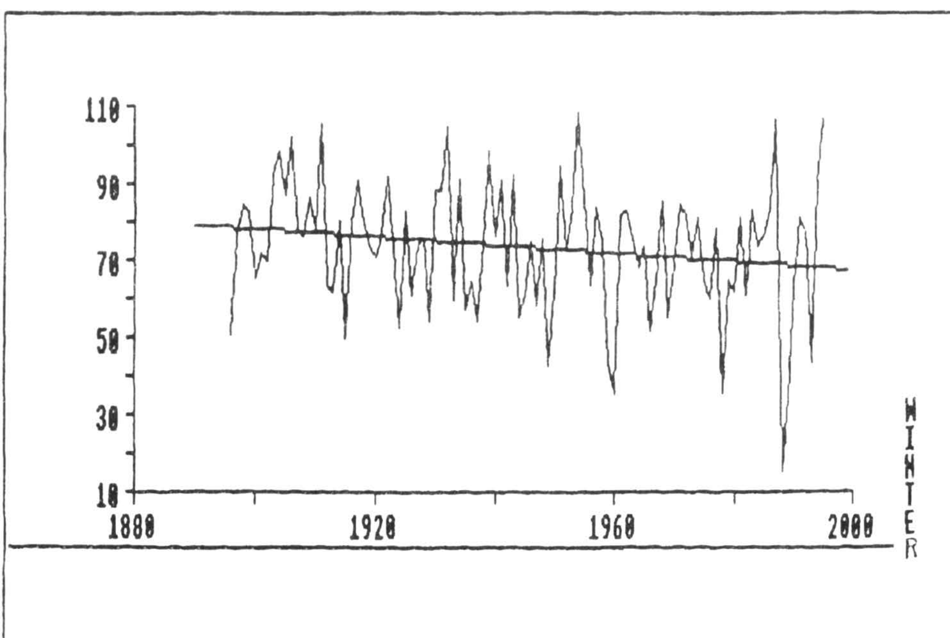

Fig. 2b – Time Evolution of the Latest Day with Snow Cover.

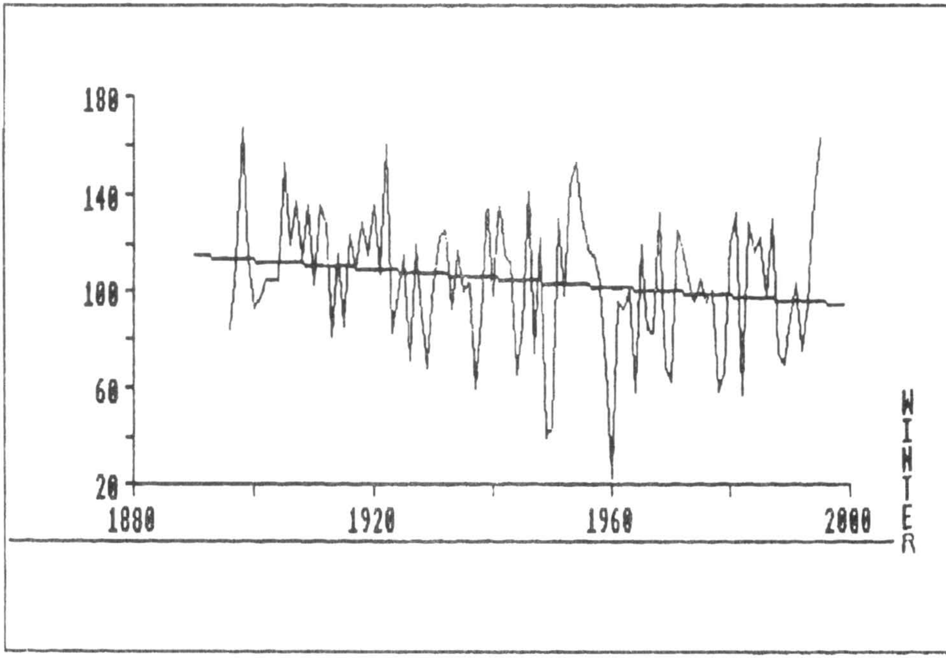

Fig. 3 – Time Evolution of the Length of the Snow Cover Interval.

Table 1

Winters Classification Grid

Class	Winter Type	Code	Temperature Range
1	Exceptionally warm	EW	$t_i > \bar{t} + 2.5\sigma$
2	Abnormally warm	AW	$(\bar{t} + 2.0\sigma) < t_i \le (\bar{t} + 2.5\sigma)$
3	Very warm	VW	$(\bar{t} + 1.5\sigma) < t_i \le (\bar{t} + 2.0\sigma)$
4	Warm	W	$(\bar{t} + 1.5\sigma) < t_i \le (\bar{t} + 1.5\sigma)$
5	Slightly warmer	SW	$(\bar{t} + 1.0\sigma) < t_i \le (\bar{t} + 1.5\sigma)$
6	Normal	N	$(\bar{t} + 0.5\sigma) \le t_i \le (\le \bar{t} + 0.5\sigma)$
7	Slightly colder	SC	$(\bar{t} - 1.0\sigma) \le t_i < (\bar{t} - 0.5\sigma)$
8	Cold	C	$(\bar{t} - 1.5\sigma) \le t_i < (\bar{t} - 1.0\sigma)$
9	Very cold	VC	$(\bar{t} - 2.0\sigma) \le t_i \le (\bar{t} - 1.5\sigma)$
10	Abnormally cold	AC	$(\bar{t} - 2.5\sigma) \le t_i \le (\bar{t} - 2.0\sigma)$
11	Exceptionally cold	EC	$t_i < (\bar{t} - 2.5\sigma)$

Starting from the mean monthly and seasonal temperature and from the mean multiannual temperature of winters the variable function was analysed of the normal standardized distribution which in this situation is estimated as (2):

$$I_S = \frac{t_i \bar{t}}{\sigma} \quad (2)$$

where I_s = standardized index of winters;

t_i = mean winter temperature;

$\bar{t}$ = mean multiannual temperature of winter season;

σ = standard deviation.

The computation of the standardized index for each winter allowed the affiliation of each winter to the corresponding severity class (Table 2). The way the standardized index and its variation are displayed makes it easy to trace the severity class where each winter belongs (Fig. 4).

Table 2

Affiliation of Winters in Bucharest According to the Classification Grid

Crt. no	Winter type	t° C	Standard Index	No of cases	%
1	EW	> 3.6	> 2.6	–	–
2	AW	3.1; 3.5	2.1; 2.5	1	0.7
3	VW	2.1; 3.0	1.6; 2.0	6	4.3
4	W	1.1; 2.0	1.1; 1.5	15	10.8
5	SW	0.0; 1.0	0.6; 1.0	26	18.7
6	N	– 0.1; – 2.0	0.5; – 0.5	49	35.2
7	SC	– 2.1; – 3.0	– 0.6; – 1.0	18	13.0
8	C	– 3.1; – 4.0	– 1.1; – 1.5	10	7.2
9	VC	– 4.1; – 5.0	– 1.6; – 2.0	11	7.9
10	AC	– 5.1; – 6.0	– 2.1; – 2.5	3	2.2
11	EC	< – 6.0	< – 2.5	–	–
TOTAL				139	100

Out of the 139 winters subjected to analysis, 49 (35%) characterize as normal ones, showing a mean temperature ranging between –0.1 and –2.0°C and a standardized index between –0.5 and (+0.5) (Table 3). A number of 48 winters (34%)-classes 1 to 5 were found to be warm, with mean temperatures between 0.0°C and over 3.6°C, and the cold winters belonging to classes 7 to 11 were as many as 42 (31%), with mean temperatures between –2.1°C and –6.0°C.

It is to be remarked that the somewhat peculiar winter 1995/1996 belongs-according to the classification grid to class 7 (slightly cold) due to the mean winter temperature of –2.2°C. There were 11 very cold winters (7.9% of total) with mean temperatures from –4.1 to –5.0°C and just three abnormally cold winters (2.2% of total).

In the Bucharest area the occurrence of the warmest winters mostly in the second half of the 20th century may be a signal of an ongoing warmer phase within the climate variability owed to the anthropogenic influence, characteristic to the large urban crowds.

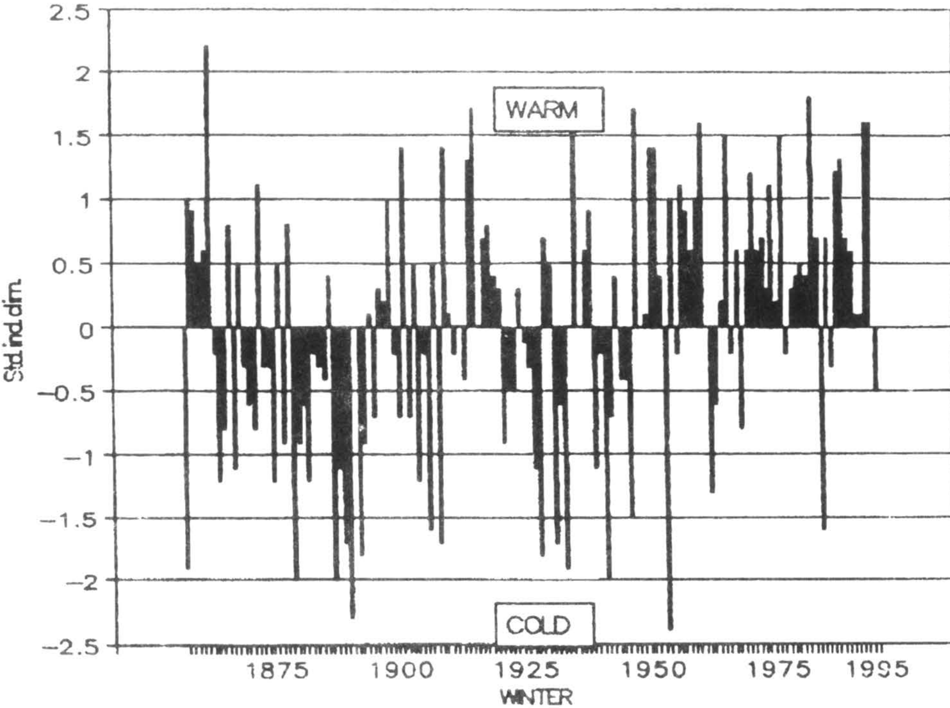

Fig. 4 - Variation of the Winter Standardized Index.

From investigating the winter variations in Bucharest, the following may be concluded:

– series of cold winters occurred rarer and mostly in the last two decades of the 19th century, as for instance a string of four such winters: 1887/1888, 1888/1889, 1889/1890, 1890/1891, and the succession of two cold winters in the first half of the 20th century (1927/1928, 1928/1929);

– normal winters are met in series of four (1912–1916) or five (1977–1982);

– series of four warm winters occurred (1858–1862), along with series of three (1957–1960) or two consecutive warm winters;

– abnormally warm or normally cold winters manifested as single events;

– the winter season is very complex, requiring the analysis of all the meteorological parameters which contribute to define and frame it within a severity degree;

– it is also compulsory to study the winter season not just calendaristically, but from its start to its end month, following both air temperature and the snow-cover setting-in and disappearance;

– further studies are bound to correlate winters to the characteristic atmospheric circulation and also the maximum and minimum solar activities.

Table 3

Winter Climate Indices for Bucharest City

EW	AW	VW	W	SW	N	SC	C	VC	AC	EC
	1862	1915	1872	1858	1863	1865	1864	1857	1887	
		1935	1901	1859	1869	1870	1867	1879	1890	
		1947	1909	1860	1873	1871	1875	1889	1953	
		1960	1914	1861	1874	1877	1882	1892		
		1982	1950	1866	1876	1880	1888	1906		
		1993	1951	1868	1883	1881	1904	1908		
			1956	1878	1884	1893	1927	1928		
			1959	1898	1885	1895	1939	1931		
			1965	1903	1886	1900	1946	1933		
			1970	1907	1891	1902	1962	1941		
			1974	1917	1894	1921		1984		
			1976	1918	1896	1922				
			1987	1929	1897	1923				
			1988	1937	1899	1932				
			1994	1938	1905	1942				
				1954	1910	1963				
				1957	1911	1968				
				1958	1912	1995				
				1967	1913					
				1969	1916					
				1971	1919					
				1972	1920					
				1983	1924					
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CONSIDERATIONS UPON THE ROLE OF THE WIND IN THE PROCESSES OF PROPAGATION AND DISPERSION OF ATMOSPHERICAL POLLUTANTS IN MOLDAVIA'S SUBCARPATHIANS

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Key-words: air pollution, wind speed and direction, Moldavia's Subcarpathians

Considérations sur le rôle du vent dans les processus de propagation et de dispersion des polluants atmosphériques dans les Subcarpates de la Moldavie. Puisque le vent est le principal élément climatique impliqué dans la pollution et la dépollution de l'atmosphère, on souligne l'influence de sa vitesse et de sa direction sur le niveau de la concentration des noxes atmosphériques dans les Subcarpates de la Moldavie. On présente les résultats des recherches faites dans la dernière vingtaine d'années, dans les régions avec un haut potentiel de pollution des Subcarpates de la Moldavie, Săvineşti-Roznov dans la Dépression Cracău-Bistriţa et Oneşti dans la Dépression Tazlău-Caşin. Hautes concentrations se produisent conformément à la direction du vent, mais aussi sur des directions limitrophes. Les vitesses de jusqu'à 2 m/s et le calme atmosphérique favorisent de hautes concentrations autour des sources et sur des distances moyennes (jusqu'à 5 km), et les vitesses de 2–3 m/s favorisent de hautes concentrations à grandes distances. Dans ces processus interviennent aussi d'autres facteurs comme la hauteur de l'émission, la température d'émission et la nature chimique des polluants.

The wind, "the pollution's vector," is the main climatic element involved in the dispersion and the propagation of the atmospherical noxa.

In the geographical literature, the problem of the influence of the meteorological or climatical conditions on the processes of emission, propagation, dispersion or stagnation of the atmospherical pollutants, are usually discussed in a general, enuntiative way. Referring to the wind's characteristics is only mentionned that the atmospherical calm favours the increase of the pollution degree in the proximity of the source and that speeds over 3 m/s favour the dispersion. This problem is much more complex as the local geographical factors, especially the relief, the proximity or the distance from the source of the studied region, the interferences of the other climatic factors involved, the height of the source, the temperatures of the emited gases, the power of the source, the chemical nature of the atmospherical pollutants, etc., are involved too. This way, as it follows, on the base of the measurements made in the last 20 years in the Moldavia's Subcarpathians, we shall try to bring some contributions to these problems.

The researches are made in regions affected by pollution from the subcarpathian depressions Cracău-Bistriţa and Tazlău-Caşin. In the central zone of the Cracău-Bistriţa Depression there is the chemical platform Săvineşti-

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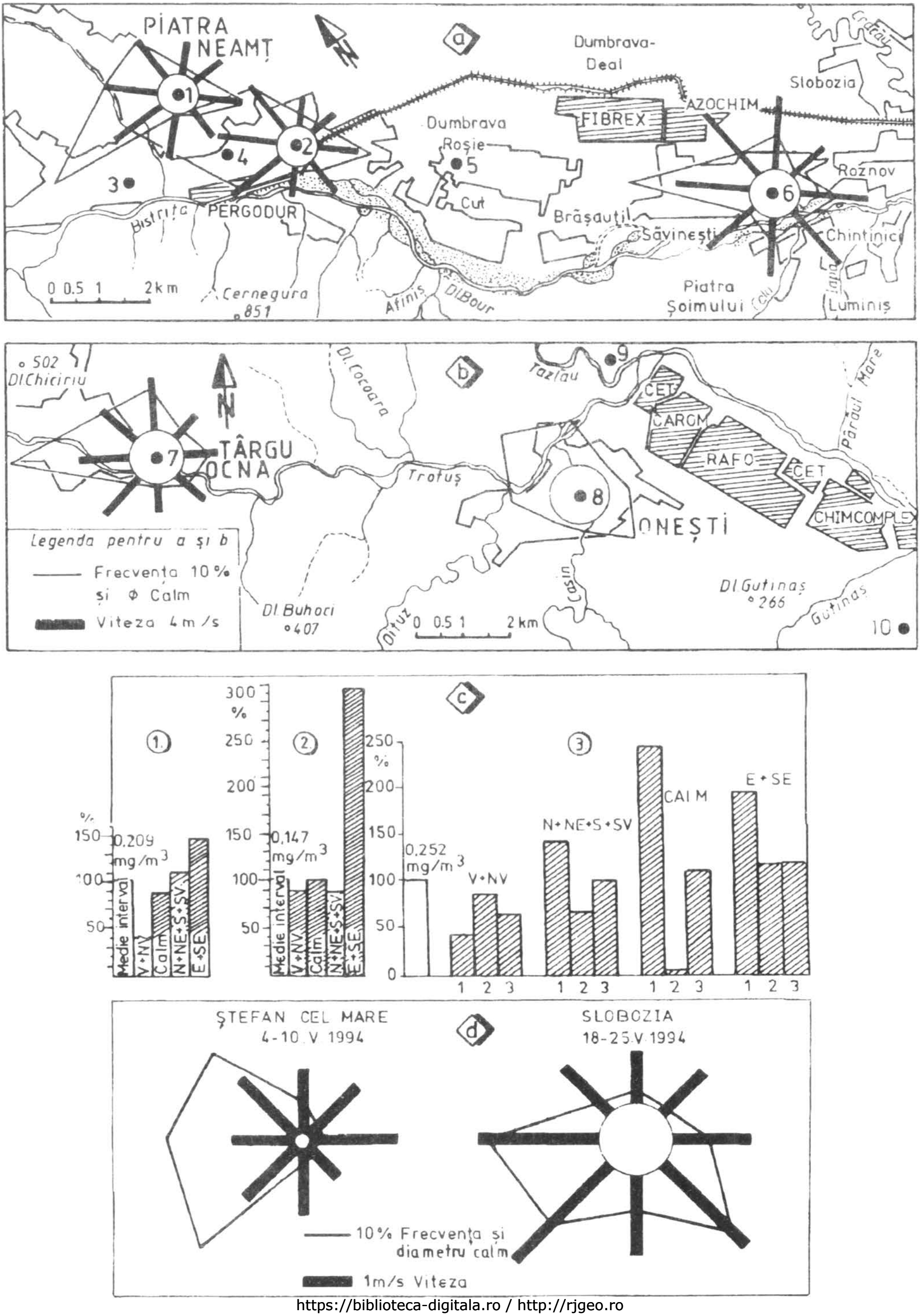
Roznov (synthetic fibres and nitrogen fertilizers). Noxa emited on the territory of Piatra Neamţ city were added, especially the sulphurous noxa from the cellulose manufacture. On the Trotuş valley, in the Tazlău-Caşin Depression, the industrial platform Borzeşti includes, as main pollution sources, the thermo-electric power station working with coal, the synthetic rubber factory, the refinery and the chemical factory. Both the industrial platforms are situated on the valleys of the rivers Bistriţa and Trotuş, in the down stream of the biggest cities of the Moldavia's Subcarpathians, Piatra Neamţ and Oneşti. From the multiples noxa emited in the two regions we shall refer only to the main specific noxa, common to both the zones and emited in big quantities (nitrogen bioxid, nitrogen monoxid, sulphur bioxid, ammonia, chlorine, sulphate ions and oxidizers).

Besides our data, we used also climatological data from the National Institute of Meteorology and Hydrology (I.N.M.H.) net and toxicological data from the protection of the environment agencies Piatra Neamţ and Bacău and from the Preventive Medicine Center Piatra Neamţ, totalizing thousands of toxicological data and tens of thousands climatic data on the wind parametres.

The wind's characteristics in the mentionned zones are similar. This way, the prevalent western circulation expresses itself directly, or becomes, by canalization, north-western, with the contribution of the northern currents that predominate in the east of the Eastern Carpathians. The local periodical circulation is superposed on this general system of winds, circulation well expressed like frequence on directions and with high speeds, especially at the contact with the mountains. This circulation is better evidenced in the Bistriţa valley than in that of Trotuş. In the central zones of the depressions the northern currents are favoured by large openings to north, on the valleys of Cracău and Tazlău (Fig. 1).

Referring to the influence of the wind direction on the degree of pollution, for the central zone of Piatra Neamţ city situated in the up stream of the main source of pollution of the city (the cellulose and paper factory "Pergodur", situated at 1 km down stream from the central zone of the city, with emissions

Fig. 1 – The influence of the wind direction upon the concentration of the atmospherical noxa. **a**, The compasses cards and the sampling posts of the atmospherical noxa in Piatra Neamţ zone; *1*, The meteorological station (data for the period 1986–1992), *2*, The meteorological station, former location (1968–1985), *3*, The Central Hotel, *4*, The Chemistry High School, *5*, Dumbrava Roşie, *6*, The Biological Station Săvineşti (1975–1976); **b**, The compasses cards and the sampling posts of the atmospherical noxa in Borzeşti zone; *7*, The meteorological station Târgu Ocna (1970–1990), *8*, Oneşti (1961–1979, hours 5, 11, 17 and 22), *9*, Slobozia, *10*, Ştefan cel Mare; **c**, The concentrations of atmospherical noxa in the region of Piatra Neamţ city for different groups of the wind directions: *1*, in the proximity of the Central Hotel for the period 24 II–23 IV 1988 (chlorine, sulphate ions), *2*, in the proximity of the Central Hotel for the period 14 V–13 VII 1988 (chlorine, ammonia and sulphate ions), *3*, on a profile between Piatra Neamţ and Săvineşti for the period 7–13 IV 1988 (chlorine, ammonia, sulphur bioxide and sulphate ions); **d**, The wind compasses cards of the frequency and the speed on directions at the measurements stations from Borzeşti region, for the period of May 1994.


a
PIATRA NEAMȚ
N
Dumbrava-Deal
Slobozia
FIBREX
AZOCHIM
Dumbrava Roșie
Cut
Roznov
Brăsauți
PERGODUR
Bistrița
Săvinești
Chintinici
0 0.5 1 2km
Cernegura 851
Afiniș
Dl. Bour
Piatra Șoimului
Luminiș
b
502 Dl. Chiciriu
Dl. Cocoara
Tazlău
N
TÂRGU OCNA
Trotuș
CET
CAROM
RAFO
CET
CHIMCOMPLEX
ONEȘTI
Pârâul Mare
Legenda pentru a și b
Frecvența 10 % și Φ Calm
Viteza 4 m/s
Dl. Buhoci 407
Oituz
0 0.5 1 2 km
Cașin
Dl. Gutinaș 266
Gutinaș
c
0.209 mg/m3
0.147 mg/m3
0.252 mg/m3
Medie interval
V+NV
Calm
N+NE+S+SV
E+SE
CALM
%
d
ȘTEFAN CEL MARE
4-10.V.1994
SLOBOZIA
18-25.V.1994
10% Frecvența și diametru calm
1m/s Viteza

at low and medium heights, from 0 to 50 m), it was noticed the reduction of the pollution level at 40–90% to the average, in the case of the group of directions "depolluting", west and north-west. The concentrations were closed to the average of the entire period of (90–100%) in case of atmospherical calm and winds from "neutral" directions, from north, north-east, south and south-west. In the case of the "polluting" winds group, from the source, from east and south-east, the concentrations grew strongly having a value of 150–300% , if compared to the average on the whole period (Fig. 1). For the profile made on the Bistriţa valley, the measurements points were inserted between the main sources of pollution: the central zone of the city, to its south-eastern extremity and to half the distance between the city limit and the chemical platform (situated on plane and open field, having sources of emission at all levels). In comparison with the average situation during the period of determinations the winds from the mountain, depolluting for the central zone of the city become polluting for the region from the down stream of the urban source, where the medium concentrations diminish with 25% on a distance of 5 km. The directions so called "neutral" and the atmospherical calm increase substantially the concentrations in the urban zone and around the main sources. The "polluting" directions, east and south-east, aggravate the pollution in open, plane field, near the main source (Fig. 1). For the urban spaces, situated in regions with highly fragmented relief, where the air's turbulences are strong, are necessary measurements of the direction in several points between the sources and the point of noxa sampling. In these cases, for emissions at low and medium height (0–10 and 10–50 m), the results are relevant for groups of three directions only, from the eight main directions of the wind. At low and medium concentrations of the atmospherical noxa, the pollution degree diminished slowly, while the distance from the source grew. On "neutral" directions the concentrations were relatively big in comparison to the forecasts, in the regions with great fragmentation of the relief and in the urban zones. Totalling up the two conditions, the registered concentrations were even bigger than the averages for all the directions and atmospherical calm for all the sampling periods. If during the periods with atmospherical calm the concentrations around the sources situated in open and plane field were just a little over the average, in the fragmented zones and in the urban zones the concentrations were 250% bigger than the average. On the "polluting" directions, in open and plane field, the concentrations were 25% bigger than the average and double in the regions with great fragmentation of the relief and in the urban zones (Fig. 1).

The values of the frequency and medium speed on directions of the wind at Ştefan cel Mare and Slobozia (Table 1 and Fig. 1) result from automatic meteorological measurements[1] and the medium values of the atmospherical noxa were made on the basis of the automatic analysis made every half an hour (Table 1).

[1] These data have been put to our disposition by the Agency of Environment Protection Bacău.

Table 1

Average values of the atmospherical noxa for the different wind directions in the region Oneşti (**A**, Ştefan cel Mare, 4–10 May 1994; **B**, Slobozia, 18–25 May 1994)

Direction	Frequency (%)	Average speed (m/s)	Noxa concentrations (mg/m^2)			
			SO_2	O_3	NO_2	NO
A.						
Calm	3,43	0,0	0,003	0,071	0,006	0,001
N	6,99	1,3	0,006	0,071	0,009	0,002
NE	1,92	1,4	0,004	0,077	0,009	0,002
E	2,71	1,8	0,000	0,078	0,011	0,002
SE	1,23	0,9	0,003	0,073	0,008	0,001
S	2,72	1,4	0,001	0,076	0,010	0,002
SW	29,13	1,5	0,001	0,046	0,000	0,001
W	26,89	1,4	0,004	0,051	0,006	0,001
NW	24,68	1,6	0,018	0,061	0,009	0,003
B.						
Calm	15,97	0,0	0,008	0,034	0,007	0,002
N	1,83	0,9	0,007	0,066	0,006	0,002
NE	1,49	1,2	0,012	0,065	0,008	0,003
E	5,80	1,6	0,028	0,053	0,014	0,005
SE	18,80	2,3	0,014	0,064	0,009	0,003
S	7,08	1,6	0,003	0,056	0,007	0,002
SW	17,23	2,7	0,003	0,068	0,000	0,002
W	22,08	2,5	0,004	0,067	0,007	0,003
NW	9,67	1,3	0,005	0,048	0,006	0,002

For Ştefan cel Mare locality, the concentrations were directly proportional with the frequency of the "polluting" directions only for the sulphur bioxid, which is emited from the industrial platform Borzeşti at all the levels of height (*low*, 0–10 m; *medium*, 10–50 m; *big*, over 50 m). The nitrogen oxides, most of them emited at big height were very exposed to the photo-oxidation processes during the periods of samplings data collecting, warm periods, with prevalently clear sky. In these conditions the distribution of the nitrogen bioxid and of the nitrogen monoxid were almost similar also at pretty low concentrations for all the wind directions. Only in Ştefan cel Mare locality, on the south-western direction there were registered lower concentrations of these noxa, because, from the south-west direction, from the upstream of the Bogdana valley, the clean air masses penetrate the locality, moved by the mountains winds currents which develop during the night and the morning as part of the periodical local circulation. The ozone's distribution, emitted in this zone by the industrial processes, but resulted especially from the photo-oxidation processes, was constant and relatively high for all the wind's directions, due to the powerful insolation during the periods of data collecting. The pollution level with oxidizing substances was almost similar in all the surrounding zones of the factories. If for low and medium emission heights, the level of the concentrations can be well correlated with the wind's direction registered at 10 m height, in case of the emission at big heights, measurements of the wind direction at the height level of the emitted gases are necessary.

The influence of the wind's speed on the atmospherical processes of pollution and depollution will be evidenced for medium monthly, weekly and daily values, for different heights of the emission sources for plane and irregular relief, for zones situated at different distances from the sources.

At the level of the monthly average, the dependance of the concentrations on the wind speed was better expressed in the case of the sedimentable dusts (Fig. 2), decisively intervening the state of the soil's surface (wet or dry) and the presence or the absence of the snow.

At altitude, together with the increase of the wind speed, takes place a diminution directly proportional of the atmospherical noxa concentration emitted at low heights and a slower diminution for the noxa emitted at medium and big heights, especially for the noxa emitted at high temperatures (Fig. 2).

The medium daily concentration registered increases around the sources, up to medium speeds of 2 m/s, and in case of the noxa emitted at low height even up to 3 m/s, observation also confirmed by the determinations made at medium distance from the source (fig. 2). In these determinations interfered a lot also the influence of the chemical nature of the noxa.

As a conclusion, generally, the atmosphere's polluters propagate from the source on the wind's direction, but also on neighbouring directions, especially in the regions with very fragmented relief and in the urban zones, where the aggravating influence of the atmospherical calm is more obvious. In these regions, the measurements of direction must be made on the whole tract between the source and the station of prelevation of the atmospherical noxa, and in case of the emissions at height will be taken in consideration also the wind direction at the level of the emitted gases.

For powerful sources of emission, as in the case of the two chemical platforms, Săvineşti-Roznov and Borzeşti, in relatively plane field, our researches evidenced processes of dispersion of the atmospherical noxa, similar for the same classes of speed of the wind in case of emissions at the same categories of height. It was analyzed the influence of the wind speed in the processes of pollution and depollution of the atmosphere in exposed zones, situated on the direction of the wind to the source, with a 45° tolerated leading astray plus-minus. For emission sources situated at low and medium height and atmospherical calm very big concentrations were produced in the surrounding zones of the factories (up to 2 km from the source), big concentrations at medium distances (2–5 km), the diminution of the concentrations being then sudden. Medium speeds of 0,5 to 2 m/s produced big concentrations to at the most 5 km distance from the source, after that their diminution being slow. The average

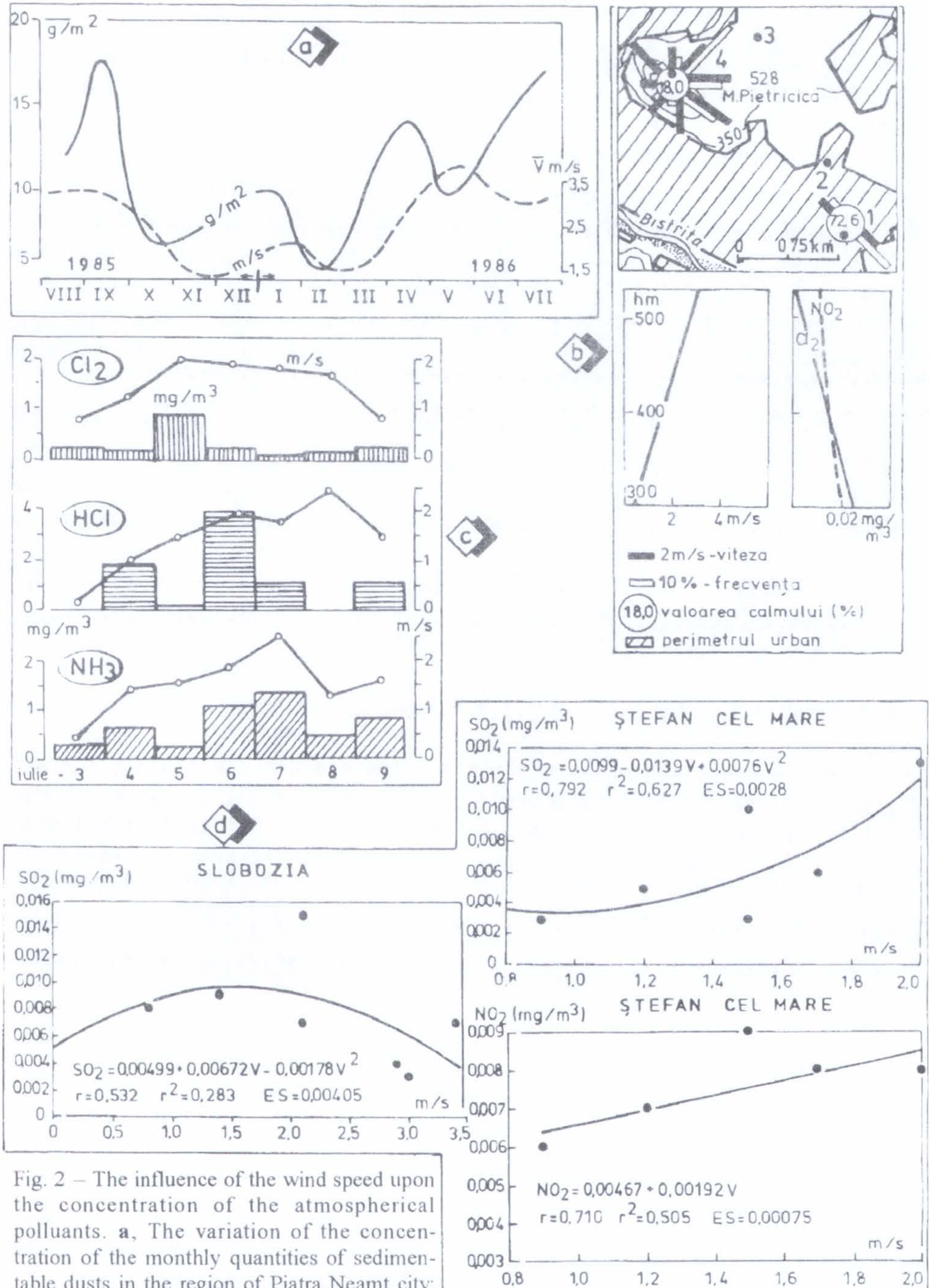


Fig. 2 – The influence of the wind speed upon the concentration of the atmospherical polluants. **a**, The variation of the concentration of the monthly quantities of sedimentable dusts in the region of Piatra Neamț city; **b**, the distribution of the atmospherical noxa on an altitudinal profile in Piatra Neamț (15–21 september 1984); **c**, the variation of the medium concentrations of the atmospherical noxa at S.C. "Chimcomplex" S.A. Borzești; **d**, the concentration of the atmospherical noxa in Borzești region (Ștefan cel Mare, 4–10 May 1994, Slobozia, 18–25 May 1994).

speeds of 2–3 m/s generated moderate concentrations around the sources, big concentrations at medium distances, and after that their diminution was fast. For medium speeds over 3 m/s, the concentrations were low at all the distances for which the determinations were made. For the sources situated at big height, the atmospherical calm favoured low concentrations in the whole territory. The speeds of 0,5–2 m/s produced low concentrations in the sources zone, moderate at medium distances, diminishing then slowly. The medium speeds of 2–3 m/s favoured the registration of low concentrations in the sources zone, moderate concentrations at medium distances and slight increases in comparison to the average concentrations at distances of 5–10 km, diminishing then slowly. The medium speeds over 3 m/s produced diminutions of the noxa concentrations in all the zones.

The influence of the wind speed in the atmospherical pollution and depollution is bound, not only to the height of the emission source but also to the temperature of the emitted gas, the two factors constituting a parametre that indicates the real height of the source (the height to which the gas rises). It interferes also the chemical nature of the atmospherical noxa, the physical state of the atmosphere which modifies the reaction mechanisms of the noxa with the natural components of the atmospherical air and the reactions between the noxa.

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ROBERT FICHEUX, *Les Monts Apuseni (Bihor). Vallées et aplanissements.* Edit. Academiei Române, Bucureşti, 536 p., 118 fig. dans le texte, 23 pl. hors texte.

Le livre *Les Monts Apuseni* du professeur Robert Ficheux est un monument scientifique, comme d'ailleurs est l'auteur même. Une présence vive dans le monde géographique roumain et le monde culturel de Cluj d'entre les deux guerres mondiales, le professeur Ficheux a dédié toute sa vie à la connaissance des Monts Apuseni: dix ans vécus en Roumanie et encore 60 ans après son départ. Fruit d'un travail d'une grande minutie, d'abord au terrain et ensuite sur les cartes et dans la bibliothèque, le livre sur les Monts Apuseni est unique par maints traits caractéristiques.

D'abord il contient toute une époque ayant le parfum, déjà historique, des années d'entre les deux guerres mondiales, les années prodigieuses qui ont créé la Grande Roumanie. C'est la période d'intense émulation scientifique, avec des méthodes emmenées en Roumanie surtout par des savants et des chercheurs venus de l'étranger. Le professeur Ficheux a été l'élève du grand maître Emm. de Martonne, qui lui a suggéré, comme sujet de thèse, l'étude géomorphologique des Monts Apuseni et M. Ficheux a appliqué dans son étude les méthodes envisagées par celui-ci. Ces méthodes prévoient dans le domaine de la géomorphologie la connaissance approfondie du soussol (donc la géologie) et l'exploitation exhaustive de la carte topographique, accompagnée par des observations de terrain. Il faut souligner ce fait car dans les années d'après la deuxième guerre mondiale, ces méthodes ont été presque oubliées, les géographes des nouvelles générations travaillant parfois moins rigoureux, sans une analyse minutieuse des cartes. De ce point de vue, le travail accompli par le prof. Ficheux est un modèle qui pourrait donner à penser aux actuels chercheurs roumains, parfois disposés de tirer des conclusions hâtives sur des documents précaires. Le livre est un modèle de ténacité, de grande sériosité; il témoigne un grand dévouement pour la recherche.

Mais ce n'est pas seulement un oeuvre-document d'époque et un exemple, mais surtout un travail qui apporte des éléments essentiels pour la connaissance de l'évolution géographique, et notamment géomorphologique, d'un territoire de grand intérêt. La bibliographie et son utilisation nous montrent que l'auteur a incorporé toutes les nouvelles acquisitions des connaissances géologiques qu'il les a exploitées au maximum. Par son coté géologique on peut apprécier la modernité du travail, moins du coté géographique car il y a peu de données nouvelles, d'analyses morphologiques acquises au fil du temps. Les seules nouveautés de valeurs parues ce demi-siècle dans le domaine appartiennent au... professeur Ficheux.

Le point de départ du système de recherche de l'auteur est l'étude très détaillée des bassins hydrographiques et surtout des profils longitudinaux des rivières afin de déchiffrer les étapes de l'évolution du massif, ça veut dire de l'entaillement des vallées dans le corps montagneux, surélevé par étapes. Pour mieux comprendre ces étapes, l'auteur fait une pertinente synthèse des travaux réalisés sur le difficile problème de la naissance de la percée du Danube à travers les Carpates dans le défilé des Portes de Fer. Ces données sont capitales pour voir le mode de drainage du principal bassin récepteur des eaux surgissantes des Monts Apuseni, c'est-à-dire le Bassin Pannonique. Ensuite l'analyse s'étend sur toutes les rivières drainant les Monts Apuseni en utilisant d'innombrables profils, interprétés du point de vue géologique et morphologique.

Le résultat de ce prodigieux travail est l'identification d'un grand nombre de surfaces d'aplanissement (probablement 24, mais groupées en 12 principales, datées à l'aide des

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données géologiques), nombre innattendu vu les résultats des prédécesseurs. Mais la démonstration est convaincante et il sera difficile à démonter l'argumentation, peut-être seulement en réalisant une analyse au moins si minutieuse que celle de M. Ficheux, ce qui est, pour les géographes contemporains, peu probable.

Evidemment, dans les 500 pages du livre il y a une fouille d'observations de détail, de nombreuses explications pour les moindres anomalies de relief et seulement un connaisseur profond du terrain est capable de comprendre l'argumentation. Mais ce connaisseur, en fermant l'ouvrage parcouru, aura la joie d'avoir une meilleure compréhension du relief de l'un des plus intéressantes groupes de montagnes, non seulement des Carpates Roumaines mais aussi de la chaîne alpine de l'Europe.

Le livre de M.Ficheux porte la valeur d'un modèle de recherche scientifique approfondie et représente un témoignage de la grande amitié prêtée par un géographe français à la terre roumaine.

La publication du livre du professeur Ficheux est le mérite d'un groupe d'admirateurs et des Editions de l'Académie Roumaine avec l'appui des Services culturels français de Bucarest, qui ont rendu ainsi hommage à un savant authentique, un grand ami de la Roumanie et qui a réfléchi, pour réaliser cet exceptionnel travail, toute une vie, ce qui représente beaucoup, vu que M.Ficheux va accomplir son centenaire en 1998.

Marcian Bleahu

VASILE BĂICAN, *Geografia Moldovei reflectată în documentele cartografice din secolul al XVIII-lea* (The geography of Moldavia in 18th-century cartography), Edit. Academiei Române, Bucureşti, 1996, 170 pages, 23 fig., 14 tables, XXX plates.

This recently published work of cartographical and geographical history is richly documented. It contains two parts: 1) cartographic documents (over 60 maps and sketches); 2) references to general and special works (over 130 titles) and an annex (23 facsimile maps, several engravings of settlements or strongholds (e.g. Iaşi city, Soroca and Hotin strongholds or of military action the conquest of Iaşi city, the shelling of Hotin stronghold).

The text itself represents the author's doctoral dissertation submitted to the "Al. I. Cuza" University of Iaşi. It is written in a sobre style of great scientific rigour. The numerous cartographic historical, ethnographic, cartographic, memorialistic and travel documents referred to are given an original interpretation.

Although historians, geographers, and military researchers have so far dealt with the 18th-century cartography of Moldavia, they did but inventory maps, occasionally analysing some of them, and incidentally outlining some components of the whole territory, or some parts of it. Vasile Băican takes an objective look at the authentic documents and their interpretation, highlighting both the positive sides and the limitation inherent of 18th-century cartographic production, or the one-sided view offered by some later researchers.

The author also provides an almost complete list of the 18th-century cartographic documents on the then historical province of Moldavia between the Carpathian Mountains and the Nistru River.

The second part of the book makes an analysis of the substance and form of the most significant documents, with critical considerations on the achievements and failures of cartographic productions. Using historical as well as other types of document, the author discusses the scale of representation of natural environments (landforms, waters, plant cover), of the social-economic life (population, settlements, means of communication, economic, cultural, political and other components), and of the political administrative framework (borders, administrative divisions).

Vasile Băican reaches the conclusion that apart from Dimitrie Cantemir's map (1715–1716), all the other productions up to the 1770s give but a brief and very inaccurate picture of geographical elements. But these cartographic drawbacks were common at that time world-wide.

Over the last three decades of the 18th century, the military and momentous political requirements led to significant changes in the content, plasticity and accuracy of maps. Noteworthy are the maps of Cantemir and its simplified copy due to d'Anville, of Bawr, Bruschel and Otzellowitz.

Vasile Băican refutes the severe and unfounded criticism levelled by some authors at Bawr's map and the would-be grave errors therein, rehabilitating other cartographers, too, e.g. Roth, Schmidt and von Raan. A qualitative leap in the content of map-drawing was made by late 18th-century Austrian cartographic representations (the so-called „Josephine" map), but as far as Moldavia is concerned they cover only parts of its historical territory.

Undertaking a physiographical analysis is a difficult task because of the scarcity and inaccuracy of data and information on the relief, waters, plant cover, etc. Hence, the difficulty of working out factorial thematic maps or landscape maps. The maps due to Cantemir, to Russian and Austrian authors remain a reference cartographic source (the planimetric ones, as altimetric determinations lack in exactness).

Using direct cartographic sources and related documentary material, the author offers a fairly accurate image of the 18-th-century-Moldavia natural environment. Readership: geographers, historians.

Victor Sficlea

GHEORGHE LUPAŞCU, *Depresiunea subcarpatică Cracău-Bistriţa. Studiu pedogeografic* (La dépression subcarpatique de Cracău-Bistriţa. Étude pédogéographique), Editura Corson – Iaşi, 1996, 196 p., résumé en français.

Le flanc extérieur des Carpates Orientales est bordé presque entièrement par les Subcarpates de Moldavie. Ceux-ci sont formés d'une série de dépressions et d'une suite de collines. La plus grande de ces dépressions, Cracău-Bistriţa, fait l'objet d'une étude pédogéographique, fruit de plus de deux décennies de recherches. L'intervalle de temps n'est pas démesuré, car «tout ce qui est "subcarpatique" est compliqué aussi – le domaine se constituant comme une transition extrêmement complexe entre le carpatique et l'extra-carpatique» – comme le professeur Nicolae Barbu le remarque à juste titre dans la préface.

L'ouvrage est constitué de sept chapitres qu'on pourrait réunir en quatre sections: la première porte sur le milieu géographique, la seconde sur la couverture de sols, la troisième sur les problèmes de l'application, enfin la quatrième sur les conclusions.

On présente dans la première partie (ch. 1, 2) la situation géographique et les facteurs pédogénétiques, d'une manière détaillée et avec de nombreuses contributions originales, sans omettre pour cela les connexions dynamiques qui apparaissent dans l'interaction de ces facteurs.

La deuxième partie (ch. 3) porte sur une analyse complète et complexe de la couverture des sols des terrains agricoles, qui dépassent 62 000 ha (les terrains sylvicoles représentent actuellement une surface négligeable). Des dix classes de sols du Système roumain de classification des sols (1980), il y en a dans la dépression de Cracău-Bistriţa six: des mollisols (ayant la surface la plus étendue, presque 30% de la dépression), des sols argiliques, des cambisols, des sols hydromorphes, des vertisols (ayant la surface la moins étendue, au-dessus de 1% de la dépression), enfin des sols non évolués, tronqués ou bien défoncés.

La troisième partie (ch. 4, 5, 6) porte sur l'achèvement pratique des sections précédentes, sur l'évaluation des sols, sur la nécessité des travaux agropédoaméliorants et sur la division du territoire.

Les conclusions (ch. 7), un ample résumé en français (15 pages) et la liste bibliographique (presque 300 titres) achèvent l'ouvrage. Tous les chapitres sont pourvus de cartes, de tableaux et de graphiques.

Nous espérons que ce volume marque un début de bon augure pour la publication des monographies pédogéographiques régionales et constituera également un véritable modèle pour ceux qui auront la capacité d'aborder un problème pareil.

Nicolae Băcăinţan

ION MUNTEANU, *Soils of the Romanian Danube Delta Biosphere Reserve*, NV Drukkerij Erasmus, Weteren, 1995–1996, 174 pages, 33 figs., 45 tables, 1 plate format 135/100 cm.

The present work, which contains two distinct items: 1) the Soils Map on the scale of 1:100 000, large format (kind of wall map), and 2) a text volume, is the outcome of a collaboration between several high-profile Romanian and Duch institutions. The map itself, printed in 1995, is due to the joint endeavour of the Research Institute for Soil Science and Agrochemistry (ICPA), Bucharest, the Institute for Inland Water Management and Waste Water Treatment – Lelystad (RIZA) of the General Directorate for Public Works and Water Management (DGGALP), the Netherlands, and the Danube Delta Institute-Tulcea (ICPDD), Romania. The text volume, published in 1996, is the work of the Danube Delta Biosphere Reserve Administration, ICPDD – Tulcea and RIZA – Lelystad.

The Map of Soils of the Romanian Danube Delta Biosphere Reserve was drawn up by I. Munteanu and Gh. Curelariu of the ICPA-Bucharest based on previous soil mappings made by the Institute's team, and on aerial photographs dating from the years 1975 and 1992. It also benefits from the contribution of researchers from ICPDD-Tulcea, Biological Research Centre-Iaşi and Pedology and Agrochemistry Departments in Ploieşti and Tulcea. Digital data transcription is due to I. Grigoraş, A. Constantinescu – ICPDD-Tulcea and A. Groeneweg, Chr. Roelfsema, I.W. Dniker DGGALP-Delft. The work was printed at Weteren in Belgium. A geomorphological map of the Danube Delta Biosphere Reserve (scale 1:300 000) is appended.

The explicative volume, covering with a wide range of topics, is divided into eight chapters: a summary and a brief introduction (three chapters) presenting a history of soil studies in the Danube Delta, and a data base; an extensive description of the Danube Delta's physical and socio-economic geography, authored by P. Gâştescu of the Bucharest Institute of Geography (chap. 4); delta evolution and geology, written by N. Panin of the National Institute of Marine Geoecology-Bucharest (chap. 5). The largest part of the volume is devoted to the subject of soils proper - author I. Munteanu of ICPA-Bucharest: soils (chap. 6); legend of the Danube Delta soils (chap. 7) and soil salinity and alkalinity; pyrite formation and soil acidity (chap. 8). An exhaustive bibliography, a glossary of soil terms, and 47 soil profiles (depicting main characteristics) with one-two detailed physiochemical tabulations conclude the text.

Providing a comprehensive image of natural conditions and soils in the Romanian Danube Delta Biosphere Reserve, this work has relevance for specialist world-wide. Readership: soil scientist, geographers, geologists, chemists, agronomers, etc. Accessibility of soil map and legend is ensured by having added, apart from Romanian soil names, also the names listed in the FAO/UNESCO Revised Legend and the USA Soil Taxonomy. A highly accurate and clear language style, figures and tables, as well as the colours used at the soil and geomorphological maps (with legends in English and Romanian) recommend this work as an exceptional achievement, as a model of co-operation between specialists from two countries animated by the desire to produce reference works.

Mircea Buza

GH. IANOŞ, M. GOIAN, *Solurile Banatului. I. Evoluţie şi caracteristici agrochimice* (The soils of Banat. Evolution and agrochemical features), Ed. Mirton, Timişoara, 1995, 272 pages, 80 figs., 33 tables, summary in English, bibliography, authors' index.

This is the first volume of a monographic series devoted to soils in Banat. It deals with a wide range of problems connected with the soil cover of this historical province located in the SW of Romania and covering 1,881,337 ha. The book, divided into three parts and 16 chapters, discusses matters of soil evolution, also offering some forecasts on this line.

The introduction gives a presentation of the state-of-the-art in research with highlight on soil formation and evolution, influence of environmental factors on soil genesis and development (relief, rock, climate, waters, vegetation, fauna, paleoclimate and anthropic activity), taxonomy and soil classification world-wide and in this country, land availabilities in Banat – the groundwork for agricultural soil research.

Part I: *The making and the evolution to the Banat soils*, makes short references to solification factors involved in the formation and evolution of this province's soils (geology, geomorphology, rocks and solification materials, climate, hydrography, hydrology, hydrogeology and vegetation), dwelling at large upon soil formation and evolution under natural conditions (pedogenesis) and the anthropic impact (metapedogenesis).

Part II: *The state of supply with nutritive elements of agricultural soils in Banat* makes some general remarks on the methods used to study reference profiles, the response of farming lands, considerations on possible evolutions and change, humus, nitrogen and mobile phosphorus content in farming lands, evolution and possible change.

Part III: *The protection and preservation of soil fertility in Banat* focuses on limitative and restrictive factors of farming land fertility in the light of the physio-chemical properties of soils (degradation, salinization, acidification, humus reserves, depleted nutrient content and excessive calcium carbonate amounts). The concluding chapter suggests measures for the protection and rehabilitation of soil fertility in Banat.

The highly complex and topical issues approached, as well as the numerous diagrams and tables make this work a major contribution to the pedogeographical knowledge of Banat*

Readership: wide-ranging specialists, primarily pedologists and geographers, but also biologists, chemists, agronomers and everyone interested in the soils of this province.

M.B.

VICTOR SOROCOVSCHI, *Podişul Târnavelor – Studiu hidrogeografic* (Târnavele Plateau – A hydrogeographical study), CETIB, Cluj-Napoca, 1996, 192 p., 67 fig., 57 tables.

Most geographers agree that our science, geography, which is so complex and beautiful, still suffers from the influence of descriptivism introduced in the first half of our century. This descriptivism – sometimes very pleasant, but most frequently excluding the possibility of practical use specific for the second half of the 19th century – has characterized especially monographic studies.

* The volume received the "Gheorghe Ionescu Şişeşti" prize of the Romanian Academy for 1995 during the General Assembly of the Romanian Academy, December 1997 (n.d.l.r.).

We have now the possibility to read a monograph which dissipates any prejudice regarding this purely descriptive character. Although it is a study on a hydrological subject, it goes beyond the limits of this geographic branch, as it deals with the hydrological phenomenon in close relation to the other components of the geosphere, including man's needs and activities.

The determinist study of the phenomena and the large use of quantification confers the book, along with an obvious geographic character, an undeniable interdisciplinary value. It is a source of information for other sciences and fields of activity – chemistry, ecology, environmental protection, water management, hydrotechnical designs and constructions – which find useful data and interpretations for their own fields.

From a methodological point of view, the book represents an eloquent example of analysis, interpretation and description of hydrological phenomena. It is noteworthy that qualitative conclusions are based on quantitative analyses, which also gives the book its practical scientific value. Although it concerns a territorial physicogeographic unit, the methodology used may be considered as generally valid by accuracy, logic, professionalism.

The book consists of nine chapters.

In the first part, we get acquainted in a very laconic but concrete manner with the Târnavele Plateau.

In Chapter II, the conditioning of river runoff by the physicogeographic factors as well as by the anthropic factor is explored. Interpretations are based on a very rich material.

Chapter III presents the river system, morphometric characteristics, as well as a short history of hydrographic knowledge.

The study of the multiple aspects of river runoff from Chapter IV is a model of hydrological analysis. The description of river supply sources is followed by a complex analysis and synthesis of multiannual mean runoff and water balance. Then, the time-space variation of different runoff types is detailed.

Chapters V and VI focus on water temperature, winter phenomena and freezing status of rivers.

Chapter VII offers an eloquent presentation of alluvial runoff variation and of the differentiation of areas with pronounced erosivity and erodability.

After the chemistry of rivers is dealt with in Chapter VIII, the analysis of water quality aspects introduces us to the issue of human influence on rivers. This subject is continued in Chapter IX by aspects concerning the use of resources and hydrographic basins.

„Târnavele Plateau – A Hydrogeographic Study" is a book necessary not only to any geographer or hydrologist, but also to all those who study natural phenomena or are concerned with the practical study of water.

Gavril Pandi

GEORGE ERDELI, IOAN ISTRATE, *Amenajări turistice* (L'aménagement touristique). Editura Universităţii din Bucureşti, Bucureşti, 1996, 163 p., 8 fig., 19 tab.

Récemment, les Editions de l'Université de Bucarest ont publié une étude qui aborde les problèmes de l'aménagement touristique, résultat de la collaboration des professeurs George Erdeli de l'Université et Ioan Istrate de l'Académie d'Etudes Economiques de Bucarest. L'ouvrage s'adresse surtout aux étudiants géographes et économistes, mais il suscite aussi l'intérêt des spécialistes qui travaillent dans le domaine de la géographie du tourisme. Le volume pourra constituer un modèle d'entamer un tel sujet.

L'ouvrage est structuré en 11 chapitres, et met à la disposition des lecteurs un ample image sur l'aménagement sur des bases scientifiques des ressources touristiques caractéristiques aux zones naturelles homogènes (de montagne, littoral, zones périurbaines et villages touristiques), aux parcs et aux réserves pour la protection de certaines plantes et animaux rares, aux réserves de la biosphère. On met en valeur le caractère spécifique et les problèmes que posent chaque modèle d'aménagement, mais aussi les situations où le volume des flux touristiques détermine l'équilibre écologique et la qualité des ressources. Le potentiel et l'aménagement touristique du Delta de Danube, réserve de la biosphère, ses particularités et les types de tourisme y pratiqués, sont présentées de manière détaillée.

Les auteurs ont distingué les modalités d'aménagement et de revitalisation des stations balnéaires et climatiques et des villages touristiques, en soulignant, pour chaque type d'aménagement, l'expérience internationale (concrétisée en modèles d'aménagement) et ses particularités pour la Roumanie.

L'insertion des activités touristiques dans les grandes villes, le rapport entre les dimensions des exigences et les paramètres des conditions matérielles et d'agrément urbain sont détaillés dans un chapitre sur le tourisme dans les grandes villes.

L'ouvrage s'achève par une division en zones touristiques de la Roumanie, élaborée ayant comme principal élément la littérature roumaine de spécialité et des critères et régles précis. On met en évidence les priorités dans le développement en perspective des zones touristiques. Les lecteurs ont à leur disposition une évaluation prospective sur l'évolution des activités touristiques en Roumanie, dans le contexte de leur intégration aux standards du tourisme international.

Radu Săgeată

MELINDA CÂNDEA, *Carpaţii Meridionali în sistemul montan românesc. Studiu de geografie umană* (The Southern Carpathians in the mountain system in Romania – A human geography study), Edit. Universităţii din Bucureşti, Bucureşti, 1996, 155 p., 33 fig., 15 tables.

This seven-chapter work takes a comprehensive retrospective look at the evolution and characteristics of the humanisation process in the Southern Carpatians, with emphasis on the role of depressions and valley corridors in the spread of settlements and of economic activities in this the highest mountain chain in Romania.

A brief introduction is followed by a history of geographical research in the Southern Carpathians and by a chapter depicting the features of the natural background, a prerequisite for the evolution and specificity of the humanisation process.

Chapter III – *The place and role of depressions in the history of the Romanian land and its people* – hightlights this landform as a natural shelter-ground for the building of the earliest settlements and fortified cities, the starting point for the further development of human dwelling places in the mountain zone. The great many archaeological discoveries come to substantiate this truth. This was the locus of the first centralised Dacian State, and close to it, edging the mountains, in the Haţeg Depression, was the core of the Roman Dacian province. Depressions and valley corridors represent major axes of Carpathian and Transcarpathian circulation, a topic dealt with at large in Chapter IV – *The historical function of Transcarpathian axes associated to depressionary areas and their role in humanising the respective zone.*

The next chapter (V) comprises two distinct sections: main stages of humanisation, from ancient-to-modern and contemporany times, and principal geodemographical features in the 20th century, in the aftermath of urbanisation and industrialisation and their population impact.

Chapter VI makes a detailed presentation of the particularities and progression of the human settlement net, based on available documents, characteristics of the intra-mountainous rural habitat, village origin and mode of formation, territorial distribution of settlements, demographic potential of the countryside, types of rural habitat in terms of natural conditions and specific economic resources, traditional and modern economic activities, functional differences specific to the depressionary zone and an outline of the urban phenomenon.

And finally, chapter VII offers a prospective view of the human impact on the geographical landscape, aesthetic and land-use changes – indicators of geographical space organisation.

The wide range and topicality of the data included in this work makes in attractive to a large readership: teachers, researchers, students, pupils, and all those who find an interest in the geography and history of this mountain space.

R. S.

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