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ON THE OCCASION OF THE 25 th INTERNATIONAL GEOGRAPHICAL CONGRESS

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THE CONCEPTION OF SOCIAL-ECONOMIC GEOGRAPHY

S. Nõmmik, U. Mereste

I. On the genesis of the system of societal-geographical sciences

For a long time the traditional system of Soviet geographical sciences has consisted of two qualitatively different but dialectically interconnected sub-systems. They are physical geography and economic geography which are linked by the theory of geography.

In recent times another pair of general categories - natural geography and societal geography - can be met in literature more and more often. Such a scientific generalization is based on the cognition of reality as the unity of nature and society by materialistic philosophy. In the present paper societal geography is treated as a sub-system of the entire system of geographical sciences. Its elements are the already existing geographical sciences as well as those still in the process of coming into being. They study geographical aspects of the life of the society (social and spatial relations) within the societal-geographical systems and between them. Such an interpretation does not exclude but rather assumes the existence or the possibility of the rise of new natural-societal and societal-natural geographical sciences on the borderline of natural and societal sciences.

The scientific categories "natural geography" and "societal geography" reflect more completely than physical geography and economic geography the qualities of both sub-systems and are in better accordance with the division of reality into nature and society as it is done by materialistic philosophy. Such a division is particularly necessary because of the operation of different laws of development in both sub-systems from which in their turn arise essential methodological differences also in the branches of geographical sciences.

The idea of studying society geographically is not new in the Soviet Union. It attracted the attention of N. Baranski, who in his fight for independent economic geography pointed out the need to investigate reality from the sociogeographical aspect too. Later this idea was developed further by M. Kabo (1947) and I. Saushkin (1973). The conception by societal geography has also found support by V. Gohman (1981) and others. The idea of the necessity of the distinction of societal geography stems from the understanding that social life as a whole in all its spatial varieties and not only its economic aspect may become the object of geographical research.

I. Saushkin has underlined the necessity of conscious territorial organization of the society as a whole. This, in its turn, has made integral geographical investigation of the society inevitable, and as a result of it, societal geography has come into being. At the present time we are already witnessing this process.

The emergence of societal-geographical conception is lawful and timely. It is possible to say even more: preconditions for such shifts in Soviet geographical science have already been ripe for a long time.

In reality, more and more new branches of both the production and the non-production spheres crop up. They require geographical research, and the determination of their place in the territorial organization of society. This in its turn, brings about the formation of special branches of geography, and thus today the system of societal-geographical sciences is becoming ever more perfect in the process of transformation.

For a long time Soviet geography regarded economic geography as the only societal-geographical science. Studying its object - the production sphere - economic geography worked out its own theory, methodology and methods. But economic geography has already become too narrow for embracing all societal geographical problems. According to V. Rom's (Ром, 1979) expressive view, the present-day economic geography accumulates a lot of new information, that exceeds the boundaries of the existing conception. As a result of this critical standpoints concerning the contemporary generally recognized theoretical conception, are taking shape. Scientific and technological progress gives rise to new social-economic and ecological situations which require new scientific solutions, among others also geographical ones.

Hence, the existing societal-geographical sciences are connected with economic, demographic and sociological sciences. Hitherto, attempts have been made to press them into the framework of traditional economic geography, though the object, methodology and methods of the new societal-geographical sciences do not entirely coincide with those of economic geography.

Thus, for example, in the field of population and settlement geography only the geography of labour power may indisputably be regarded to belong to the sphere of economic geography. Of course, this does not mean that the treatment of labour should be severed from population geography. On the contrary, the authors of the paper wish to emphasize that in the researches of labour force economic investigations coincide totally with geographical ones integrated with demography. In geographical research of birth and death rates, marriages, divorces, migration et al. demographic processes a certain economic element is also required, but it does not embrace the whole essence of the respective processes. Consequently, comprehensive geographical investigation of these processes cannot be limited to their economic geographical treatment.

The group of geographical sciences studying various fields of the non-production sphere having almost the same methodology and methods, can be summed up under a common name - the geography of the non-production. These fields of the life of the society are linked by the fact that their material bases belong to the economic organization, while they function in the sphere of social relations. Therefore, it is not right to include the geography of the non-production as a component in economic geography on the same basis as the geographies of production branches.

Territorial differences in the non-production sphere bring about territorial differences also in the social sphere in which they become in the form of people's living conditions the research subject of sociology and on this base - of sociological geography or sociogeography. It is understandable that the whole sociogeography with its problems, some of them very far from economy, cannot be included as a component part in economic geography either. The same is true of political geography, ethnogeography, cultural geography (in their narrow sense) and also of those societal-geographical sciences which may still come into being and the objects of which will be geographical aspects of social relations.

In the last few decades new scientific trends have risen on the borderline of physical and economic geography. They can be summarized under the name of nature-use geography. The works by A. Mints, V. Preobrazhenski and others have laid the foundation for the science of resources which includes also the doctrine of resource cycles created by I. Komar. O. Nazarevski has laid the foundation of the geography of the population's living conditions, etc.

Ecology is in close connection with nature-use geography. In societal-geographical research works social ecology, economic ecology, the ecology of settlements, towns, etc. are mentioned. Great emphasis has been laid on the interdisciplinary character of ecology (Лавров, Сдасюк, 1980).

As could be seen above there incontestably exist several branches of societal geography each of which investigates a certain aspect of society as a complicated protosystem. At present the most important among them are: 1) economic geography which studies the territorial organization of economic relations in the production sphere; there is existing the non-production geography which studies the sub-system of economic and social relations in the field of the territorial organization of non-production sphere; 2) population geography which investigates the sub-system of demographic relations from the geographical point of view; 3) sociogeography whose subject of research lies in the territorial aspect of the sub-system of social relations; 4) nature-use geography has to investigate both social and natural phenomena proceeding from social relations and the laws of nature.

The first three branches of societal geography are based on the entire complex of social relations (economic, demographic, social). They sprang up in the primary synthesis-integration process of social sciences and geographical sciences (Мересте, Райтвийр, 1978) which investigate the respective aspects of social life from the geographical point of view. They are relatively simple components of societal geography. The geography of the non-production and nature-use geography are more complicated sciences. They represent a complex of societal geographical components. The most original and by its composition the most intricate component of societal geography is social-economic geography (Нымміик, 1983).

Social-economic geography as it is forming today and as it exists and functions in Soviet geography is understood as the result of the secondary integration of the natural and societal geographical sciences dealt with above. It is principally a new science, which is based on the laws and regularities comprehended by its "parent" sciences. Social-economic geography strives to synthesize the laws and regularities of special (branch) sciences into regularities of the functioning of social-economic territorial systems. Social-economic geography is based on information which differs from the information of branch sciences. Scientific comprehension of this information, in its turn, has required a more abstract methodology, system of notions and specific concrete methods of research. All that determines the nature of social-economic geography as a science of synthetical and complex nature.

2. The essence of social-economic geography as a synthetical and complex science

There are certain difficulties in understanding the essence of social-economic geography. A lot of controversy occurs in determining its place among other geographical sciences, particularly in comprehending the relations between economic geography and social-economic geography. The realization that the object of science being multiaspected and complex, its scientific reflection must be complex as well, has given rise to social-economic geography. The growing significance and role of social-economic spatial systems (complexes) on the social scale have led to the understanding that the study of these geographic complexes by means of single special sciences (e.g. economic geography, population geography, etc.) is not sufficient and a new science is needed to investigate them in a new way - as social-economic territorial complexes. That has called forth the social necessity for a new synthetic science - social-economic geography.

Social-economic geography is an independent complex-systemic science which has its own subject qualitatively different from that of its "parent" sciences. Social-economic geography has constant variegated interrelations with the sciences which participated in its formation. E.g. its continuous relations with economic geography assume in their turn that the genesis of social-economic geography does not eliminate economic geography. Quite on the contrary, the latter continues its development in a more profound manner and at a growing rate.

Social-economic geography came into being as a scientific reflection of the integrity of all economic and social links in their objective territorial unity. A prerequisite for the emergence of social-economic geography was the understanding that for the determination of geographical relations and connections of social reproduction it is necessary to have a sub-system of societal geographical sciences which is provided with synthetic methodology and methods.

The necessity of comprehending the territorial organization of social life as integral temporal and spatial complexes rose at the investigation of settlements and detailed social-economic regionalization. On studying these problems the advisability of regarding the settlements as well as regions as a single complex of the production as well as the non-production speres became evident. Correspondingly, synthetic research methods are needed, too.

In order to comprehend properly the essence of social-economic geography it is imperative to determine its general object of study in the first place and only then to decide on its specific character and its direct subject of research.

The objects of research for social-economic geography are social-economic spatial systems which are the systemic complexes of the objects of all its "parent" sciences. The substance of social-economic spatial systems can be expressed as an aggregated whole or as a social-economic spatial system as follows:

$$S_{sEg} = S_{Eg} ; S_{Dg} ; S_{Sg} ; S_{NUg} ; \ldots$$

Each component in this formula corresponds to a specific geosystem existing in the objective reality which consists of the respective material elements and relations between them.

S_{Eg} - economic geosystem

S_{Dg} - population (and settlement) geosystem

S_{Sg} - social geosystem

S_{NUg} - nature-use geosystem, contains unity societal and natural geosystems

The complex nature of social-economic geography results directly from the complex character of its research subject.

Social-economic geography as a system of knowledge is not the sum total of its "parent" sciences, but a homogeneous and integral science of a higher rank than the sciences it has proceeded from. It does not only unite but it also synthesizes its research subject, the subject matter of economic geography, population geography and other branches of societal geography. It investigates qualitatively new problems, but does not study the sum of the problems the specific sciences mentioned above deal with. The direct object of social-economic geography is made up of the geographical inter- and intrarelations of social-economic spatial systems existing and functioning in the objective reality. In the planned social-economic development of our country the investigation of them is gaining importance. The emergence of social-economic geography as a science has been dictated by the comprehension of the fact that under the conditions of developed socialism it is indispensable to study social-economic spatial systems in a new way (Агафонов, Анучин , Лавров, 1983).

Social-economic spatial systems as the research subject of social-economic geography consist of material elements including social as well as natural and technical elements. In these systems natural and social phenomens constitute one complex. The synthetic character of social-economic geography is determined by the synthesis of the subject matter of special sciences and accordingly by the fact that it has its own specific subject matter the study of which cannot be coped with by any other science.

Thus, <u>the complex object and synthetic subject matter are</u> simultaneously typical of social-economic geography. Consequently, we have every right to call it a synthetic-complex science. In the hierarchic model of science social-economic geography is in a lower position than societal geography as a whole and in a higher position than economic geography, demogeography and all the rest of societal geographi-

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cal special sciences.

A more complete comprehension of the essence of social-economic geography as an independent synthetic complex science is facilitated by analogy between philosophy and old traditional specific sciences. Philosophy, in fact, comprises the objects, operates with the notions and categories of all the special sciences and deduces from them generalizations of higher rank. It is an essential precondition for philosophical synthesis and for the derivation of laws and regularities of the development of objective reality. At the same time the subject matter of philosophy and approach to are highly specific. Therefore, philosophy does not fill the place of any other science.

Social-economic geography itself also investigates a very wide object (compared with the objects of its "parent" sciences), but it has its specific approach to it. It neither pretends nor can pretend to provide the solution to the specific problems of other societal geographical sciences - economic geography, demogeography, etc., yet it develops in close contact with them. Social-economic geography discovers with the help of its notions, categories and laws of objective logic the regularities of the rise and functioning of social-economic spatial systems and thereby contributes to the territorial organization and regional management of society.

Referring to the functional similarity of philosophy and social-economic geography we do not, of course, consider the latter to be a philosophy of societal geography. It is not able to fulfill such functions as it belongs to the group of material sciences, i.e. to the sciences that study concrete material objects.

Social-economic geography is a science of secondary integration. It becomes evident first and foremost by the fact that its "parent" sciences result from primary integration of geography with various neighbouring sciences. Such a synthetic-integrational complex science bears naturally the stamp of its "parent" sciences which study the respective material objects.

In case of social-economic geography we cannot speak about primary integration in the form of synthesis-integration for two reasons: there does not exist a single science whose integration with geography would guarantee the genesis of social-economic geography whose object consists of several components. The actual development of social-economic geography has undergone the process of evolution from special sciences to a synthetic-complex science, not the other way round.

Social-economic geography is not only a science of an integrational origin but it has also a remarkable ability of integration. As it can be seen in Figure I., social-economic geography stands on the borderline of natural and societal sciences. It does not only include societal phenomena but within the framework of nature-use geography also the research objects of natural sciences. Thus, it is a connecting and integrating link between these spheres of science.

The appearance of social-economic geography, no doubt, made the structure of societal geography more complicated. One more synthetic-complex science, original by its nature, came into existence and one more level was added to the hierarchic model of geographical science. A phenomenon characteristic to the development of present-day science is that one object (in the present case, social-economic spatial systems) may be investigated by numerous sciences. In the framework of geography economic geography studies economic geosystems, the geography of population and settlements deals with demographic geosystems, socio-geography is interested in sociological geosystems, etc. The research subjects of social-economic geography are the extremely complicated social-economic spatial systems as a whole or social-economic geosystems.[I] The chief attention of social-economic geography is focussed on the systemic nature of the research subject which does not manifest itself in any specialized geosystem and obviously cannot be comprehended by the corresponding branches of geography.

Thus, social-economic spatial systems are the object of research for a whole complex of closely interrelated sciences among which social-economic geography, thanks to its synthetic-complex character, plays a special synthesizing and generalizing role.

"The division of labour" in the system of sciences, investigating society from the geographical aspect, is at the

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[I] The concepts "spatial system" and "geosystem" are synonyms.

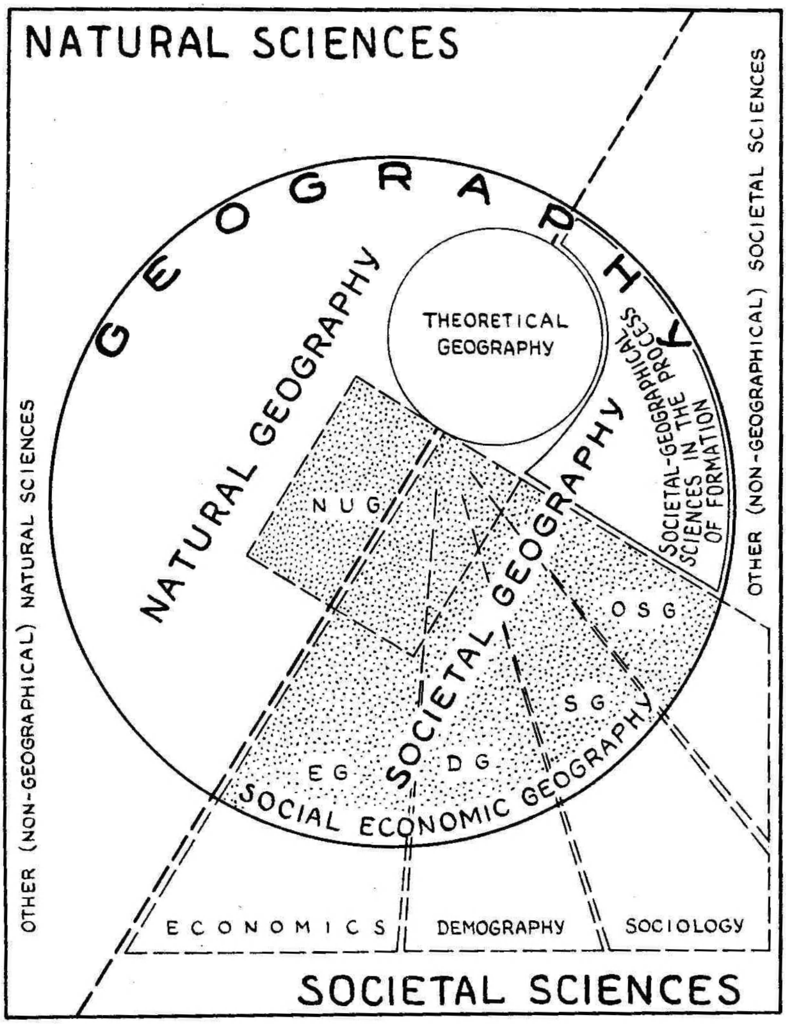

FIG. 1. **SOCIAL-ECONOMIC GEOGRAPHY IN THE SYSTEM OF THE SOCIETAL GEOGRAPHY**

EG - ECONOMIC GEOGRAPHY, DG - POPULATION AND SETTLEMENT GEOGRAPHY, SG - SOCIOGEOGRAPHY, NUG - NATURE USE GEOGRAPHY, OSG - OTHER SOCIETAL GEOGRAPHICAL SCIENCES same time one of the many examples how relations between sciences themselves and between their research subjects, as well as the relations of understanding all this change, too. Such a phenomenon was still considered theoretically non-typical or even unimaginable a couple of decades ago. Today it has become characteristic of a wide field of scientific research. That is why it is impossible to understand the place and functions of social-economic geography correctly on the basis of the outdated, but in certain part of geographical literature still popular principle that only one object can be researched by one science, or that only a certain science can investigate a certain object. Thorough criticism of the application of this incorrect principle to special sciences has been presented by Academician V. Kedrov (Кедров, 1980).

The research subject of social-economic geography covers the major part of the object of societal geography. It is wider than any objects of its "parent" sciences and is in the direct sense of the word a complex of the objects of its "parent" sciences as it can be seen clearly in Fig. I. It must be admitted that the slow development of the system of societal geographical sciences and its gradual formation are partly due to the absolutization of economic geography, The latter has resulted from the conviction that geographical investigation of all social phenomena is the task of economic geography. In geographical literature such views can be met with even today (Ткаченко, 1982).

The system of societal geographical sciences is at present in the process of formation. The reason why the study of societal geographical phenomena has lagged behind has been also the vague interpretation of the immediate object of geography. As it was assumed that the possible objects of geography could be only geographical localities, the landscape sphere, the earth's crust, the geographical sphere, territorial production complexes, etc. it becomes clear that many phenomena of social life (as culture, science, art, language, etc.) were excluded from geographical research. It was not until the systemic conception appeared in science that such confusion in relation to the object of geography disappeared. Now the road for a rapid development of the united system of societal geographical and natural geographical sciences has been paved.

3. Social-economic geography and the sociologization of economic geography

The term "social-economic geography" is popular both in foreign and Soviet geographic literature. At the same time, opinions differ as to its content (substance) and place in the framework of the system of sciences. The majority of the authors regard social-economic geography simply as transformed economic geography (Алаев, 1980; Hristov, Bachvarov, 1976; Мукитанов, 1979, et al.). Only a minority of geographers admit that the research object for social-economic geography consists of social-economic spatial systems (Лавров, 1982; Поросенков, 1979; Шарыгин, 1983). Unfortunately, these authors do not take a proper stand on the interrelations of social-economic geography and economic geography. Social-economic geography is mostly considered to be sociologized economic geography.

All that brings about the need to touch upon the question of the sociologization of economic geography on the one hand and the relations between social-economic geography and economic geography on the other hand.

There certainly exists a link between the sociologization of economic geography and the emergence of social-economic geography, but this link is far from being simple, unequivocal. Sociologization is a richer and wider process than the rise of one or several integral or complex sciences. Sociologization means the application of sociological notions, categories, methods, laws, etc. in the respective other sciences. The sociologization of economic geography means that greater attention is paid to the social aspects of economic and social life of the society.

Growing attention to the social aspects of the life of the society in the Soviet Union is a normal phenomenon. It has been programmed in geography as the principal law of the development of socialist society concerning the growing welfare of its members. This principal law in its turn has a firm theoretical-methodological basis created in the constructive collaboration between materialistic philosophy and the practice of the national economy.

Sociologization (analogically to mathematization and ecologization) is a form of interdiscipline zero integration by its nature (Мересте, Райтвийр, 1978). As such, zero integration does not and cannot change the general character of the sciences participating in integration. Nor can it change their place in the system of sciences. Accordingly, it is impossible to agree to the views of E. Alayev, (N. Mukitanov et al.) that sociologization means the transformation of economic geography into social-economic geography. Such interpretation of the changes in economic geography resulting from the integration of economic geography and sociology is due to the simplified conception of interdiscipline integration. In order to refute such an understanding it suffices to point at similar integration processes between other sciences, the results of which are different from those imagined by the authors mentioned above.

At the present time intensive and manysided sociologization of economics is going on which is manifested by the appearance of the social aspect in the research of all branches of economics, particularly in the theory of planning and the management of the national economy. A new borderline science, economic sociology has cropped up, but as far as we know, not a single author has raised the question as if economics had ceased to exist as a result of this or that it may become social-economics in the future.

The mathematization of physics, sociologization of economics as all the other processes of the same quality and nature, the sociologization of geography among them, are of great significance both for the progress of science and the practice of the national economy. But zero integration, owing to its nature, is not able to change these sciences into new ones though thanks to integration they enrich one another essentially. That is why there is no reason to think as if economic geography would die out and become social-economic geography, such an idea has spread quite widely in recent years. The cause of the erraneous argument trying to substantiate such a wrong comprehension is the ignoring of the laws of development in the structure of science.

x x
x

The basic components of the system of societal-geographical sciences are economic geography, population and settlement geography and sociogeography. Their secondary synthesis-integration process has resulted in social-economic geography which has asserted itself as an independent science among other societal-geographical sciences. Social-economic geography has its own specific object, its synthetic methodology and concrete research methods. Social-economic geography has its subject matter, which is not investigated by any other science. It is a synthetic and complex science of investigating social-economic spatial systems. By the present time the idea of social-economic geography has found recognition in the scientific centres both in the Soviet Union and abroad. Collections of papers and monographs are published and conferences are held in this field.

We must repeat once more that the sociologization of economic geography is a very important specific process in present-day geography. However, it cannot be interpreted as the transformation of economic-geography into social-economic geography. There is no objective scientific reason for it because zero integration does not, as a rule, lead to such profound changes either in specific sciences or systems of sciences as was shown above with the help of other sciences.

Nothing can substantiate the hypothesis as if economic geography would cease to exist as an independent science. The national economy of any given country lives on in objective reality as an actually existing integral system, being the research subject for economics. That is why it must be studied from the geographical point of view by social-economic geography. The logical conclusion is that the appearance of social-economic geography does not bring about the elimination of other societal-geographical sciences. On the contrary, they all develop further in the direction of ever deeper geographical investigation of the various aspects of societal life.

The subject matter of social-economic geography is very topical due to the necessity of further construction of developed socialism which requires not only economic-geographical but also social-economic geographical investigations.

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INDUSTRIAL-GEOGRAPHICAL CHANGES IN THE EVOLUTION OF THE GEOSYSTEM AGAINST THE BACKGROUND OF THE DIACHRONICS OF THE EARTH

M. Vabar

1. The industrial-geographical transformation of the geosystem as a result of the technogenic innovation

The progress of the scientific and technological evolutional epoch has been accompanied by technogenic industrial-geographical changes in all parts of the geosystem. Industrialization has changed and is still changing any human activity much more effectively than earlier. It also amplifies the homoeostasis of the social system, in the first place that of the settlement system, transforming also territorial associations of other systems.

An essential factor in the mechanism of industrial-geographical changes is the factor of innovation and the agents influencing its regional distribution (diffusion). Innovation is the application of a renewal and the stabilization of the renewal in a certain place.

Innovations of different phenomena are studied by specific disciplines but they are interested only in discipline-specific results of concrete innovations. However, several technical innovations bring forth a chain reaction of changes and transformations in the whole complex of the geosystem in the given region - and its analysis is the task of geography.

Innovation in itself is not an industrial phenomenon, but as a rule, today it is either a precondition or a result of industrial-geographical development. For example, widespread consumption of manufactured goods in an area where mainly handmade products were consumed formely is a revelation of the diffusion of industrial-geographical innovation even in case no industrial production takes place in the area. Industrial-geographical transformation finds an expression also in the application of modern (mechanized and automat) services, transport, communications, etc. as well as in the industrial pollution of the natural environment.

The industrial-geographical transformation of the geo-system results thus from the components that are concrete innovations following the scheme:

creative innovation	→	its industrial application	→	the social-areal spread of its consumption	→	its results in the geo-system

Today one can certainly find thousands, even hundreds of thousands technical-social innovations everywhere, whose industrial-geographical transformational effect is not only the sum total of their separate results, but a result,often unpredictable amplified by their combination. The regional differences are so wide that it is hard to give a general model of the mechanism of their effect.

As an example we would cite here the development of industrial production itself, which results in economic, social and cultural transformation of the whole society,cumulative technological progress as well as environmental pollution and the exhausting of resources,demographical explosion and urbanization, the multiplication of productive and economic connections, the development of transport and the frequenting of international communication, and various other circumstances which could not be foreseen at the initial stage of industrial development.

For a long time industrial changes in the society were treated as linear processes that proceed smoothly and in one direction only. The increase of production and labour productivity, concentration and centralization, urbanization, the growth of the population and its welfare and other phenomena were described this way. But time has proved the nonlinearity and at places even discreteness of a wide range of industrial-geographical phenomena, in the same way every concrete innovation is discrete as well. Every rise is followed by a stabilization or even a certain decline (though on a new qualitative level), every concentration by decon - centration, at least in the form of expansion or diffusion.

The principle of universal pulsation of matter (from the megagalaxy to the microcosm) seems to be valid also in case of industrial-geographical phenomena.

At the present stage the population losses in urbanized centres do not mean a regression to the rural society, but ever increasing resettlement of inhabitants with an urban way of life to suburban and even distant rural districts, where transport, communication, commerce, services and the availability of jobs enable them to lead an urban way of life.

Likewise, the decline of industrial growth rates does not mean a setback towards the agrarian society, but the emergence of the tertiary sector, the emphasis of economic activity being inclined from material production to services and the entire social sphere, a rise in the importance of intellectual and cultural activities.

Industrial changes are already so conspicuous in the whole society and all parts of the geosystem that we can undoubtedly speak about a new, industrial epoch in the history of our planet.

2. Industrial epoch - an evolution or a reversion in the development of the geosystem?

Industrial development causes a lot of harm to living nature - hence the question arises whether it can be called development at all? Development is a transition from a simple state of the system to a more complicated one, but the industrial changes result in the degradation of several complicated ecosystems to simpler ones.

From the position of the ecosystems of the biosphere certain reversion really occurs, but the technical systems themselves are getting more and more diverse and complicated. The social systems, economy, culture, etc. are also in evolution. Thus, we must determine what part these qualitatively so different systems play in the universal evolution of the geosystems, what balance of progress and regress will be achieved from the stand point of the planetary geosystem as a whole?

The negentropy of the development is always achieved at the expense of increasing the entropy. A new stage of development in the evolutionary dialectics can be reached by the denial of former stages, braking and deforming their systems. Man's activities have from the very beginning of the human society been damaging or changing natural systems so that scientists have been compelled to take into use the epochs of "antropogen" and "noosphere" to classify the history of the Earth.

Even the biosphere has not always existed on the Earth, it also came into being once, deforming seriously the hydrosphere, litosphere and even the atmosphere, which were already present. The same can also be said about the emergence of the hydrosphere: it was accompanied by the beginning of intensive erosion process, that "broke" and reshaped the upper strata of the litosphere.

To answer the questions set we must have a closer look at the evolutional stages of the geographical geosystem as a whole, the role and changes of its main elements (subordinate systems) in its development.

3. A functional and evolutional classification of the elements of the geosystem

To observe the part and dynamics of industrial geographical changes in the development of the geosystem, we must start from a functional classification of the elements of the geosystem. While geographers worked out quite thorough regional classifications (landscapes, districts, complexes), the treatment of functional elements has remained in the background, being grounded mostly on traditional divisions or some taxonomy borrowed from other branches of science.

A rather detailed analysis of the functional elements of the geosystem as a whole has been presented by the Latvian geographer Zigrids Dzenis in the work "Methodology and Methods of Social Economic Geographical Studies" (Дзенис, 1980). To determine functional elements of the geosystem he started from the primary problems: the subject of geography and the research object. As the research object of geography is the surface geosphere of the Earth (the outer shell of the Earth) together with all the natural and social phenomena and processes that occur in this sphere, the subject of geography is research into the structure of the geosphere as a system, its functions and development on the level of different species and scales. Z.Dzenis regards the building of rigid taxonomic groups (districts) of complex territorial systems, that has often been a favourite occupation of geographers, as fruitless because of the enormous variety of the contentional parts of the geosphere.

The geosphere as a uniform higher system is divided by Z.Dzenis into five subsystems: the sphere of the inanimate nature (geosphere in its narrowest meaning),biosphere,technosphere, demosphere and mentosphere. This is a functional classification of the geosphere, and is a step forward in comparison with the earlier static classifications which were based on the state of the substance in these systems (solid, fluid, gaseous, living) or on their origin (natural, technogenic, organic, inorganic etc.).

The treatment of real world phenomena as functional systems is nowadays the prevailing methodological technique in systems approach, and thus Z.Denis's conception can be considered quite modern. Still, in universal scientific philosophical polemics the functional classification has been criticized; it has been charged with certain formalism and inadequate stress on evolutional factors (Зинченко, Мамардашвили, 1977). Instead, a classification is recommended (Щедровицкий, 1976, Юдин, 1973), which would ensure a unique system of subdivisions and methodological unity. They stress the menace of interdisciplinary dispersion of the subject studied in case of the traditional methodology, which is avoidable by a genetical classification. The subject of geography being interdisciplinarly widely dispersed, the application of this methodological principle should be topical for classifying the geosystem as well as in other fields of geography. Unfortunately, it has been used very seldom (Вабар, 1981). The problems of classifying the geosystem and dividing it into subsystems have been treated with greater zeal in natural geography, where the publications by I.Krut and N.Sotschava (Круть,1978, Сочава,1978) are prominent achievements. However, evolutional elements occur only in subsystems and not in higher systems, the latter remaining on the level of static or functional classification.

Below an universal scheme for genetical (or evolutional or diachronic) classification is presented. It enables to clarify also the prospects of some differentiated branches of geography (among them economic geography).

Development means qualitative changes, stage by stage transition from simpler to more complicated structures, dialectics of the processes entropy and negentropy. From the standpoint of geography, the first stage was the genesis of the Earth as a planet within the solar system about 6,5 milliard years ago. First the concentration of gravitational and other forces took place, the ergosphere appeared, as a result the mass of the Earth was accumulated into a rounded planet. Then the rocky part of the Earth, the lithosphere or the terrasphere came into being with its surface that was quite different from the present one. During the next stage the hull of gas of the Earth, the atmosphere was formed, whose physical-chemical qualities were not suitable for organic life at first. During long evolution the temperature of the strata of the atmosphere nearer to the Earth stabilized at a level under +100°C, in consequence of this water covered the major part of the Earth surface and the hydrosphere was formed. And when the temperature of the water fell under +50°C, conditions for an intensive propagation of organic life, the emergence of the biosphere were formed.

Biological development has passed a number of evolutionary stages, which form the genetical subsystem of the biosphere. Several of them have considerably changed the structures of the surface of the terrasphere, the hydrosphere and the atmosphere. All this has happened in the course of the adaptation of living organism to the environment. Conscious accomodation of the environment to the needs of the organism started only after the emergence of the rational being - man. This was a new major qualitative change in consequence of which the area of human activities with the transformation of its results is called noosphere or anthroposphere.

4. The diachronic structure of the noosphere

On the basis of the diachronic evolution of the Earth following genetical line can be differentiated in the geosphere: ergosphere - terrasphere - atmosphere - hydrosphere - biosphere - noosphere. The emergence of every new sphere brought about a new level of negentropy, a new evolutionary stage towards creating a more complicate system. The rise of a new sphere meant also a break in the existence of the

Earth's surface. For example, in the geological stratigraphy of the parts of the terrasphere, whose origin was affected by the formation of the atmosphere, hydrosphere and biosphere, are clearly distinguishable. The rise of a new sphere marked also a new, more complicated integrational system between the components of the geosphere.

The functioning of noosphere, the new sphere connected with the origin and development of the human society, is no exception to this. It forms also a new level of evolution, differentiation and integration in the geosphere, and it also develops partly on account of ruining other, older systems as well (the intensification of entropy).

While it is enough of only one category, that of noosphere is sufficient for physical geographers to characterize natural geographical processes connected with human activities, in social geographical subjects the need to differentiate also the noosphere is inevitable. This is why the notions of technosphere, demosphere, mentosphere (Дзенис, 1980, p.91) as well as sociosphere, econosphere, infosphere and cultural sphere have been taken into use. There is no consensus among scientists in the question concerning the existence of these spheres or their belonging to the geosystem, neither has anybody presented a wellfounded or united classification of them that would be associated with other spheres.

Below a genetical classification of the social-geographical noosphere based on the diachronical method is presented as a continuation of the analogical natural geographical division.

The emergence of the <u>sociosphere</u> should be regarded the first stage of the noosphere, because mankind arose as a social association. The crowd of anthropoids turned into a social group of men in connection with instinctive activities becoming conscious, the emergence of articulated speech, social rational work (in getting wood, clothing and shelter) and making tools. Of course, primeval society had its own demographical, social-administrative and tribal-ethnical structure, but they must be regarded as components of the sociosphere.

The evolution and existence of mankind under the wild conditions of obtaining livelihood lasted for a very long time - over two million years (Марков, 1979, p. 138). The social development achieved a qualitatively new stage after passing over from usurpation-consuming to cultivating economy, which meant the formation of entirely new relations between nature and the society: cultivation of wide areas, breeding of domestic animals (i.e. pasturing, altering native flora and fauna), emergence of more effective tools and working regulations. This took place about ten thousand years ago, resulting also in a "demographical explosion"of that time, because it became possible to obtain livelihood for a far bigger number of people than during the consuming period of gathering, hunting and fishing.

Cultivating economy is already a more developed economic system, that created a higher labour productivity and founded a base for further division of social labour. The economic sphere - econosphere - sprang up in the social and natural spheres as a new integrational system. Although this system was still natural economy based on manual work and the use of draught animals, it still caused an intensification of social changes and development, that led to the fall of the primitive communal system and the rise of the class society, cumulating division of labour specialization.

The rise of the slave-owning system and the first states, about 6000 years ago meant the origin of organized system of power - the sphere of administration or adminosphere. This power was based on a well organized military force specialized in fighting, as a result of which steady states were formed, promoting the creation of civilization since the differentiation of social division of labour caused the separation of mental and manual work. Science and art came into being. This meant that culture (in a wider meaning) became separate autonomous system that started to exert serious influence on social development through its branches such as education, sciences, literature, art,architecture,sports, etc., and above all by such influential spheres as labour culture and the art of warfare. Together with the development of the cultural sphere the complicated and more effective than ever before system of administration based on delegating the power and promoting the formation of slave-holding empires and their urban cultural centers was reshaped as well. The new administrative system, through being an offspring of civilization is still organically bound to the sociosphere rather than the cultural sphere.

The evolution of the cultural sphere into an independent system created favourable conditions for the development of science, perceiving natural laws and employing natural resources for people's well-being. Still, cultural and scientific development were slow at first, probably because of the social-economical limits. And although the steam-engine was invented already in ancient Rome, the mankind reached the epoch of techical-industrial development only at the end of the 18th century.

The rise of the qualitatively new, dynamic industrial-technical technosphere is certainly a stage that emerged from the cultural sphere as an outcome of scientific and technological inventions, but it materialized only within the framework of the social-economic sphere, integrating at a new level. The emergence of the industrial-technical sphere was realised only after commodity production had replaced natural economy, i.e. the social division of labour reached the level where material wealth was no longer produced for one's own use but for exchange, for sale. That was the innovational complex, forcing the industrial development.

The first stage of commodity production - commodity production on a simple scale - is based, true enough, or manual work, but being grounded on privately owned production means and an instensive growth of commercial and money relations (commodity circulation), it brings forth simple commercial cooperation, which creates preconditions for applying machinery and mechanization in manufacturing. Simple commodity production and cooperation give birth to competition, as a consequence of which machinery and mechanization, technological inventions and organizational innovations find intensive application in manufacturing (through the agency of the law of value).

Science, formerly a differentiated part of the cultural sphere, was integrated with the sphere of production (the essential component of the economic sphere), which resulted in immensely effective mechanized industrial large-scale production.

An especially intensive expansion of the technosphere began in the stage of the scientific and technological revolution, causing destructive changes first and foremost in the biosphere, but likewise in the hydro- and terraspheres. This has created a new situation: in realizing whatever technical-economic plan, one must consider the complex of all its possible results in natural as well as social systems. For analyzing the emerging quite complicated chain reaction of causes and results the methodological arsenal of geography suits much better than the methology of other disciplines with differentiated research objects.

In brief, a genetical classification of the subject of geography enables to:

1. Treat the geosystem and its regional parts as dynamic complexes, the development processes of which have evolutional connections with each other.

2. Classify geography as a discipline in accordance with the genetical classification of its research object. Hence the following system of subdivisions in geography is obtained:

a) The geography of the sphere of nature, consisting of the following subsystems of elementary spheres:

- the geography of the ergosphere, i.e. the fields and radiation;
- the geography of the terrasphere, i.e. the Earth's surface;
- the geography of the atmosphere, i.e. the airspace;
- the geography of the hydrosphere, i.e. the waters;
- the geography of the biosphere, i.e. living nature.

b) The geography of the noosphere or the social-technical system, that can be divided into elementary subsystems of:

- the geography of the social sphere, i.e. human relations, activities and welfare;
- the geography of the econosphere, i.e. economy;
- the geography of the adminosphere, i.e. administration;
- the geography of the cultural sphere, i.e. culture;
- the geography of the technosphere, i.e. the technical systems.

This classification is of course just an abstract construction that does not coincide with the real division of geography, since geographical research is not directed upon the study of isolated abstract spheres, but treats geosystems as complex territorial units. The real branches of geography are complex in character, for example, climatology incorporates besides the treatment of the atmosphere and the ergosphere also partly that of the terra- and hydrospheres; the geography of industry studies not only the industry, but also social, administrative and technical components of industry, etc. However, the present classification may have cognitive importance in analyzing the functioning of geographical components and study of the systems of their all possible relations (interactions).

3. Investigate the dynamics of anthropogenetic innovations and the industrial transformation of the whole geosystem against the background of its evolutional diachronics, in so doing the following rules are observed:

a) the younger the sphere, the more widespread and intensive the technogenic innovations inherent in it are. Consequently, older spheres suffer less from industrial-geographical transformations than younger ones;

b) industrial-geographical changes appear faster, more directly and positively from the view-point of men in younger spheres, although there are some exceptions, indirect- and side-effects with complicated feedbacks. In broad outline it can be said that within the noosphere industrial-geographical changes positive from the view-point of men dominate, but as to the natural sphere, negative destructive transformations are observed which are the most intensive in its youngest subsystems, the biosphere. Disturbances in the balance of the ergosphere are expected only during the following decades;

c) the rule that industrial-geographical changes are more local in character in younger spheres and more global in older ones, should not be considered universal.

To sum up, we can say that up to now industrial-geographical processes have been a reflection of the positive development of the Earth's geosystem in spite of some destructive impacts. However, the danger of industrial-innovational reversion exists in the form of global pollution or an extensive military nuclear catastrophe, that may destroy younger homoeostatic systems of the geosphere. Essential differences between the subsystems of the noosphere and the genetic subsystems of the natural sphere should be stressed. The latter exists as a functioning association of concrete objects and their environment, while the subsystems of the noosphere are abstract, since human specialized activities, created by the new subsystems are more effective than earlier. It comprises all the objective reality on the Earth, adding to it a new quality, and often transforming or amplifying its earlier qualities.

Taking into consideration the extraordinary effectiveness of the scientific and technological innovations in affecting the geosystem, which has allowed scientists to oppose the epoch of technical civilization the entire earlier development of mankind as a qualitatively new epoch, we can add to the previous geosystematic diachronics of 5 + 5 elements a more abstract diachronics of 2 + 2 elements. It would comprise the inanimate and living nature systems from the natural sphere, and the humanitarian and technical systems from the noosphere. While it took the living organisms millions, even milliards of years to change and reshape components of inanimate nature, the industrialized technosystem will spend only some decades to transform all earlier elements of the geosystem. This is often accompanied by too intensive destructive effect on the earlier diachronic formations.

Only such industrial-technical development that would preserve the earlier elements of the geosphere and being about an optimal harmony in their functioning can be considered progressive because development lies in the domination of constructive tendencies over destructive ones. The diachronic elements of earlier origin are not only the past of the Earth, but also its inseparable integral components today - their damage will harm the geosystem as a whole.

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REGULARITIES OF URBANIZATION AND DEMOGEOGRAPHICAL PROCESSES IN THE ESTONIAN SSR

A. Marksoo

Introduction

With the expansion of urbanization and scientific and technological progress the set of factors affecting the location of population, i.e., its distribution among different types of settlements and their territorial systems is becoming ever more complicated. On the one hand, several factors promoting the concentration of production and settlement pattern gain strength, especially in the early and middle stages of urbanization: I) As a result of mechanization, the demand for manpower decreases in dispersed primary (rural) branches, and increases in concentrated secondary ones, especially in "science-intensive" branches of manufacturing. 2) The labour process acquires an industrial character also in farming, forestry and fishing, this is conducive to the concentration of rural settlement pattern. 3) At the advanced stage of urbanization the number of jobs increases the most rapidly in tertiary sectors; part of them, above all administration, science, arts, higher education, and research and development tend to concentrate in big cities - in the capital or regional centres.

On the other hand, the development of urbanization is accompanied by certain factors counteracting excessive concentration: I) In rural production branches a high concentration of fixed assets and manpower in a few settlements brings about difficulties in intensive cultivation of land in areas far from concentration centres. A high concentration of cattle aggravates environmental problems. 2) Complicated ecological problems arise also in cities and agglomerations, which in turn impels to avoid excessive concentration of urban production branches and population. 3) The population's demand for various cultural and everyday services is rising in towns as well as in the rural areas. To make these services available, the distribution of the corresponding establishments cannot be too highly concentrated. This circumstance affects the distribution of service establishments between rural and urban localities as well as between towns of different types.

The above-mentioned factors exert direct influence on the intensity and territorial peculiarities of such demographic processes as natural movement, migration and labour commuting. These processes can be called demogeographical ones since from the standpoint of settlement geography it is the territorial aspect of them that stands in the foreground.

During the early and middle stages of urbanization when factors conducive to concentration are prevailing the demogeographical processes are also quite one-directional. Migration flows from rural to urban localities and from smaller to larger towns predominate. As a result of migration the total population number in the rural areas decreases, among it the share of young people of working age and women of fertile age. This brings about an absolute and a relative decrease in the birth rate. At the same time the share of young people increases in towns and their demographic potential rises.

At the advanced stage of urbanization when both opposite groups of factors are already functioning the character of demogeographical processes becomes more complicated. This is valid especially for the socialist countries where the advanced stage of urbanization is accompanied by the replacement of expanded reproduction of population by simple reproduction resulting in labour shortage. It is namely under such conditions that the demogeographical analysis of the settlement system and labour resources becomes vital. A general decrease in population increment is usually not a sign of the territorial levelling of the demographic situation but, on the contrary, that of higher differentiation. Settlements and their subsystems enjoying a more favourable location and combination of activities as well as a better social infrastructure at the given stage preserve their demographic growth potential, the others lose it. The demographic growth potential of a settlement is expressed by I) the existence of natural increase, and 2) migrational attraction, the ability to concentrate young people of working age which in turn ensures natural gain. Under certain conditions the so-called unilateral demographic activity may be observed - the population of a settlement increases as a result of natural increase though in-and-outmigration is in equilibrium, or the opposite case - natural gain is lacking but the population increases and maintains its sex and age structure due to inmigration. The size and functions of the settlements and their territorial subsystems which acquire the highest growth potential, as well as the differences between them and the stagnating settlements of the same region are determined by the historical and socio-economic conditions of the region. It depends on these differences which problems deserve special attention in the research into demogeographical processes. There it should be stressed that a demogeographical analysis has always practical as well as theoretical aims. It gives the necessary initial data for compiling regional labour balances and socio-economic plans as well as for developing measures for affecting the demographic situation. At the same time such an analysis allows us to draw conclusions on the systemic nature of the development of settlement of a given region and the stage of urbanization reached - whether concentrating factors are still predominant or whether deconcentrating forces can already be observed. This is especially significant for drawing up forecasts for the development of the settlement system of a region.

Pursuing the above aims the demogeographical processes in the Estonian SSR have been investigated at the Chair of Economic Geography of Tartu State University. The present contribution is a survey of the trends inherent in the dynamics of demogeography in the Estonian SSR after World War II, especially during the last decade. During these years the share of urban dwellers was already over 70 per cent, at the same time the growth of urban population decelerated as a result of the decline of both migration and natural gain. This allows us to speak about the beginning of a new stage in the urbanization process in the Estonian SSR. The present contribution aims at elucidating I) whether and to what extent the territorial tendencies and qualitative composition of migration have changed in the new demographic situation; and 2) how these changes are reflected in different functional-hierarchical groups and territorial subsystems of the settlement of the Estonian SSR and in their demographic growth potential.

The paper is based on a comparison of the author's earlier investigations and those conducted in recent years.[I] As in the earlier investigations, the principal methodological foundation is here a combination of demogeographical and systems approaches, i.e. the settlement system is treated as an integral, hierarchical and centralized system. Demogeographical processes - migration, commuting and natural movement - are interpreted as an expression of the system's behaviour, its functioning and growth. Proceeding from this the author tries to prove with the treatment of demogeographical processes that the development of the settlement system has several features analogous to the behaviour of other self--managing centralized systems. This is above all revealed by the proportions of the main centre and centres belonging to lower levels of the hierarchy (towns of different ranks), and a proportional interdependence of the population number of individual centres and their hinterlands.

I. THE ROLE OF MIGRATION IN THE DYNAMICS OF THE POPULATION NUMBER AND SETTLEMENT PATTERN IN THE ESTONIAN SSR

As to its territory (45,I00 km^2) and population number (I.5 million in I983) the Estonian SSR is one of the smallest union republics of the Soviet Union. However, several relative indicators show that it belongs among the areas with high urbanization and intensive economy. In Estonia, just like in the other Baltic union republics, the natural increase of the population has been lower than the average of the Soviet Union during the whole post-World War II period. At the same time, however, Estonia has experienced net inmigration from other union republics of the USSR. Inmigration has chiefly been caused by the necessity to satisfy the

[I] The mentioned earlier investigations deal with structural changes in the republic's settlement system, above all the concentration process and demogeographical dynamics in the period I959-I973 (Marksoo, I976; Marksoo, I980; Марксоо, I977; Марксоо, Тонсивер, I979; Марксоо, I979) demand for labour of industries having all-Union significance (or regional significance in the Northwestern Economic Region) such as oil shale mining and processing, the power industry, engineering, ocean navigation and port industry, et al. Depending on the growth rate of these industries as well as the increment of labour resources the republic, the absolute size of inmigration as well as its share in the total population increase has been different in different years. As a rule migration gain has accounted for over a half of the total population increase, being thus the main component of growth (Tables I and 2). Since the mid-I970s the net inmigration has decreased due to the changed demographic situation in the regions of the Russian SFSR where the majority of inmigrants originate. As a result of the declining birth rate, the share of young people has decreased there. As the majority of migrants are young, outmigration from these regions has also declined. At the same time the birth rate has decreased also in Estonia, and so inmigration still accounts for the major part of the population increase, while total increase has considerably declined.

Together with its general growth, population has been concentrating from rural to urban places. The urban settlements of the Estonian SSR have taken over four fifths of the net inmigration from other republics, and since I964 have been responsible for the whole natural increase. Besides, urban settlements have grown considerably due to intrarepublic rural-urban migration. Intrarepublic migration has been the main factor of rural population loss in the Estonian SSR. The volume of intrarepublic rural-urban migration has depended simultaneously on several factors: socio-economic conditions in the rural areas, the number of jobs and dwelling construction in urban settlements and the size of labour force gained as a result of interrepublic migration. In the I950s when working conditions in farming were still hard, the rural areas of the Estonian SSR accounted for more than a half of the influx of people into urban settlements. In I959-I973 when the state and collective farms became increasingly more affluent and the net inmigration from other republics increased, their share declined to nearly a quarter (Марксоо, Тонсивер, I979). In the second half of the I970s when the influx from outside Estonia decreased, the rural areas of the republic itself accounted again for nearly a half of the to-

Table 1

The dynamics of the population number in the Estonian SSR in 1950-1982 +

Period	Pop. nr. at the beginning of the period (thous.)	Among it: urban pop. (thous.)	Among it: rural pop. (thous.)	Percentage of urban pop. at the beginning of the period	Gain or loss (thous. people): total pop.: total of the period	total pop.: annual average	urban pop.: total of the period	urban pop.: annual average	rural pop.: total of the period	rural pop.: annual average
1950-1958	1096.7	516.1	580.6	47.1	100.1	11.1	162.4	18.0	-59.3	-6.6
1959-1963	1196.8	675.5	521.3	56.4	70.3	14.1	101.2	20.2	-30.9	-6,2
1964-1968	1267.1	776.7	490.4	61.3	67.2	13.4	83.0	16.6	-15.8	-3.2
1969-1973	1334.3	859.7	474.6	64.4	83.7	16.7	93.2	18.6	-10.5	-2.1
1974-1978	1418.0	952.9	464.1	67.2	48.8	9.8	69.4	13.9	-20.6	-4.1
1979-1982	1465.8	1022.3	443.5	69.7	41.2	10.3	49.9	12.5	-8.7	-2.2
Jan. 1, 1983	1507.0	1072.2	434.8	71.1	x	x	x	x	x	x

+ Tables 1 and 2 are based on statistical yearbooks Eesti NSV rahvamajandus 1974, 1980 and 1982.

Table 2

The share of natural increase and migration gain in the dynamics of the population number in the Estonian SSR in 1950-1982

Period	Natural increase (thous.)		Migration gain (thous.)		Average annual per 1000 inhabitants		Share of migration gain in the total increase, %
	total of the period	average annual	total of the period	average annual	natural increase	migration gain	
1950-1958	54.9	6.1	45.2	5.0	5.3	4.4	45.1
1959-1963	33.9	6.8	36.4	7.3	5.5	5.9	51.8
1964-1968	27.6	5.5	39.6	7.9	4.2	6.1	58.9
1969-1973	31.0	6.2	52.7	10.5	4.5	7.6	63.0
1974-1978	24.2	4.8	24.6	4.9	3.3	3.4	50.4
1979-1982	17.5	4.4	23.8	5.9	3.0	4.0	57.6

tal migration gain of the urban settlements (about 3500 people a year). The continuing population outflow which aggravated labour shortage in the rural areas made farms take new effective measures to retain labour force (higher remuneration, expansion of housing construction, better services). At the same time restrictions were set to the creation of new jobs in towns in order to promote an increase in labour productivity. As a result of these measures the outflow of population from rural areas into urban centres decreased at the beginning of the present decade. As the natural increase of urban population has also declined, the demographic growth resources of the urban settlements of Estonia are now considerably smaller than at the beginning of the previous decade. On the basis of absolute and relative changes in the rural and urban population numbers, as well as their growth components we can distinguish between three stages in the progress of urbanization in Estonia during the post-war period.

The first stage - 1945-1963 - comprises the years of post-war reconstruction, rapid industrialization of the national economy, and the transfer from small-scale production to socialist large-scale production in the farming. During this period the number of urban and rural population and their proportion changed the most rapidly, and it was during this stage that the share of urban population in the total population of the republic increased to over a half. Besides natural and migration gain the number of urban population increased also as a result of administrative changes, i.e., as a result of granting rural settlements the status of urban localities: in 1945-1955 3 previous rural settlements were granted the rights of a town, and 26 those of an urban-type settlement[1] (Марксоо, Тонсивер, 1979).

The second stage of urbanization comprises the years 1964-1973. The absolute and relative increase of urban population was not so conspicuous and the loss of rural population was twice as slow as during the previous stage. Urban localities increased above all as a result of interrepublic migration. Administrative changes played already a negligible role.

In 1974 the transfer to the third, advanced stage of

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[1] In Estonia alev, in Russian посёлок городского типа juridically belongs to the category of urban settlements.

urbanization began. This stage acquired its typical features at the beginning of the 1980s. The percentage of urban population rose over 70, however, at the same time the growth rate of urban population showed an absolute as well as a relative decline. With the reduction of the total increase of urban population, the importance of its natural increase gained momentum.

An analysis of the growth rate of urban population and its components by different functional-hierarchical groups of urban settlements (Tables 3 and 4) allows us to draw the following conclusions.

Irrespective of different growth rates of the groups of urban settlements studied, their proportions with respect to one another have changed relatively little during the period observed. This shows that in Estonia as an old settled region the established functional-hierarchical structure of urban settlements is generally stable and for the functioning of the settlement system as a whole all its hierarchical levels are needed. The stability of the settlement structure is proved also by the fact that the development trends inherent in different groups of settlements during the last decade have the same direction: the growth rate of population has slowed down, and the share of migration gain has declined. Consequently, the decreasing share of rural settlements (and above all a strong decline of the significance of villages having no central functions) has been the most important outcome of the concentration process. Changes in the relative size of different groups of urban settlements are but of minor importance. Among the structural shifts the following deserve special notice: 1) the rise in the share of the capital's agglomeration, 2) the rise in the share of the North-East Estonian industrial agglomeration, especially so during the early and middle stages of urbanization, and 3) significantly above-average growth of young raion centres, i.e. those which were granted this status only in 1950. These centres developed their administrative and economic management functions mainly in the 1960s when the hinterland subordinated to them administratively expanded considerably as a result of the reorganization of the administrative division of the republic. The growth of old raion centres, i.e. enjoying the administrative functions (county centres[1]) already before the

[1] In Estonian maakonna linn, in Russian уездный город

Table 3

The growth rate of the population number of the functional-hierarchical groups of the urban settlements of the Estonian SSR and their changing share in 1959-1981

Functional-hierarchical group	Population increase,% 1959-1981 (1959=100)	Among it		Share in % urban pop. growth			Share in % urban pop. (at the beginning of)		
		1959-1973 (1959=100)	1974-1981 (1974=100)	1959-81	1959-73	1974-81	1959	1969	1982
The capital with its nearest satellites	162.6	142.4	114.2	47.2	44.1	55.5	42.8	42.8	44.4
North-East Estonian industrial agglomeration	174.9	159.6	109.6	21.0	23.1	15.6	15.9	17.8	17.8
among it: its major centres	181.4	166.3	109.1	17.8	19.9	12.0	12.4	14.2	14.3
Polyfunctional regional centres	144.9	132.4	109.7	13.4	13.2	13.8	16.8	16.0	15.5
Raion centres	151.8	139.7	108.6	12.9	13.7	10.9	14.1	13.7	13.7
among them: old	144.6	135.7	106.6	10.0	11.0	7.3	12.7	12.2	11.7
new	215.5	175.9	122.5	2.9	2.7	3.6	1.4	1.5	2.0
Local centres	129.8	123.5	105.2	5.5	5.9	4.2	10.4	9.7	8.6
among them: polyfunctional	130.4	123.7	105.4	4.1	4.4	3.3	7.7	7.1	6.4
narrowly specialized	128.0	122.7	104.4	1.4	1.5	0.9	2.7	2.6	2.2
Total	156.7	141.1	111.1	100.0	100.0	100.0	100.0	100.0	100.0

Table 4

The components of the dynamics of the population number of the urban settlements of the Estonian SSR in 1959-1981

Functional-hierarchic group	Share in urban population's		Ratio of natural increase and migration gain+ (natural increase = 1)		
	natural increase, %	migration gain, %	1959-81	1959-73	1974-81
The capital with its satellites	39.4	51.6	1:2.3	1:2.5	1:2.1
North-East Estonian industrial agglomeration	23.1	19.8	1:1.5	1:1.8	1:0.8
among it: its major centres	19.3	16.9	1:1.6	1:1.9	1:0.7
Polyfunctional regional centres	14.9	12.5	1:1.5	1:1.7	1:1.1
Raion centres	13.8	12.5	1:1.6	1:2.1	1:0.7
among them: old	11.0	9.5	1:1.5	1:2.0	1:0.6
new	2.8	3.0	1:1.9	1:2.5	1:1.3
Local centres	8.8	3.6	1:0.7	1:0.9	1:0.4
among them: polyfunctional	6.0	3.1	1:0.9	1:1	1:0.6
narrowly specialized++	2.8	0.5	1:0.3	1:0.5	1:-0.1
Total	100.0	100.0	1:1.8	1:2	1:1.4

+ migration gain comprises also changes in population number due to administrative changes;

++ this group includes also a few isolated settlements with a narrow specialization whose functions of a local centre are weakly developed.

establishment of Soviet power has been considerably slower, since their proportions in respect to the subordinated hinterland are already reaching their upper limits. Generally the growth of old raion centres slows down when their population number is approaching or is already above 20,000.

The growth rate of local centres is even more notably differentiated than that of raion centres (Fig. I). The bulk of the natural increase and migration gain of this group occurs in IO polyfunctional and 4 narrowly specialized local centres, i.e., in scarcely half of the total number of local centres. Among polyfunctional centres relatively rapid growth is experienced by those concentrating besides service also production, primarily such enterprises that render technical services (land improvement, repairs, supplies, building, etc.) to farming. Through such enterprises the respective local centres develop close relations with their agricultural hinterland which is the main reserve for their population growth. As to the narrowly specialized local centres, rapid population growth occurs in those where the major industrial enterprise has been recently expanded or which have an additional function of a residential satellite being located in the capital's hinterland. In recent years both these subgroups have enjoyed approximately equal growth rates, polyfunctional local centres, gaining inhabitants mainly by net migration, and narrowly specialized ones almost equally by natural increase and net migration. The population number of the other polyfunctional and narrowly specialized local centres are stationary or declining. Either because of their location or combination of functions these urban places are under less favourable conditions, and are therefore short of growth reserves. As a rule, they suffer net outmigration. The location of a local centre may be unfavourable when it is situated in outlying districts of the Estonian SSR (also far away from major roads), or isolated from agricultural areas by large forest expanses or marshes, in some cases also if other local centres are too close. In such cases the network of local centres is too dense. At the same time there are several agricultural regions which have no urban local centre at all, though one would be needed. In such a situation some larger quickly growing rural settlement (in Estonian alevik) may grasp the functions of a local centre. Thus, side by side with the stagnation of some old centres,

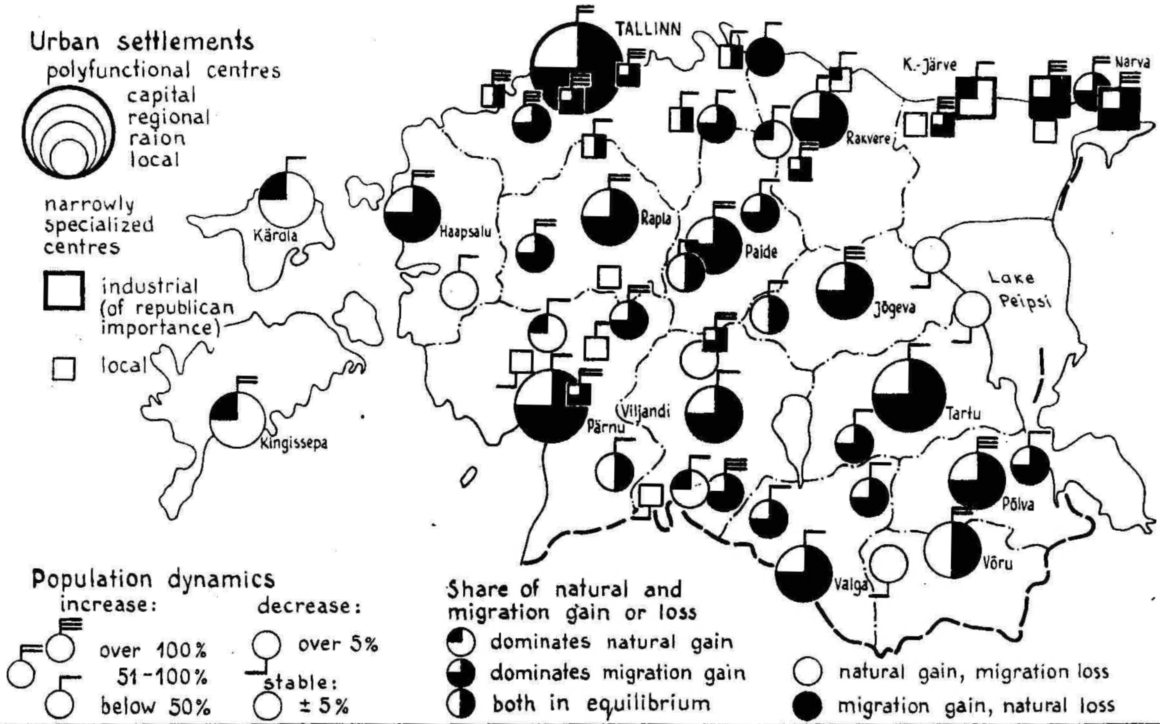


Fig.1. The population dynamics and its components of urban settlements of the Estonian SSR in 1959-81

new ones come into being. This shows that the lower levels of the hierarchy of urban settlements just like rural settlements adapt themselves to the shifts having taken place in rural production branches and services connected with them.

It should be noted that when estimating the share of migration gain in the growth of urban population and in the changes of its territorial distribution, the relative and absolute values of net inmigration are not sufficient. The effect exerted by migration gain or loss on the natural increase in the settlement should also be taken into account. With a few exceptions a high migration gain brings about a rise in natural increase as well, and the latter stays at a relatively high level for quite a long time after the decline of migration gain. It is as a result of former high net inmigration that the majority of industrial centres experience higher than average urban natural increase also today. Long-term migration loss brings about a decline in the number of young people of marrying age, as a result of which natural increase is reduced to the minimum, being in some cases replaced by natural loss.

2. ON THE POSITION OF DIFFERENT TYPES OF URBAN CENTRES IN THE SYSTEM OF MIGRATION FLOWS IN THE ESTONIAN SSR

Above a general survey was given of the changes in net migration with in the dynamics of the settlement system of the Estonian SSR has a whole and its different functional-hierarchical subdivisions. For a better understanding of the regularities observed and their alteration trends, the position of the different settlement types and territorial subsystems of the settlements in the general scheme of the migration flows should be assessed. This position is characterized from two main aspects: I) which other settlements and regions lose inhabitants to the settlement group of interest and what are the destinations of their outmigration; 2) what are the main reasons for population concentration and, on the contrary, population loss. At that we are interested in the share of migration directly or indirectly affectable by governmental measures, i.e., to what extent and how the migration mechanism of different settlement types can be affected change of residence in connection with official transfer or recruitment or workers to new jobs, the assignment of young specialists to jobs on graduation, as well as the settling of state dependents in invalid's and children's homes can be regarded as migration patterns directly affectable or controllable by administrative, planning or economic authorities. The migration connected with studies is indirectly affectable by planning organs since the specialization, location and enrolment of educational establishments is fixed by plans. Migration destinations can indirectly be influenced by several other measures such as the location of new jobs and housing construction, etc. Below, when discussing the share of directly and indirectly controllable migration, organized migration connected with work and studies is considered.

Detailed research into the migration relations and mechanism of different functional-hierarchical types of settlements of the Estonian SSR has been conducted twice. One of the investigations analyzed the period of I968-I973, i.e., the second half of the middle stage of urbanization, the other treated the time interval I980-I98I, i.e., the beginning of the advanced stage of urbanization.

A generalization of investigation results is presented in Figures 2, 3 and 4.

The figures show that during the middle stage of urbanization all main migration flows reflected continuing concentration in the settlement system. First, the number of rural to urban migrants was considerably higher than that of urban to rural ones, at that the biggest migration gain at the expense of rural areas was experienced by the capital - the head of the settlement system, and raion centres, i.e., the nearest administrative and economic centres of all raions. Raion and local centres gained population by net migration only from the same subordinated raion, whereas the capital attracted settlers also from all other rural raions of the republic (they accounted for nearly two thirds of the capital's migration gain from rural settlements). The only group of urban settlements experiencing net outmigration to rural areas of the republic is (and has been) the industrial agglomeration in North-East Estonia. This agglomeration has a somewhat exceptional position serving as the so-called "entrance gate" for the influx of migrants into the Estonian SSR. Its location at the republic's border and industrial

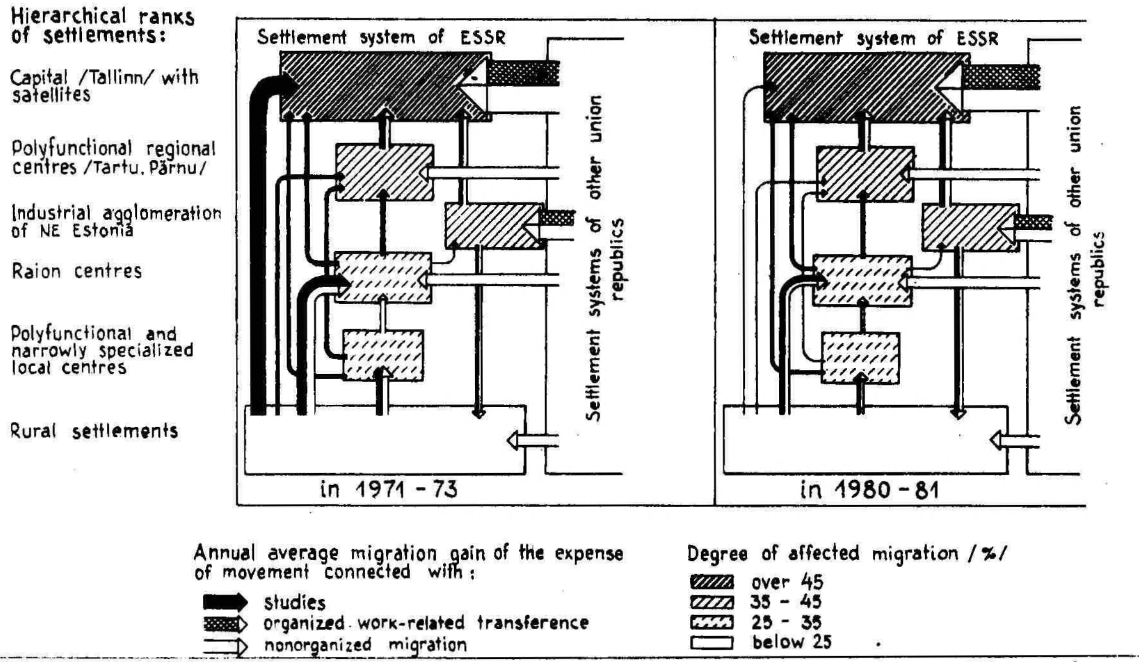


Fig. 2. The population redistribution in the hierarchy of the settlement system of the Estonian SSR in 1971-73 and 1980-81

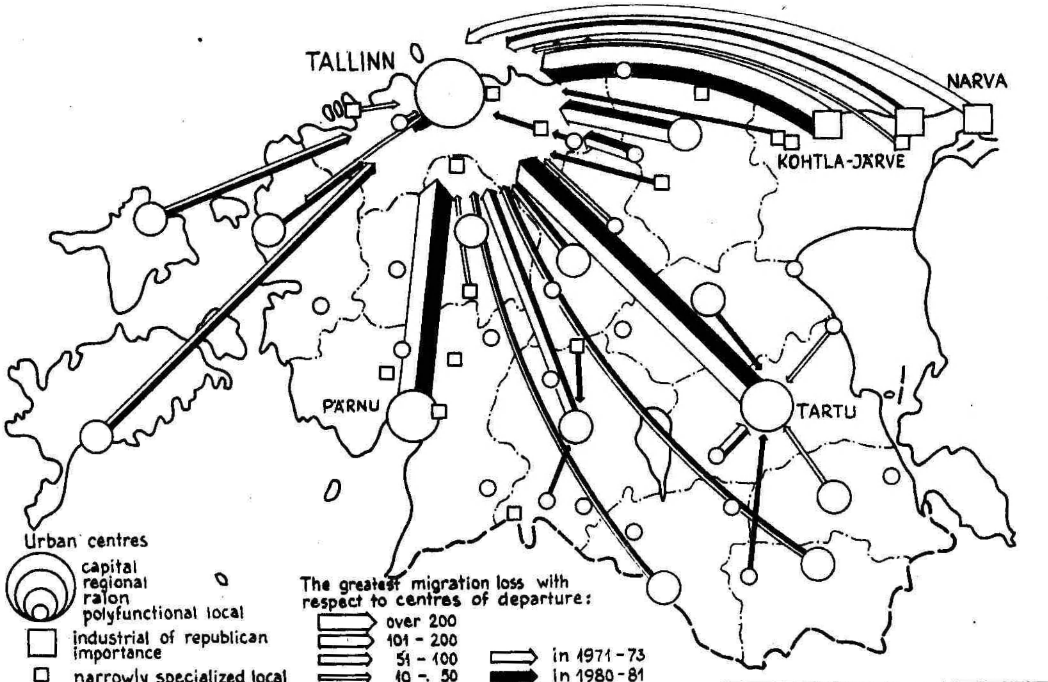
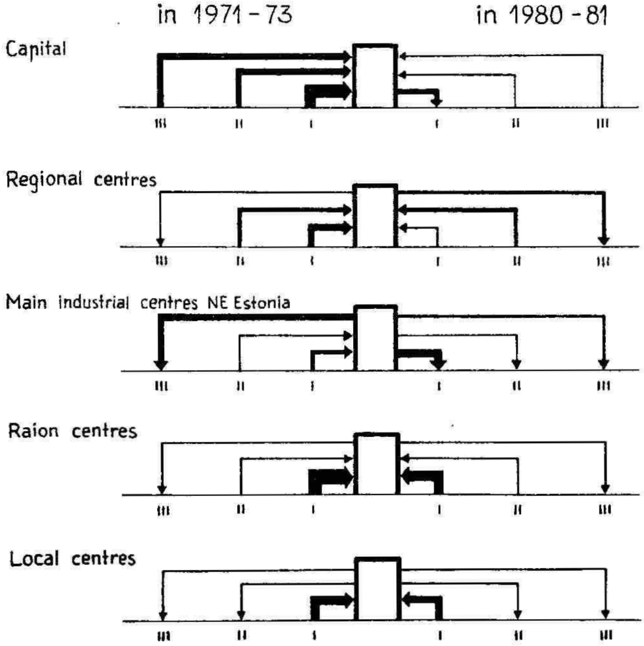


Fig.3. The main trends of urban population redistribution of the Estonian SSR in 1971-73 and 1980-81



⟹ trends of migration gain or loss with respect to urban centres

I the nearest administratively subordinated rural raion

II rural raions of the same region

III remoter rural raions (in Estonia)

Fig. 4. Principal scheme of population redistribution between rural areas and urban settlements of different hierarchical ranks (comparison of periods 1971–73 and 1980–81 on the basis of the annual average migration gain or loss)

specialization are conducive to close relations with the Leningrad Oblast and remoter industrial areas whence its migration gain originates. Part of the inmigrants assigned to jobs in this region after graduation or recruited from other republics move on to other towns or districts of the Estonian SSR. The majority of outmigrants go to Tallinn (two fifths for educational purposes) and North-West Estonian rural areas.

Secondly, in the intrarepublic urban to urban migration a strict regularity was observed: lower ranked centres lose people to higher ranked centres. Consequently, the concentration of urban population proceeded along the settlement hierarchy in upward direction with the capital serving as the final point of destination in the intrarepublican migration. The capital gained the largest number of inhabitants from its nearest hierarchy level - polyfunctional regional centres.[I]

Thirdly, inmigration from other Union republics of the USSR also contributed to the concentration of population in the higher ranked centres: Tallinn and North-East Estonian industrial agglomeration acquire nearly three quarters of the net inmigration.

In this connection it is important to note that the population concentration in the higher ranked centres is above all a result of organized migration connected with work and studies. Fig. 2 shows that the share of migration affectable by planning authorities is the highest in higher ranked centres, and lowest in rural areas.[II] In intrarepublic migration that connected with studies is the most extensive, while organized movement of manpower plays the greatest role in inmigration from other republics. In the early I970s Tallinn

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[I] The regularity that at the middle stage of urbanization in the urban-rural and rural-urban movement upward migration flows dominate in the settlement hierarchy, is stated also by A. Żurkowa (I98I), who analyses the spatial structure of Polish migration.

[II] In rural to rural migration, especially over short distances, indirectly controllable migration flows play a relatively important role. Such migration is induced above all by new housing projects on state and collective farms. Housing construction is one of the main factors affecting population redistribution within farms as well as between them.

and Tartu, the two major educational centres in Estonia, acquired the bulk of their migration gain on account of those migrating for educational purposes. Tallinn concentrated in addition skilled labour from the other towns of the republic (mainly regional centres) also by official transfer of people. In the net immigration to Tallinn and the North-East Estonian industrial agglomeration from outside Estonia people recruited to construction, transportation and industrial enterprises accounted for nearly a half. In the migration from rural settlements to raion and local centres movements connected with education are of minor importance. Therefore, over a half of the migrants gained by these centres leave rural areas on their own initiative (to obtain a more attractive job, better housing conditions, advantages of urban way of life, etc.).

A comparison of the above-described trends of population redistribution with those observed in the early 1980s shows that intrarepublic urban to urban and interrepublic migration have not undergone notable changes. With a certain decline in the total volume of interrepublic migration (its reasons have been referred to above), net inmigration into Estonia has also decreased, but the distribution of the inmigrants by different settlement groups is almost the same as earlier. However, the proportions of intrarepublic rural to urban migration show evidence of considerable changes. The most noteworthy phenomenon is that the capital and polyfunctional regional centres, i.e., towns of the highest level of the settlement hierarchy, have lost their migration gain from rural areas. So far the number of migrants moving to Tallinn from some rural areas of North-East and South-East Estonia is still higher than that of those leaving Tallinn for these areas, but Tallinn has net outmigration with respect to Harju Raion administratively subordinated to it. Because of outmigration to this raion, the net migration between Tallinn and the rural settlements of the republic is in equilibrium. Tartu, the second largest town and one of the two major educational centres in Estonia has net inmigration with respect to the rural raion subordinated to it. However, Tartu loses so many graduates to remoter rural areas that its net migration with respect to the rural settlements of the republic is nearly zero. Thus we can see that nowadays the redistribution of rural inhabitants to urban settlements results mainly from short-distance migration between raion and local centres and rural settlements of the same raion, i.e. from intraraion migration. As compared to the previous stage of urbanization, the migration gain of raion and local centres from rural areas has declined nearly by a half. As the outflow of population from raion and local centres to the higher ranked towns is continuing at nearly the same pace as previously, the decline in the inflow of rural people of the same raion is the main reason why nearly a half of local centres have suffered net outmigration in recent years, while the migration gain of raion centres has considerably decreased.

All this shows that during the present stage of urbanization the structure of the settlement system has begun to stabilize, and population migration is a direct carrier of this process. This process does not begin simultaneously in all units of the settlement system whereas its progress is affected by different factors. To understand this, the analogy of the behaviour of the settlement system with that of other centralized hierarchical systems should be considered. As it is known, centralized systems function faultlessly when they have a powerful main centre, and subcentres of secondary, tertiary, etc. levels having proper proportions with respect to the main centre. That is why at the stage of system formation nearly all intra- and extrasystem growth reserves are mobilized to strenthen centres, especially the main one. However, when the system has already reached the so-called mature stage, the time comes when the proportions between the centres and the remaining elements of the system cannot be changed in favour of the former any longer. If they are changed, the centres themselves will lose the subordinated subsystems as their primary growth reserves and objects to be managed. In such cases centres have to apply their own regulatory functions to avoid undesirable disproportions. The development of a settlement system is subject to analogous laws, this is evidenced especially by the course of urbanization and changes in the proportions of urban and rural settlements. The leading urban centres of the system whose migration enjoys a high level of control are during the early stages of urbanization the main concentrators of population, and during the later stages they are the first to apply "brakes" to check excessive concentration. In the Estonian

SSR such checking is required since too high outflow of labour from rural areas is hindering the growth of agriculture and other rural activities. Above we relationed already two-sided measures (restriction of the creation of new jobs in towns, and increased benefits for rural workers, etc.) which have been applied to avoid disproportions in the national economy. Migration investigations show that such incentives affect first the migration flows connecting towns of the higher levels with rural settlements. Tallinn and Tartu are no longer the main centres attracting rural population, now their functions with respect to rural settlements consist in training qualified personnel. The decline of the migration gain of raion and local centres from rural places shows that the stabilization process between the urban and rural localities is already apparent also at the lower ranked urban settlements.

However, not all rural areas are involved in the turnaround of rural-urban migration, it concerns only a relatively small area, mostly the nearest hinterland of the capital, regional and raion centres. People who stay in the country or move there from urban places prefer to live in areas having good access to a town. Rural areas far away from larger and medium-sized towns are still experiencing net outmigration. Areas adjacent to towns are in more favourable conditions also from the standpoint of the location and variety of jobs. A number of towns have relocated various enterprises requiring large sites (construction, transportation, warehousing) or a quiet environment (research institutions, hospitals) in the suburban zones. As a result, people living in these zones can either work at these enterprises or commute to work in town. Therefore, areas adjacent to towns attract mostly young persons of working age. At the same time, the growth in the number of jobs in the vicinity of towns has resulted in increased labour commuting originating from towns. At the present time the labour commuting between the big and medium-sized towns and the rural settlements of the Estonian SSR is almost balanced, i.e. the number of commuters in both directions is equal. All this has resulted in a notable differentiation of the rural settlement system: in the vicinity of towns zones with a higher demographic potential having close daily commuting ties with the towns and characterized by urban way of life are clearly distinguishable.

To sum up we can see that the demogeographical processes in the Estonian SSR during the advanced stage of urbanization are characterized by two main trends. On the one hand, the growth of urban places is decelerating. This is mainly caused by declining immigration reserves, and thus the towns cannot expect any significant rise in natural increase. On the other hand, urbanization is continuing in an implicit form with the formation of the so-called rururban zones around towns. The demographic growth potential of these zones is not much lower than that of the towns themselves. At first the formation of these zones decelerates the growth of the central town (part of the inhabitants and jobs being relocated in this zone). However, in the future the existence of such a zone will provide a local reserve for the further growth of the central town. Consequently, the migration affecting measures taken in recent years have influenced the demographic dynamics mainly of Estonia's larger towns and rural areas in their nearest hinterland. How rapidly and to what an extent the number of population and workers can be consolidated in remoter rural areas is not clear yet. It is necessary to make migration policy more effective just in this line. The last problem must be partially solved by means of urban settlement, enlivening the development of small towns in agricultural areas. That will diversify the possibilities of employment for rural inhabitants and enable their better access to services.

In conclusion it can be said that the changes in the migration streams of the Estonian SSR are in many respects similar to those in other countries having reached the advanced stage of urbanization some time earlier. In the USA and several countries of Western Europe the relative migration gain of small towns and thinly-populated rural areas exceeded that of large cities and agglomerations already in the early 1970s. This phenomenon, so-called migration turnaround has been under study over the last decade by many authors (Ter Heide, Eichperger, 1981; McCarthy, 1980; McCarthy, Morrison, 1977; Hansen, 1977; Chàlmers, Greenwood, 1977). The factors, however, which have caused the deconcentration of population, are not entirely alike in Estonia and the above mentioned countries. In the USA, for example, the phenomenon dealt with here has been partially connected with recreation and retirement as well with ecological difficulties of huge agglomerations; in Holland the physical planning of newly settled regions, etc. In Estonia the main reason for the inhibition of the population concentration process has been so far associated with the desire to contribute to the development of agriculture. As agriculture occupies an important place in the republic's national economy, then the rural settlement is also a significant component in the republic's settlement structure and its rapid decline must be avoided. The aim is not to maintain fully the present number of the rural population, but first of all to improve its sex and age composition and thus to strengthen its natural reproduction ability.

As it was said above nowadays it is not possible to raise the demographic potentiality of rural settlement only on the basis of purely agricultural settlements. It is necessary to diversify the functional structure of rural settlements, and intensify their labour and service commuting to urban settlements.

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FORMATION OF LABOUR RESOURCES AS A TERRITORIAL PROCESS AND ITS NATURE IN THE ESTONIAN SSR

J. Kõre

The situation on the labour market may become strained in the whole Soviet Union including Estonia in the near future due to the age structure of the population on the one hand and the continuing fast and extensive growth of production on the other. It is for this reason that the raising of the efficiency of the use of labour resources and the ensuring of the maximum employment of all population categories have become highly important in the management of the national economy both on sectoral and territorial levels. The territorial aspect of the formation of labour resources which has so far been neglected requires special attention. Research into territorial regularities of the formation of labour force should be based on productive forces as uniform territorial systems whose component the population is. The territorial aspects of the formation of labour resources are affected by demographic and economic factors as well as social ones, especially the educational system.

I. On systems approach to labour resources

In recent years principles of a systemic approach have been widely used in the study of complicated objects. Attempts to apply systemic analysis to the study of various phenomena in economic geography are of great interest. Without dwelling in detail on the conception of a system, we shall try to clear up the possibility of applying this approach to the study of labour resources. So far attempts have been made to apply the systems approach to the investigation of population reproduction (Коростелев , 1979), the system of settlement (Марксоо, 1977) and the management of labour resources (Ладенко, 1975; Либанова, 1982; Суворова, 1980).

Labour resources are part of the population, thus they have two poles - the biological and the social one. The biological aspect ensures the reproduction of the whole population, thus also that of the labour resources. This process is controllable only indirectly and with a large delay in time. Hence, the management of labour resources is aimed primarily at the optimization of social indicators. The natural movement of the population is regionally affected by the redistribution of the reproduction potential through migration. Demographic policy in general (among it regional demographic policy) is still in the state of formation in the Soviet Union.

On the other hand, the labour resources are primarily a socioeconomic category. The national economy of any region can be regarded as consiting of the following subsystems: 1) production of material wealth, 2) the infrastructure of production, 3) population and labour resources, and 4) social infrastructure. Evidently, the separation of labour resources from the total population on the one hand and from the national economy on the other is rather conventional. This can be justified only by the circumstance that the formation of the labour resources, their rational employment and the raising of their quality are key problems in the further development of the national economy.

Attempts at systems approaches to labour resources have been made by I.S. Ladenko and I.P. Suvorova (Ладенко, 1975; Суворова, 1980). They treat the formation of the labour resources, their distribution and redistribution as well as their employment as individual elements. One can agree to such a division in principle but one cannot agree to the content ascribed to the elements by I.P. Suvorova. Besides, they are rather groups of elements (subsystems) than elements.

<u>The formation of labour resources</u> may be treated in wider and narrower meanings. In its wide meaning this term refers to the increment of labour resources through natural and mechanical increase of population. Here the treatment of the general dynamics of population and that of labour resources should be closely linked. Naturally, the socio-economic peculiarities of any given regional economic system leave their imprint on this process. In its narrow meaning the formation of labour resources refers to their replenishment - above all

through the educational system of the given region but also through migration.

The distribution of labour resources is a link uniting the elements of their formation and employment. It is not always easy to define the boundary between them since the structure of the educational system and network determines to some extent also the distribution of future workers among the enterprises of different sectors. However, a large number of young people find jobs on their own, thus various indirect factors are required to ensure a rational distribution of manpower.

The redistribution of labour resources is on the one hand a plannable and controllable process caused by the development and changing importance of the national economic sectors, enterprises and specialities. On the other hand, however, the movement of manpower on people's own initiative is also involved. This process is generally not controllable by the respective authorities.

The employment of labour resources determines the structure of the population's employment. In this connection it has become traditional to deal with the population employed in social production in the spheres of material production and non-production. Evidently the activities of the population engaged in individual households and housekeeping are not less important for the society if the aims posed by the society are served.

One conception which requires more detailed clarification in the study of labour resources is the relationship between the elements of the system. When observing the system of labour resources, management relations of a vertical nature are the most conspicuous. The training and retraining of the personnel for a certain sector, ministry or enterprise are organized proceeding from the principle of vertical links. As a rule, the major part of the vertical relations of enterprises are material ones (goods, energy), while information exchange and the movement of workers form a minor part of them. Vertical relations are mostly linked with a certain management centre. Experience shows that the nearer the management centre according to subordination or territorially, the greater its influence on the workers' collective. When vertical relations become weaker, horizontal (i.e. territorial) ones gain significance.

Labour resources are always related to a certain territory, a settlement system or a settlement. The treatment of labour resources as a mobile part of the productive forces does not preclude such an approach - productive forces (or part of them) are relatively mobile. The lower the living standard of inhabitants, the cheaper it is to assign them to jobs in places suitable for social production. When the living standard rises, it may be necessary to act on the contrary. Dissatisfaction with work, with one's working team, living conditions, etc., are the main reasons for a change of one's place of work (family reasons which are often closely linked with the above ones, form a separate group). The change of workplace is also affected by the peculiarities of the settlement or the settlement system. The more varied the functional structure of the settlement, the more changes of workplaces occur within the settlement and the fewer between settlements.

While the vertical relations between enterprises maintain themselves through technology, material and technical supplies and management, the horizontal links reflect the whole variety of interests which connect separate collectives. First of all, on a certain territory we can find a varied complex of production enterprises and enterprises serving the former or the inhabitants. Secondly, scarcely any of these enterprises can operate without any interrelations. Because of the predominance of the principle of sectoral management, too little attention has been paid to the nature of the horizontal relations and the possibilities of affecting them.

2. The formation of labour resources and its territorial management

For its further deepening territorial planning should be closely related to the administrative division of the terrytory and socio-economic zonation.

Detailed zonation schemes are usually based on a hierarchical settlement system. In the Estonian SSR a five-stage hierarchy is used: (I) the intra-farm settlement system as a form of territorial organization of productive forces on the territory of a large-scale farm, (2) the settlement system subject to the local centre, (3) the settlement system of the administrative district (raion), (4) the regional settlement system, and (5) the settlement system of the Estonian SSR as a whole headed by the capital of the republic. In recent years a similar hierarchical structure of settlement has been gaining favour also elsewhere in the Soviet Union (Ныммик, Мурель, 1974).

Here the questions arise as to what regularities of the formation of labour resources are characteristic of different levels of the socio-economic hierarchy, and to what extent this process is controllable.

In reality it appears that labour resources are not formed in the same way on all the levels of the socio-economic hierarchy. Differences are due to the extent to which administrative and economic principles are combined and other circumstances. It should be noted that in the Soviet Union the formation of the labour force of individual enterprises and consequently of the respective regional unit takes place under labour shortage. Workers have an opportunity to choose a job offering better working and living conditions. This, in turn, gives rise to competition for labour among the spheres of economy and individual enterprises. As a rule, the competition manifests itself within a regional or an administrative unit.

The most general regularity is the concentration of inhabitants and labour resources from settlements of the lower levels of the hierarchy into the settlements having a higher status. The concentration process taking place in the settlement system of the Estonian SSR is strongly influenced by interrepublic migration, thus it does not reflect only the processes inherent in this system itself. The movement of manpower between settlements of an equal status should not be underrated either. The nature and complexity of this process differ in different settlement groups.

On the level of a large-scale farm not many direct contradictions are faced in obtaining manpower. Firstly, the farm itself employs the majority of the manpower, and therefore the activities of the auxiliary institutions serve and must serve the interests of agriculture. Secondly, since the administrative functions of the lowest administrative authority - the village Soviet - are limited, there are practically no contradictions between the economic and administrative management. One of the main factors affecting the formation of labour resources is the outflow of youth from farms into towns. This process takes place in a situation where because of the development level of the productive forces agriculture cannot afford to release any more labour. Another tendency (though not so extensive) is the flow of population from poorer farms (and districts) into better ones.

The spheres of influence of the local centres are shaped through the performance of the productional, service and organizational functions in a certain area (usually on the territory of a village Soviet). This area is not administratively marked, therefore the number of local centres distinguished by different authors varies. S. Nômmik and V. Murel, for example, have distinguished 24 urban and 50 rural settlements as plyfunctional local centres, I4 urban and 35 rural settlements as highly specialized local centres (Ныммик, Мурель, I974). E. Tsopp, however, has differentiated 25 productional, 3I productional-servicing and II organizational-servicing local centres in the Estonian SSR (Тсопп, I976). Depending on the functions performed by the respective local centre, it can have significant commuting ties with its hinterland. A certain movement of labour force between enterprises is possible since the composition of jobs is quite varied within the local settlement system.

With the formation of agricultural-industrial associations in all the raions of the Estonian SSR local centres have gained new functions. This is conductive to close relations between the local centre and its hinterland and should help to retain labour in the system.

The basic units of territorial management in a small union republic are administrative districts (raions) and towns of republican subordination. On the territory of the Estonian SSR there are I5 raions and 6 towns of republican subordination. The improvement of their efficiency is vital for combining sectoral and territorial planning, and thus also for territorial management of the formation of labour resources.

On the territory of a raion a variety of enterprises belonging to both production and non-production spheres can be found. While the competition for labour is insignificant at lower levels of the settlement system (labour force of different sexes or with different skills being employed), then here rather sharp contradictions are observed. First, the development of the two major spheres of the national economy - the production and non-production spheres - is not in harmony. Secondly, units subject to different levels of management (all-Union, all-Union and republican, republican) enjoy different development prospects. Thirdly, there exist discrepancies of interests between individual enterprises (also if subject to the same management centre).

The zones of influence of the largest towns of the Estonian SSR have given rise to such intra-republican regions as Tallinn with its influence zone in the north-west of Estonia, Kohtla-Järve in the north-east, Tartu in the south-east and Pärnu in the south-west of Estonia. These regions have no administrative foundation yet but they have been recognized as suitable units for the planning of intra-republican socio-economic development.

In the management practice the regional principle is at present applied only in the activities of the Ministry of Services of the Estonian SSR. The regional principle is to some extent taken into consideration in the organization of the system of vocational education, various other schools and extension courses. In the future this principle is to be applied on a considerably wider scale. Intra-republican regions reveal distinct differences in social and economic development as well as in the formation and employment of their labour potential. Therefore, the possibilities of controlling the process of the formation of labour resources vary from region to region.

The most important territorial management unit in the Soviet Union is a union republic, in large union republics - an oblast. If the influence of this unit in the development of the administrative management of the territory is not raised, efforts to harmonize territorial and sectoral management in lower units will be futile.

3. The role of the educational system in the formation of regional differences of labour resources

At the present time the solution of three problems is especially topical in the field of the formation and employment of labour resources, namely (I) the training of personnel, (2) the balancing of the number of working people and jobs, and (3) an improvement of people's living and working conditions.

In the training of manpower an extremely important role is played by rational organization of the educational system. The tasks of the educational system consist in giving future workers a general education and specialized skills. These tasks are fulfilled through a differentiated school network. The system of general education involves the whole population, it also lays the foundation for acquiring a specialized education. For certain jobs the knowledge and skills received at a general school are sufficient without notable further studies. Other jobs require special training offered by specialized secondary and higher schools, vocational schools or courses arranged at enterprises, etc. It would be ideal if a sufficiently diverse network of educational establishments were situated in a certain area which could satisfy the basic demand of this area for additional labour force.

In the Estonian SSR the network of general schools is on the whole in harmony with the distribution of population and the settlement system (Лаансалу, 1981), though a few deviations can be observed. Empirically it has become clear that there should be a grade school on the territory of every large-scale farm, and every local centre should have a secondary school. Schools training skilled workers and middle managers have historically developed a distribution that is not in conformity with the settlement hierarchy. In Estonia two large educational centres training the overwhelming majority of people with a higher education - Tallinn and Tartu - have come into being. A considerable portion of the middle managers and skilled workers are also trained in Tallinn and Tartu. The other regional centres - Pärnu in South-West Estonia and Kohtla-Järve in North-East Estonia take mostly local needs into account. Therefore, the situation calls for the organization of an integral educational network within the intrarepublican regions meeting the basic demand for skilled workers in the given region. So far, the regional principle has been followed in the admission to agricultural schools.

In the last few decades the population of the republic has concentrated in North Estonia, primarily in towns. In 1959 40 per cent of the republic's population lived in North-

-West Estonia; in 1979 the percentage was 44. The respective figures for North-East Estonia are I7 and I9. The role of South-West and South-East Estonia has diminished relatively, whereas the role of the West-Estonian islands has decreased absolutely. The changes in the network of schools have followed a similar pattern. The distribution of pupils shows that educational establishments nearer to homes are preferred. The distribution of those who finished grade schools in I979 according to the places where they continued their studies was in complete agreement with the general distribution of the population. Such a distribution was caused by the fact that a large number of students (over three fifths of the young people) continued their studies in secondary schools.

Of the pupils who finished grade school in I979 the following percentage continued their studies in the same region: 95.3 per cent in North-West Estonia (90.5 per cent of vocational school enrolment), 85.55 per cent (77.8 per cent at vocational schools) in North-East Estonia, 86.3 per cent (66.6 per cent) in South-East Estonia, and 77.9 (3I.0 per cent) in South-West Estonia. The opportunities to obtain a specialized secondary education in the same region are smaller in South-West Estonia than in the other regions (49.2 per cent of the pupils can do it). These opportunities are the best in North-West Estonia (82.5 per cent). The distribution of secondary general school graduates according to the location of their future educational establishment is quite different: the concentration is high in North-West Estonia (chiefly Tallinn). There are two main reasons for this. First, a high percentage of those enrolled in the Estonian higher educational establishments study in Tallinn (in I982 Tallinn accounted for 52.4 per cent of the enrolment, Tartu for 47.6 per cent). Secondly, schools training middle managers on the basis of secondary general education are virtually concentrated in Tallinn: in I982 North-West Estonia accounted for 74.4 per cent of their enrolment, North-East Estonia for 7.7 per cent, South-East Estonia for I4.4 per cent and South-West Estonia for 3.5 per cent. The training of skilled workers on the basis of secondary education follows a similar pattern: in I982 North-West Estonia was responsible for 72.2 per cent of the enrolment, North-East Estonia for I5.4 per cent, South-East Estonia for 5.8 per cent, and South-West Estonia for

6.5 per cent.

In the Estonian SSR the development of the network of vocational schools has somewhat lagged behind. In the Soviet Union as a whole there are on average 20 pupils of general educational schools per one pupil of vocational schools, in the Estonian SSR the ratio is 23 to one, whereas in the Latvian SSR and the Lithuanian SSR (our nearest neighbours) it is only I6 to one. Narrow specialization in several spheres of life, including vocational education proceeding from the interests of an individual enterprise or a group of enterprises has resulted in a situation where skilled labour is obtained from schools of neighbouring republics or economic regions or even remote districts.

At the same time it is quite evident that in order to cut labour turnover educational establishments should be situated in the vicinity of future jobs and students' residences.

Conclusions

As can be seen from the above, the formation of the labour force is a complicated socio-territorial process. It is based on the social reproduction process, being at the same time a part of it. In socio-economic territorial systems (towns, regions) regional differences in the formation of labour force are evident. They depend on the demogeographical processes and are affected by general and special laws of the development of a socialist society (the absence of unemployment, the availability of general and specialized education), by the regional structure of our national economy and the peculiarities of the social infrastructure. One of the most important factors in the formation of the labour force is the educational system whose structure and territorial organization must be in accordance with the structure of the necessary labour force and the territorial organization of social production.

It also became clear that the development of the Estonian school network requires better coordination with the regional development of the national economy, the distribution of the population and regional interests.

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DURATION OF SUNSHINE AS BASIS FOR DETERMINING TOTAL SOLAR RADIATION

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Total solar radiation is becoming widely used as a climatic characteristic, simultaneously the time intervals for which radiation amounts are needed are getting shorter and more concrete. Here we consider the determination of weather types for the purposes of characterizing the conditions of landscape, modelling plant communities as well as thermal and water regimes and productivity of field crops, for the application of solar therapy in health resorts, in construction for determining the heat insulation parametres of envelopes and the area of fenestration. During the past few years, in the context of general energy shortage, a sharp rise of interest in heliotechnical installations has been observed in the whole world, including northern countries. Finnish specialists show their guests their original "sun village" 35 km north of Helsinki where 75% of the annual heat requirement is supplied by solar energy.

For the time being, there are still few actinometric stations where total radiation can be recorded automatically, besides, the network of such stations is not regular. On the vast territory of the USSR the number of stations supplied with total radiation (Q) integrators is under 100, stations with self-recorders for direct solar radiation (S) are fewer than 20. Therefore, it appears to be indispensable to develop methods for the computational determination of radiation totals for time intervals as short as possible (days and hours). Data provided by the heliograph, the most elementary and at the same time the most common instrument for registering sunshine may serve as the actual basis for this purpose. It should be noted that in the USSR heliographs work at more than 1000 meteorological stations.

At the present time data on the duration of sunshine (s) are used for the determination of total radiation rather modestly. Papers presenting data on the relations between s and the monthly amounts of Q or S have been published, the daily amounts of Q however, it is asserted that could be computed on the basis of s only with a very low accuracy. A thorough survey of the climatological investigations of the regime of solar radiation with the purpose of its heliotechnical application has been given by T.G. Berliand (Берлянд, 1980). Dealing with the problems of compiling the sun cadastre, he considers it important that the network of stations registering the daily totals of solar radiation should be made denser, and the diurnal structure of solar radiation should be studied. However, he does not mention that the heliograph data could be used as a basis for this.

The fact that little use is made of the duration of sunshine as the basis for computing total solar radiation is partly due to a specific feature of the heliograph as a recording instrument. Namely, the heliograph does not register concrete values of radiation intensity but only the fact that it surpasses a certain threshold value. According to different sources, for the most generally used Campbell-Stokes heliograph this value is 0.20 ... 0.40 cal/cm^{2}min., depending on the quality of the glass ball and the tape. Actually, the values of radiation intensity may surpass the threshold value several times but this remains unobserved. Secondly, it must be taken into account that a shaft of rays that has passed through a glass ball with a diameter of 10 cm burns a hole into the tape in a very few seconds. If on a day with clouds variable the sun comes out from the cloudage every 5-6 minutes for 10-20 seconds it is sufficient to leave on the tape a burned trace similar to that caused by continuous sunshine. Naturally, the aforementioned shortcomings reduce the informative value of the burned trace on the tape.

Since for weather classification it was necessary to find a correct radiation characteristic that at the same time would be determined on the basis of the data from a possibly wide network of stations, we undertook to determine the relations between the duration of sunshine (s) and the amounts of radiation. As the starting point we chose total radiation (Q) that is most universal from the standpoint of weather-forming processes as well as applied fields. The form of the field of the points s and Q carried on the coordinate axes showed clearly that there existed a linear relation. Proceeding from this the correlation coefficient r was calculated. To characterize the relation the well-known linear regression equation was used:

$$y = ax + b, \quad (1)$$

where y = Q cal/cm^2 sought for; x = s in hours; a and b = = constants, the climatic value of which lies in the following: a = ascent of the correlation straight line showing by how many calories Q increases per every hour of the increase of s; b = initial ordinate, Q if s = Q.

The warm period from April till September was taken under observation, the relative role of radiation in the weather-forming process being greater and its practical applications of greater importance. At the beginning, the correlation parametres were determined for Tartu (years 1954 - 1958) and Moscow (1957 - 1961) (Райк, 1963). 150 was considered to be a sufficient number of cases for determining the density of relation between the two meteorological characteristics. Later, in order to check the territorial generality of the validity of the correlation of s and Q, data from six more stations in different districts of the USSR were processed (Пахапилл, 1974). The processed data characterize climates from the Subarctic North to Transcaucasia and southern desérts, and from the areas influenced by the Baltic Sea via regions with different stages of continentality to the coast of the Pacific.

As can be seen in Table 1, the coefficient of the relation between the daily amounts of s and Q is in most cases above 0.90, in half of the cases 0.93 and more. One case that falls out is Verkhoyansk, north the Polar Circle, that is characterized by a great number of hours of low radiation intensity due to the low position of the sun. Another exception is Tashkent with its relatively small correlation coefficients. Characteristc of the local desert climate is a very large number of days when the duration of sunshine approaches the possible maximum, but the intensity of the radiation influx fluctates mainly because of a great variation of atmospheric transparency.

When applying heliotechnical equipment it is essential to know the daily amounts of direct radiation (S). The density of the relation between S′ and s has been calculated for two places. As we seen in Table 1, the correlation coefficients

Table 1

Correlation coefficients r of the relation between daily amounts of sunshine duration (s) and total radiation (Q)

	Latitude	April	May	June	July	August	September
Verkhoyansk	67,5	0.76	0.88	0.84	0.88	0.91	0.93
Okhotsk	59.5	0.91	0.89	0.93	0.92	0.94	0.91
Tartu	58.5	0.89	0.95	0.93	0.94	0.93	0.91
Moscow	56	0.90	0.92	0.93	0.93	0.93	0.90
Omsk	55	0.94	0.91	0.94	0.96	0.90	0.92
Kaunas	55	0.94	0.94	0.91	0.94	0.90	0.93
Tbilisi	42	0.92	0.95	0.92	0.97	0.94	0.95
Tashkent	41	0.96	0.96	0.88	0.81	0.83	0.83
Correlation coefficients r of direct radiation (S')							
Omsk	55	0.94	0.92	0.93	0.95	0.93	0.95
Tashkent	41	0.96	0.94	0.88	0.86	0.91	0.89

Table 2

The values of the coefficients a and b
of the linear relation equations

	April		May		June		July		August		September	
	a	b	a	b	a	b	a	b	a	b	a	b
Verkhoyansk	14.6	239	18.3	307	21.5	270	23.6	216	24.6	166	20.7	98
Okhotsk	21.6	233	26.4	260	31.9	230	31.2	217	27.5	165	22.8	52
Tartu	24.5	185	29.5	173	29.5	208	34.2	160	27.2	163	24.9	92
Moscow	25.5	161	28.5	187	31.3	197	27.0	212	28.4	142	23.2	122
Omsk	27.1	147	38.4	185	31.1	201	30.1	184	27.0	148	22.8	52
Kaunas	30.1	134	32.1	174	29.2	219	29.6	195	33.9	132	26.0	99
Tbilisi	37.4	168	39.2	216	40.1	216	36.8	203	36.4	190	31.4	159
Tashkent	37.9	143	35.9	208	36.9	215	36.7	197	34.4	179	27.9	202

Table 3

Correlation coefficients r of the relation between hourly amounts of sunshine duration and total radiation and regression equation coefficients a and b

Tartu, 1967 - 1976

Time	6-7 a.m.			9-10 a.m.			12-13 p.m.		
Months	r	a	b	r	a	b	r	a	b
February							0.80	15.8	11.1
March							0.87	26.5	16.5
April				0.89	31.6	14.5	0.92	36.8	18.1
May	0.90	17.2	7.7	0.92	36.8	17.4	0.92	42.2	20.4
June	0.92	16.6	9.4	0.94	40.4	18.1	0.91	44.0	20.7
July	0.91	16.4	9.7	0.93	35.6	18.5	0.91	39.6	21.7
August				0.91	36.1	16.2	0.90	36.2	18.2
September							0.93	31.3	14.0
October							0.89	22.7	8.6

are generally higher than in case of Q.

The coefficients of the linear relation equation (1) are climatic constants by their nature, and their regime (change from month to month) should be regular (Table 2). But here and there apparent deviations occur, which are due to the shortness of the period studied (5 years). It is also to be taken into consideration that because of the vastness of the territory the deviation of the monthly amount of radiation from the normal annual radiation is apparently different for various regions during the period used in processing.

The determination of the relation between s and Q for a part of the day was started by a postgraduate student I. Palm, in her work designed to study the regime of the characteristics of the bioclimate of man. The period from midday till 2 p.m. was taken under observation in order to find a more correct radiation index for determining the radiative effective--equivalent temperatures and clo values on the basis of meteorological observations at one p.m.

Data processing for the relation of the hourly amounts of s and Q was performed by an undergraduate R. Tuisk. For this purpose characteristic hours that corresponded to meteorological observations carried out in every three hours were chosen. Data about Tartu (Tõravere) from 1967 to 1976 were used.

Table 3 shows that the correlation coefficient of the hourly amounts of s and Q, too, is from April till December 0.90 or more, but yet somewhat lower than in case of the daily amounts.

The number of hours when there was no sunshine at all or it was continuous, at its maximum, is big as it was expected. In both cases the dispersion of Q is high. With no sunshine the great variety of the amounts of total (actually disperse) radiation can be explained by the character of cloudiness that may vary in a wide range between Cirri and Cumulonimbi. With continuous sunshine (s = 1.0), the lower than general Q_n are in part of the cases due to a thin Cirrus coating covering the sun disc. More often it is probably connected with the shortcoming of the heliograph described above, i.e. its giving a continuous burned trace in case of alternating clouds, too, if the sun comes out from the cloudage with sufficient regularity. Thus, the category of continuous sunshine comprises also the hours when the influx of direct solar radiation is interrupted and Q_h remains lower than expected, i.e. lower than if s = 1.0. The greater alternation of cloudiness at noon probably also affects the value of r so that it is from midday till one p.m. less than at 9...10 a.m. when cloudiness is more stable.

We can still note that the regime of the coefficients a and b is substantially more regular in Table 3 than in Table 2 (Tartu). This indicates a considerable advantage of a period of 10 years in comparison with that of 5 years. The fact that in one case we have to do with daily amounts of radiation and in the other with hourly amounts, is probably of less importance.

In summing up we may draw the conclusion that the relation between the duration of sunshine and daily and hourly amounts of total radiation is close enough for using heliograph data in analysing the radiation regime and compiling the sun cadastre. Whether the accuracy of the calculations based on daily and hourly radiation amounts is satisfactory depends on the task undertaken. As the network of stations that automatically record radiation amounts is sparse and observation series are short as a rule, the heliograph data are without doubt applicable to territorial and temporal extrapolation of actinographical radiation amounts, as well as for the determination of highly needed probability and guarantee characteristics.

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ON THE FORMATION AND CLASSIFICATION OF KAMES

A. Raukas, A. Kont

On the territory of Estonia, situated on the south-eastern slope of the Baltic Shield in the north-western part of the East-European Platform kames constitute one of the most typical relief forms. They have various morphology and genesis (Раукас, Ряхни, Мийдел, 1971). Up to the present about 30 kame fields, which are mainly located in the eastern part of the Estonian SSR have been described quite well (Fig. 1).

There is no unitary classification of kames up to the present day, and because of terminological indefinition, relief forms of extremely varied structure and origin are called kames. Kames constitute the most indistinct group in the glacial relief. As S.A. Yakovlev has pointed out (Яковлев, 1954), the relief forms consisting of aqueoglacial deposits and having characters which do not correspond to any other group are taken for kames. In recent years many authors have considered even various nonglacial formations - abrasional, exarational, solifluctional, etc. to be kames. This is absolutely impermissible in our opinion. Therefore, one of the most important assignments for geomorphologists and other investigators of the Quaternary epoch is to make the term "kame" more precise.

On the initiative of Estonian geologists and geographers a special all-Union symposium dedicated to kame investigations (Строение и формирование камов , 1978) was organized in 1977.

It is necessary to present a brief survey of the etymology and history of the use of this notion to solve the above-mentioned task. The term "kame" is derived from the Scottish word "comb". The word "comb" is often met in Scottish place names and means a ridge with abrupt slopes. Before the creation of the glacial theory ridges and hillocks

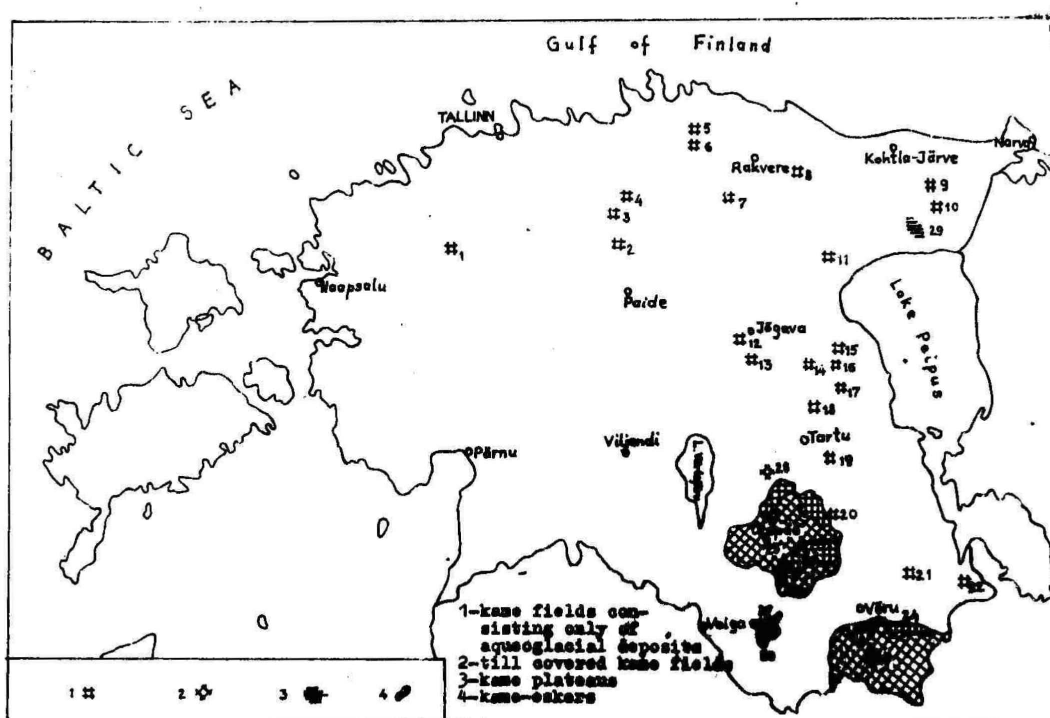

Fig. 1. The Distribution of Came Fields of the E.S.S.R.

of any kind were called kames, both sculptured and structural relief forms among them.

For the first time this term was used in a stricter sense by an Englishman J. Jamieson in 1874, who treated several formations of the glacier and its meltwater origin as kames. The same year his countryman J. Geikie in his well-known research "The Great Ice Age ..." (1874) characterized kames in greater detail, according to him kames are hillocks and ridges of gravel and sand, more rarely of pebbles, that occur in the marginal areas of big glaciers and ice sheets. He characterized the deposits of kames (Geikie, 1874, p. 232) as follows: "The deposits of which the kames are composed are usually stratified, and, in some of the finer-grained accumulations, very beautiful examples of false or diagonal bedding frequently occur. Associated with the sand and gravel, we here and there come upon deposits of silt and clay which have occasionally been worked for brick-making. These beds are usually finely laminated. But neither in them, not yet in the sand and gravel, have any organic remains been discovered."

In the 1870s the genesis of the relief formed during the last Ice Age was explained as a result of several agents' coaction - glacial, aqueoglacial and marine. J. Geikie also discovered marks of several agents in the structure of kames. He was sure that the rugged kame relief had been formed during prolonged destruction and kames essentially represented erosional-destructional remains of large landforms of earlier origin (Geikie, 1874, pp. 234, 246). He did not distinguish kames from eskers.

T.C. Chamberlin (1894) characterized kames more distinctly, considering them to be irregularly located hillocks and ridges consisting of bedded sand and gravel and separated from one another by depressions. At the same time he had a comparatively vague idea of the formation of kames, noting that irregular relief formations, consisting of stratified deposits belong to the group of kames. Usually they are connected with end moraines or form gradual transitions of them, but they differ from eskers as to their orientation with respect to the margin of the glacier. There are a number of transitional types, but one of the most important genetic peculiarities is that typical kames are the products of relatively active ice while typical eskers are formed in completely passive or even dead ice.

According to present-day opinions, fluvioglacial kames as well as eskers have formed as a result of the accumulation of aqueoglacial deposits on the surface, crevasses or tunnels of passive or dead ice, and kames differ from eskers first of all by their morphological features.

At the end of the previous century the term "kame" was widely used in geomorphological literature as can be inferred from the above-said, and its definition was almost the same as today. Much obscurity occurred about the genesis of kames at that time, but we cannot declare as if these problems were solved by today.

Systematic investigation of kames began in the Soviet Union relatively recently. S.A. Yakovlev described for the first time kames on the Isthmus of Karelia as late as 1926 (Яковлев, 1926). He defined kames nearly in the same way as T.C. Chamberlin (1894), but drew attention to the fact that such a definition was far from including all the specific features of these relief forms and that as regards their variety, kames exceeded all the other landforms of the glacial relief. He distinguished radial and marginal kames and explained their genesis as a result of the accumulation of the outwashed material from the till in the cracks of dead ice (Яковлев, 1926, 1954). S.A. Yakovlev's standpoints were elaborated by K.K. Markov (1931, 1955), who also did much to clarify the origin of kame fields. K.K. Markov believed that kame fields developed in the distal parts of surface elevations in the course of the melting of dead ice fields.

By the present time a number of investigations have been published on kames. It is necessary to refer to C.J. Holmes (1947), V.E. Boerman (1950), T. Bartkowski (1954), J. Cook (1946), G. Keller (1952), E. Markus (1930), W. Niewiarowski (1961, 1963), C. Charlesworth (1957), R. Flint (1948), P. Woldstedt (1954), R. Klebelsberg (1948/49), С.А. Яковлев (1926, 1954), К.К. Марков (1931, 1955), Е.В. Рухина (1976), Раукас, Ряхни, Мийдел(1971), et al.

It is not our task to analyse the above-mentioned works, all the more so since they are accessible to every investigator. We are making an attempt to sum up some positive points in the earlier publications and classifications presented by different authors. Relying on our own experience, some new classifications are presented for readers to discuss. These classifications of kames are naturally not completely original and conclusive and do not pretend to any final solution of the problems set up. They should be considered as a base for subsequent discussions and a stage for making up a classification acceptable to the majority of researchers.

Kames can be shortly defined as hillocks consisting of aqueoglacial deposits. But this definition unfortunately does not cover all specific features of kames and it enables to include several erosional-destructional formations into this group. On the other hand, however, if we want to include all the peculiarities of kames in one sentence, the definition will be too complicated and hardly exploitable in practice. The authors of the present paper consider kames as positive relief forms, hillocks or short ridges resulting from the accumulation of aqueoglacial deposits in the cracks and cavities of passive or dead ice or between isolated blocks of dead ice. This definition does not exclude the participation of active ice in the development of some types of kames and the existence of the lenses of till or till cover on the kames either. As we know the hillocks consisting of stratified aqueoglacial deposits are covered by till are in literature often called "dead ice moraines" (Niewiarowski, 1961, 1963, et al.). In our opinion it is more adequate to call them till covered kames. In the conditions of dead ice, the slipping down or melting out of till from icebergs is an expected rather than an occasional phenomenon.

The kame terraces - accumulative terrace-shaped landforms with flat or slightly waved surface, formed between an obstacle of the subglacial relief and passive or dead ice do not belong into the group of kames and they are dealt with as a separate morphogenetic type of landforms.

On the basis of the dynamic conditions of the glacier participating in the development of a kame, one can distinguish between the kames formed in dead ice, passive ice and those in dead or passive ice with the participation of active ice.

On the basis of the mode of formation, the kames are divided into direct ones, i.e. the landforms risen directly on the base of the glacier, and inversional ones - initially formed on ice but after its melting projected on the surface of the base (Асеев, Маккавеев, 1976).

By their location as to the margin of an active glacier, distinction is made between radial, marginal and nonoriented kames. This division is rather conventional. As kames are mostly formed in dead ice, they are situated under different angles in relation to the ice margin. On the other hand, the deposits are often accumulated in radial or marginal crevasses which are more distinctly formed as the heritage from the previous active condition. The kame fields on insular heights are mostly nonoriented, or situated annularly.

On the basis of the place of formation, subglacial, intraglacial, supraglacial, foreglacial and interblock kames are distinguished.

Considering the geological structure, one can speak about fluvioglacial, limnoglacial and complicated kames. The first group consists mainly of cross-bedded sand and gravel with additional loam and pebbles. These deposits have been accumulated in glacial streams flowing in crevasses and other cavities of passive or dead ice. They are usually covered by till.

The limnoglacial kames consist of fine-grained sand, silt and clay in the composition of which also coarsegrained fractions are represented. The limnoglacial deposits are predominately horizontally bedded, very often varved, but seldom wave-bedded. They have been formed in ice-dammed lakes, which existed in passive or dead ice.

Part of the material of complicated kames has been deposited in glacial streams, another part in ice-dammed lakes. Often lenses of till occur in their composition. The structure of the complicated kames may be two- or three-storeyed and even block-shaped. For a more vivid characterization they have been called superposed kames (Каяк, 1963). Kames as the youngest glacial relief formations may be placed on drumlins, morainic hillocks or any other kinds of landforms, even on kames formed earlier.

The most complicated task seems to be the composition of a morphological classification of kames acceptable to the majority of investigators. The kame fields vary greatly by their morphological types of landforms. The most frequently used terms are the following: hillocks, knolls, cupolas, crests, ridges, ramparts and plateaus.

Kames and eskers often exist together, and the distinction between prolonged kames and short eskers is rather conventional. Therefore, transitional landforms may be called esker-kames or kame-eskers.

The primary shape of kames may have greatly changed as a result of glaciodynamic, gravitational, erosional-destructional, abrasional and other geological actions. In such cases one can speak about transformed kames, at the same time pointing to the main refashional agent (abrased kame, etc.). If kames have changed beyond recognition, it is not proper to call them kames any more. For instance, the landforms influenced by push glacial tectonics belong to the group of push glacigenic formations.

Kames are located both separately and in groups. A group of kames adhering to a common base should be called a kame massif. An area where a number of kames are concentrated can be called a kame field. Several types of landforms may exist in composition. An association of different kames which have undergone a similar formation process (simultaneity, genetic identity, etc.) should be called a kame complex.

The main common terms and their brief definitions are the following:

behindfrontal kame - the kame which has formed behind the passive glacier margin (the way of forming is quite problematical and the term is not recommended);

combined kame - synonym of the kame of complicated structure (redundant term);

complicated kame - the kame of multi-stage structure composed of limnoglacial and fluvioglacial deposits, sometimes lenses and blocks of till occur;

crevasse filling kame - the kame formed as a result of filling the crevasses (supraglacial) or cavities (englacial) of dead ice with deposits;

direct kame - the kame formed independently on the subglacial surface;

dome-shape kame - the kame with steep slopes and a convex top;

englacial (intraglacial) kame - the kame formed in the crevasses and depressions of a stagnant glacier;

esker-kame - the intermediate form between an esker and a kame;

esker-kame (kame-esker) relief - the type of accumulative relief of eskers and kames, the second part of the term indicates what kind of relief forms are prevailing;

fluvioglacial kame - the kame with predominantly fluvioglacial deposits;

frontal kame - the kame formed within the marginal belt of the glacier with the same orientation; in some places the frontal kame presents itself as a substitute of the end moraines;

interblock kame - the kame formed between dead ice blocks;

intraglacial kame - englacial kame;

inversional kame - consists of deposits accumulated on or inside a glacier and projected to the subglacial surface after the ice had melted out;

kame - accumulative form (hill, mound, knob, hillock, irregular ridge) of fluvioglacial or limnoglacial origin formed in a depression, crevasse or cavity of dead or passive ice;

kame complex, complex of kames - an association of kames of a common genesis;

kame delta - an inappropriate term; it is more correct to use "fluvioglacial delta";

kame-esker - an intermediate form between a kame and an esker, elongated kame or short esker, synonym of esker-kame;

kame field - an area occupied by kames;

kame hill - the kame with more or less rounded contour of the foot line;

kame massif - a group of closely associated kames on the common cocle (base);

kame moraine (redundant term);

kame plateau - an elevated area of the kame relief with slight ruggedness;

kame plain, plain of kames - a wide area of the distribution of kames which is not elevated upon the surrounding area (not a recommendable term);

kame terrace - accumulative terrace with hollows and a flat or undulating surface which has formed between the slopes of ice;

kamoid - a kame-like form with evidences of glaciodislocations; it must be included to the group of the push--forms;

lateral kame - the kame formed in front of the lateral side of the glacial lobe (tongue); the term is not recommendable;

limnoglacial kame - the kame in which the limnoglacial deposits are prevailing;

marginal kame field, marginal field of kames - the kame field which is situated more or less parallel to the ice margin, individual ridge-like kames can be also marginal ones;

mixed kame (not a recommendable term for the kame of complicated structure);

morainic kame - (the term is not recommendable, a redundant synonym of the till-covered kame);

outwash kame, kame-like outwash (cone) - (redundant term);

plateau-like kame - a form of considerable size with flat or slightly undulating surface and steep slopes; occupies a smaller area than the kame plateau;

proglacial kame - the kame formed in front of glacier terminus (not recommendable);

radial kame field - the kame field situated parallel to the movement of the glacier, a single kame ridge or an elongated kame may be radial, too;

relief of kames, kame relief - a relief type where kames are prevailing;

ridge-like kame - the kame of an elongated form with the length many times bigger than the width (the term is not recommendable);

small kame hillock - a hill with a convex top;

subaeral kame - the kame formed in open crevasses and holes;

subglacial kame - the kame formed under the glacier in contact with the bedrock;

superposed kame - the kame which has superposed on the relief form of different genesis;

supraglacial kame - the kame formed in the crevasses and holes on the surface of the glacier and projected to the subglacial surface after the glacier has melted out;

zvonets - the plateau-like limnoglacial kame of an iceshed region with a till cocle; a number of geologists do not consider the "zvonets" to be a kame. Named after a village in Novgorod Province;

tillcovered kame - the kame with the till cover;

The classification presented here does not include all the varieties of kames but in our opinion it is sufficient for mapping and conducting other kinds of research.

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A COMPUTER SIMULATION MODEL FOR TERRITORIAL SYSTEMS OF INTENSIVE AGRICULTURE

J. Roosaare

Today when nature management is becoming increasingly intensive and all-sided, attention is being focussed in landscape ecology on research into such anthropogenic landscapes as systems where besides traditional physico-geographical objects or phenomena also machinery or technology are represented among the system's elements, interelement connections or the connections between the system and its environment. Such systems are called geo-technological systems.[I]

Modern polders as well as other land reclamation objects with the twoside regulation of the water regime are of interest here as geo-technological systems existing already in reality and largely managed by man,as man-made landscapes within which territorial differences in functioning become evident (on local scale). Owing to their various properties it is namely the geo-technological systems of intensive agriculture that are suitable as agroecological test areas (Роосааре, 1981). Besides, their manageability enables us to stage active experiments in nature that are otherwise rather limited (see e.g., Makkink, Heemst, 1975).

Computer simulation seems to become a major experimentation technique in physical geography, allowing the researcher to use numerous and rather heterogeneous initial data and carry out numerical experiments. The latter proceed

[I] The present paper proceeds from the concept treating geographical landscapes as an hierarchy of certain taxonomic units (see Neef, 1967; Schmithüsen, 1976), in so doing the geosystems of the topological scale are observed (see Symposium..., 1972).

at a considerably higher rate than tests in nature and they do not have any negative effect on the object studied. While noteworthy experience has been accumulated in the field of the modelling of separate components and ecosystems, the number of models describing the geosystems as a whole is still negligible. As a rule, they do not take into consideration that a geosystem is territorially divided into subsystems (possessing a territorial structure) and the connections vital for the functioning of the geosystems (their functional structure) change in time. Several abstract models of "geosystems in general" are too generalized and cannot be tested with experimental data.

Proceeding from the above-said and considering that in the modelling of a geo-technological system of intensive agriculture it is the seasonal dynamics that is of greatest interest, the author set the task of constructing a determined simulation model of a geo-technological system of intensive agriculture. The model is based on a polder with an area of 450 ha (part of the polder of Tamme in Central Estonia, whose receiving water is Lake Võrtsjärv).

The paper describes the first version of the computer simulation system POLDER developed in 1979-1982. The determination of the parameters of separate model blocks, tests of the system and computer experiments are not discussed.

1. General principles of constructing a computer simulation model considering the territorial structure of a geosystem

The reality is too complex to be modelled directly, therefore, we have to separate the direct research object (the system to be studied) from the infinitely complicated universe, define its boundaries and connections with the environment, in order to determine simultaneously also the factors affecting the system (the system's direct environment). In this way also the geo-technological system of a polder is defined.

Next, the geo-technological system is to be structured: the system's elements and their interconnections are to be determined. For a geographer this usually means the determination of the territorial, vertical (component) and functional structures.

In connection with the introduction of the systems theory and remote sensing into geography the development of the theory of spatial and temporal interpolation and extrapolation is becoming one of the major tasks facing geographers. This task is evidently a part of the pattern recognition problem - one of the key problems of the modern science. Our knowledge of the regularities governing the distribution of the phenomena and objects in geographical space is still rather vague. However, we do know that this distribution is neither random nor even. At the time being territorially continuous models of the dynamics of the geosystems are beyond our powers. Therefore, a number of postulates are to be used in differentiating typological areas within a territory (Poocaspe, 1982).

The differentiation of the territorial structure of the given polder consisted in its partitioning into homogeneous territorial elementary cells proceeding from the following characteristics: 1) location with respect to the water regime (eluvial, transitional - on slopes - and superaqueous parts were distinguished); 2) hydrophysical properties of soil (on the basis of soil texture or peat stage seven typological units were discriminated); 3) amelioration (5 groups were distinguished on the basis of the existence of drainage or irrigation and their types); 4) land use (field - as the unit of land inventory - serves as the main unit of its territorial location). Since the time intervals characterizing changes in agricultural land use may be less than a year, the territorial structure of geo-technological system studied changes in time. Thus, a cell is a part of a field having to a certain extent similar water regime, soil type and level of amelioration (altogether 44 cells were distinguished on the area studied, which can be grouped into 16 types).

Such territorial differentiation is based on overlaying one "computer map" on another, it can be easily automated (Computer..., 1976), and if the cartographic information is recorded in a machine-readable form (or in geographic information systems), it enables to apply simulation models for different territories.

Traditional geography treats the functioning of a territorially homogeneous geosystem as an interaction of its components (i.e. the atmosphere, vegetation, soil, etc.). However, such an approach is unconstructive for modelling purposes. Better results may be gained by differentiating geohorizons and geomasses (Beručašvili, 1977). This approach permits to go over a discrete observation of the territorial and temporal structures (the so-called stecks or twenty-four-hour' states).

On the polder the following horizons could be distinguished (using the available information): (1) the surface air; (2) grass layer; (3) snow cover; (4) ice crust on soil; (5) frozen layer of soil; (6) humus, (7) eluvial and (8) illuvial horizons of soil (in some cells the last three may be grouped into upper and lower subhorizons on the basis of soil texture). Only a few geohorizons are stable in time. The appearance and disappearance of the others depends on environmental conditions (on hydrometeorological conditions and anthropogenic factors). The territorial elementary cells belonging to the same type consist of stable geohorizons of the same type.

Each geohorizon is a subsystem of a territorial cell (with discrete boundaries), characterized by thickness and the number and composition of geomasses involved. At that it is not merely the masses in their physical meaning that determine the state and functioning of a geohorizon but rather the interrelated parameters characterizing the respective masses. All these relations together form the functional structure of a geo-technological system, discussed in the next chapter.

While the functional and the territorial structure are relatively well known and can be quite sensibly and essentially partitioned, temporal structures of geo-technological systems have been inadequately studied so far. In our models they are more like variables sought for, and temporal partitioning is carried out more or less formally (our model was run at one-day calculation intervals over a one-year period).

The following principle underlies the uniting of the separate aspects of the structure and the modelling of its dynamics: if at a time t the territorial structure, environmental effect on the geo-technological system (input) and the values of its parameters are known, the functional structure of each cell can be found; this enables to determine the territorial and vertical structure of the system and the values of its parameters at the time $t+\Delta t$. The processes under way at the time Δt alter the parameters of territorial cells. Therefore, both the territorial and functional structure of the geo-technological system change in time: some processes bring about a temporal disappearance of intercell boundaries, others bring forth new boundaries.

Reiteration of the above-described procedures allows us to approximately describe the dynamics, and the observation of numerous cells enables to model territorially rather extensive systems. Such an approach is not far from J. Forrester's (1968) system dynamics (Goodman, 1974) where the structure of a complicated system is presented as a system of "reservoirs" through each of which a certain liquid runs. In our case the geohorizons serve as reservoirs from which different "sets" are formed for different homogeneous cells of the system by determining the functional structures of the geohorizons.

The functioning of such a system consists in the variation of its state variables (which together determine the system's state) as a result of the interaction of the system's environment and the system's interelement linkages. This is most often describable by ordinary differential equations which relate certain variation rates of state variables with input variables, other state variables and auxiliary variables (McClamroch, 1980). This way has been followed, e.g., by T. G. Gilmanov (Гильманов, 1978).

In practice mostly numerical integration based on the difference method is used to solve large systems of differential equations. However, in case of systems with complicated and changing structures considerable purely mathematical and programming (specifically debugging) difficulties crop up in solving such equations. For this reason the following simplification was made: the dynamics in time is treated as the alternation of discrete states and it is represented by a piecewise linear trajectory. At any time interval Δt the system is considered to be linear and consisting of a chain of processes where the results (output) of one process affect the initial conditions (input) of another process.

A differential equation describes a discrete variation of the function in case of discrete arguments; and indeed, the input variables serving as the arguments of the given system are discrete.

Note that linearity is not a property inherent in a system, but in fact it depends on the way a system is described (Director, Rohrer, 1972).

Now two conclusions can be drawn. First, we have a linear system at any time interval, therefore, we can enjoy all advantages of linearity, above all simplicity of solution. Secondly, the original system itself need not be linear at every time interval: the scope of the simplification depends on the duration of the time step Δt.

The system's state variables are characterized by a definite feasible region of variation, a kind of capacity, allowing us to treat them as abstract "reservoirs" (each of which is connected with the material flow of a certain definite kind). For example, the volume of water on soil surface cannot be negative. Part of the processes proceed in a strictly fixed succession, forming the so-called cascade subsystems (Chlorley, Kennedy, 1971).

As an additional condition, the priority of reservoirs was introduced into the model for the cases when the "needs" (demand) of several mutually independent reservoirs exceeded the available resources. When the demands of the reservoirs were interrelated, the iteration method was used to assess them. As all the wanted quantities were given explicitly in the model, there was no need in the model's algorithm to solve the equation system at every time interval Δt.

The necessary equations and parameters were chosen on the basis of the algorithm itself in accordance with the changes in the model's structure. The modelling of the temporal dynamics in space was carried out cell-by-cell at every time interval Δt proceeding from the fixed order of the cells (to consider intercell relations).

2. The functional structure of an elementary territorial cell

The processes characterizing geosystems (like, e.g., evaporation, infiltration, the growth of the plants' dry mass, snowmelt, surface and drainage runoff, etc.) are studied separately by the respective subfields of geography and neighbouring disciplines of natural sciences whence methods, equations and techniques of describing the functional structure can be taken over. In so doing the principal bottleneck is that the models applied in physics and chemistry are usually too complicated and exact for real geosystems.

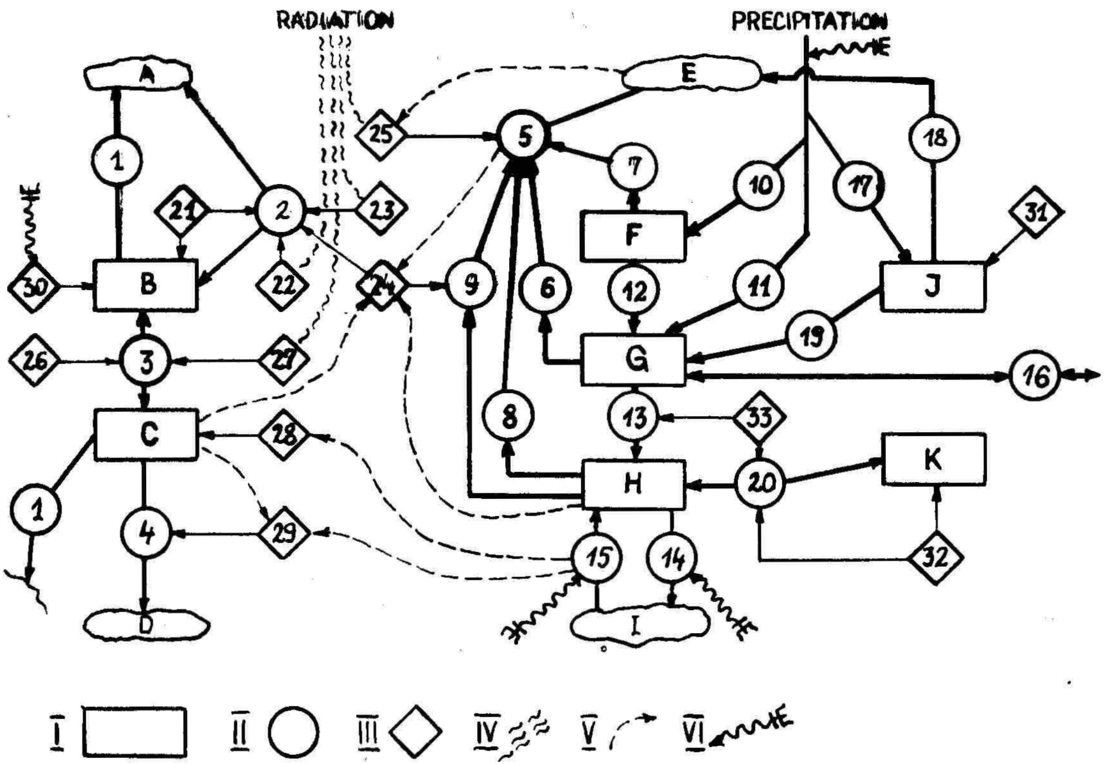
In case of a simulation model an important requirement is its harmonious character - i.e., the extent to which the blocks of the model (and the processes described) are aggregated must be the same for all of them. A comparative evaluation of the models of the plant production process has been carried out by J.Ross (Бихеле, Молдау, Росс, 1980). As the experience of simulation modelling shows, it is difficult to compile a simple and good model, and not infrequently an aggregated model is realized only on the basis of detailed models (e.g. Keulen, 1975; Рациональное..., 1981).

Geohorizons are characterized by a number of indicators. Proceeding from our goal, the indicators most important in case of intensive agriculture were emphasized.On their basis the functional structure characterizing the processes inherent in a homogeneous territorial cell was compiled. Fig.1 represents it in a simplified form.

Separate processes are related by balance equations based on conservation of matter and energy. Since the model is intended for assessing the effect of water as a limiting factor on agricultural crops under the conditions where the nutrient level is not "too low" (deWit, 1958), the water and biomass (carbon) circulation are connected by means of transpiration.

The following data (daily averages) based on observations were chosen as input variables: total incoming short--wave radiation; radiation balance of natural surface; air and soil surface (snow surface) temperatures; water vapour pressure in the air; precipitation intensity and type (snow or rain); wind velocity and direction; occurrence of dew; level of underground water; out of anthropogenic factors the land use (on the time scale modelled): what crops, where, when and at what density have been sown, harvested, mown; and sprinkling irrigation: where, when, and how much, were taken into account.

The success of the quantitative description of the



RADIATION
PRECIPITATION
A
B
C
D
E
F
G
H
I
J
K
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30 31 32 33
I
II
III
IV
V
VI

Fig. 1. Functional structure of an elementary territorial cell of a geo-technological system of intensive agriculture.

I Geomasses: A - CO_2 in the surface air; B - overground biomass; C - underground biomass; D - organic matter in soil; E - water vapour in the lowest atmospheric layer; F - water on the surface of plant cover; G - water on the ground; H - water in the soil; I - underground water; J - water in the form of snow; K - frozen water (ice) in the soil.

II Processes: 1 - respiration; 2 - photosynthesis; 3 - distribution and redistribution of assimilates; 4 - root death; 5 - evapotranspiration; 6 - evaporation on soil surface; 7 - evaporation of intercepted water; 8 - soil evaporation; 9 - transpiration; 10 - interception of precipitation; 11 - precipitation into ground; 12 - water percolation into ground; 13 - infiltration; 14 - underground runoff; 15 - capillary rise; 16 - surface runoff-inflow; 17 - snowfall or rain into snow; 18 evaporation from snow surface; 19 - runoff of snow thawing water; 20 - variation in the water content of the frozen soil layer (and, as result, variation of thermophysical properties of soil).

III Conditions determining the processes: 21 - architecture of the plant photosynthesis cover; 22 - leaf temperature; 23 - the intensity of PhAR; 24 - water regime (on the basis of relative and potential transpiration and soil moisture content; 25 - free water evaporation; 26 - conditions connected with the ontogenetic development and leaf-to-root mass ratio; 27 - soil temperature; 28 - conditions determining the root distribution pattern; 29 - root oxygen supply; conditions determining the existence: 30 - of plant cover; 31 - of snow cover; 32 - of the frozen ground; 33 - variation of the soil filtration coefficient.

IV Energy.

V Major information relations.

VI Human effects.

model without data information collected during long-term stationary observations depends to a large extent on the proper choice of mathematical models describing individual processes. Above all, we should try to use the minimum of such parameters which can be determined only in the course of numerical experiments. As a result of such "patching up", the mathematical description of the system studied becomes awkward and requires a lot of logical conditions. However, when a computer is used this is not a very serious drawback - as algorithmic models in some high-level programming language (the author used FORTRAN) or simulation language (DYNAMO, SIMULA, et al.) such structures are quite satisfactorily describable.

Owing to the limited space of the present paper, only a brief description of the model compiled is given. It is presented by functional blocks formulated as modules of the programme package.

The block of the snow cover dynamics finds the thickness and density of the snow cover taking into consideration its increase, tightening, melting, freezing of half-thawed snow (Кузьмин, 1957; 1961) and evaporation from snow surface; determines the runoff of thawing water from snow and the isolating effect of the snow cover on the soil temperature (Кузьмин, 1957). A special subroutine simulates snowstorm, carrying out a territorial redistribution of solid precipitation. In the block of the soil freezing and thawing the upper thawy layer (transitory layer), the lower thawy (unfreezable) layer, lower (ground) and upper (in case of two layers) frozen layers were distinguished. The main freezing equation is obtained by an approximate solution of Stefan's problem applying Leibenzon's method (Основы мерзлотного..., 1974), and is the essence of the subroutine. Freezing (thawing) is calculated by averaged parameters for the whole time period, though they vary at every time interval. The block of the components of evapotranspiration determines free water evaporation rate with the help of Penman's equation; the assessment of potential transpiration is based on publications by P. E. Rijtema (1965; 1968).

The plant production block as the central one in our model is discussed in a greater detail. Out of the seven land use types we selected three: spring grain crops (barley *Otra*), perennial grass (timothy grass - *Phleum pratense*) and intertilled crops (potato Sulev). Accordingly, the plant block comprises in addition to the common part three sub-blocks.

The barley subblock is based on O. D. Sirotenko and A. S. Prosvirkina's model (Сиротенко, Просвиркина, 1979) with the following changes introduced. In determining the potential production, stomatal resistance is considered to be constant. The equations approximating the redistribution of old assimilates are modified with a consideration of the observation data of H. Mägi and J. Ross (Мяги, Росс, 1969).

A common part of the potato and perennial grass subblock is the leaf gross photosyntesis subroutine (based on Keulen, 1975). Respiration is fixed according to McCree. In the model only the leaves are considered to be involved in photosynthesis. Their surface area is found using the coefficients of leaf surface density (assessed experimentally by the author) and leaf dry mass. The balance equations describing growth are based on Ross' equations, the empirical growth functions are fixed for new assimilates according to H. Tooming (Программирование..., 1978), and for old ones according to A. N. Polevoi (Полевой, 1979). The modelling starts from the emergence of shoots (with the prescribed, bigger than zero biomass of the leaves, stems and roots). The effect of the parent tuber is considered in the form of the efficiency of photosynthesis. The end of the photosynthesizing activity of the leaves and the wilting of the tops are considered discretely at a given run on the basis of the prescribed dates.

A special characteristic of the perennial grass subblock is the abrupt variation of the efficiency of photosynthesis as a result of periodical mowing. The assumption of timely mowing allowed us to confine ourselves to the modelling of the vegetative growth. The whole overground biomass was observed in an integral way; the underground biomass was considered to be stationary over years. Two periods of growth were distinguished. The initial period is characterized by the redistribution of old assimilates (stored in roots) in proportion with the soil temperature. In the second period, starting when the plant cover reaches a certain leaf area index (LAI), no redistribution of the assimilates is observed, and the distribution of the new assimilates is described with the equations: GAR = CGAR + 1 - BMR/BMRO; GAS = MAX (0; 1 - GAR), where GAR and GAS are the empirical growth functions of the underground and overground biomass, respectively; BMRO is the initial (of the beginning of the vegetation period of the given year) biomass of the roots. The transition coefficients of the biomass and LAI as well as the indices of the intensity of photosynthesis were assessed using the data of H. Mäetalu and P. Karing (1979).

The decrease in photosynthesis as a result of changes in water regime was considered to be proportional to the decrease in relative transpiration (fixed in the root block) for all crops. The ontogenetic development of all crops was described proceeding from the so-called cumulative active temperatures (threshold value +5°C).

The root block determines the vertical distribution of the root mass in soil (at a 10 cm step), taking into account the crop, root mass and groundwater level; finds the relative transpiration (according to Denmead, Shaw, 1962) and "realizes" the actual transpiration by soil layers (water consumption in proportion to the root mass). The surface runoff block based on G.I.Shveb's works (1974) is relatively simple. The block takes into consideration the variation of ground surface roughness factor in time. The block of the dynamics of soil water content is compiled in a simplified way. In the block soil moisture is treated as consisting of several kinds of soil water (with the boundaries of maximal soil water content, field capacity and permanent wilting percentage). The block is based on the balance equations between the different kinds of soil water and soil horizons. The parameters of the equations and the hydrophysical constants of the soils are determined by the environment block based on Kitse, 1978; Мичурин, 1975; Томберг, 1972) on the basis of the experimentally assessed volume weights and surface areas of the soils of the polder. The drainage flow block makes use of computation schemes which take into account typical hydrogeological situations (Муращко, Сапожников, 1978).

3. The simulation system POLDER

The logical structure of the simulation system POLDER is given in Fig. 2 in the form of a flow-chart. The integrity

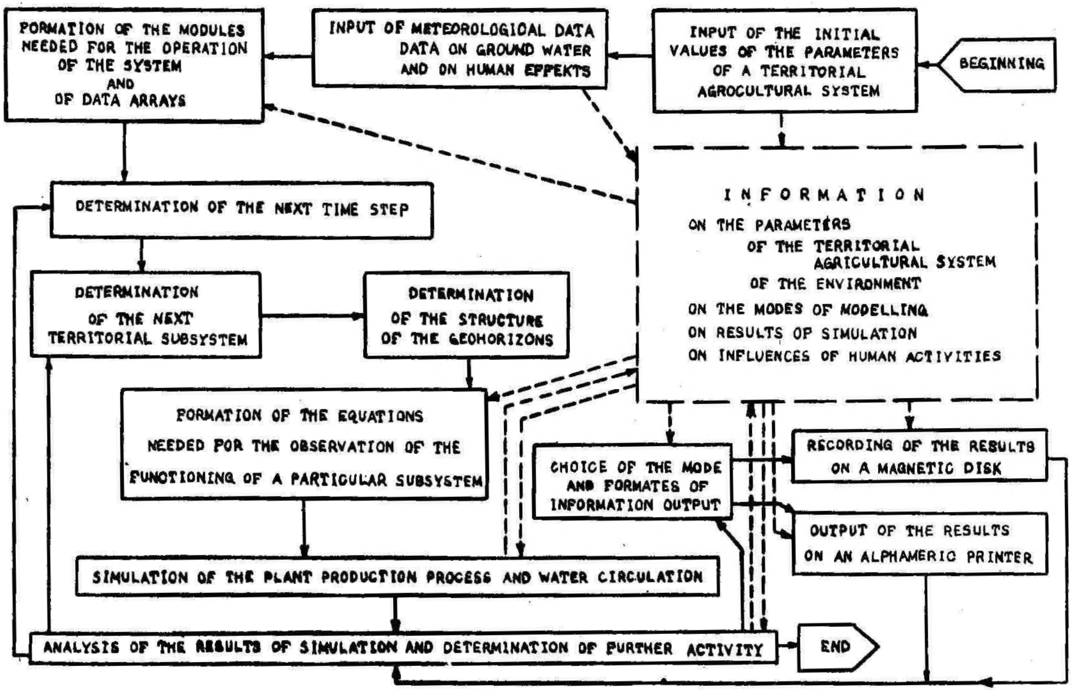


Fig. 2. Logical structure of the functioning of the simulation system POLDER. Dashed lines denote exchange of information.

of the simulation system and the co-ordinated operation of the above-described (functional) blocks and the other (technical) blocks (e.g., the interpolation of tabulated functions, the coding and decoding of typological information, the transformation of actual soil profiles into the standard form of the model, etc.) is secured by <u>the control block</u>. The tasks of this block consist in 1) determining when, where and to which block control is to be transferred in the course of the simulation process; e.g., to call the block of soil freezing and thawing, the soil surface temperature should be negative, or the thickness of any frozen layer should be positive; the existence of free water on the soil surface calls the surface runoff block only in slope cells; 2) controlling information exchange(input-output operations) on the level of application programmes; 3)finding the values of the parameters common for the whole model (e. g., the length of the daytime); 4) "materializing" human factors; 5) changing the territorial structure and typological information in connection with the emergence or destruction of various geohorizons; 6) enabling to change (with the help of additional inputs) certain parameters (e.g., the coefficient of the efficiency of photosynthesis) of the functional blocks.

Besides the above-mentioned programmes, the simulation system comprises also utility programmes: for recording input data on a magnetic disk; for recording simulation results on a magnetic disk in the form of an alphameric data matrix of the literals D x C (D denotes the number of days studied, and C that of the cells); and a programme printing the modelling results on the basis of the matrix for the days of interest for the researcher in the form of an alphameric computer map of the polder.

As the number of possible output and format instructions is large, the system's printing subrouting changes from one run of the model into another, and it is embedded together with the initial data from punch cards.

The described version of the simulation system is realized in the language of FORTRAN IV in an operating system OS (on a EC-1022 computer). It consists of 24 programme--modules and direct assess data sets on a magnetic disk. The computer's main memory capacity needed is (depending on the operation regime of the simulation system) 55-130 kbyte, the approximate operation time for simulating one year is one minute per cell.

The computer simulations were carried out in batch processing, choosing for every concrete computer run certain initial parameters and simulating (i) the variation of natural conditions (using the hydrometeorological data of a real year); (ii) different human effects (or those exercised at different times or with different intensities); (iii) changes in the properties of the geo-technological system; and (iv) the optimality of one or another structural part of the geo--technological system.

Considering the novelty of the given version of the simulation system, limited possibilities for working in interactive mode and inadequacy of empirical data, the task of compiling an optimization problem (optimal management of the polder) was not set, for this additional research is needed. Together with the creation of the primary data base and automation of computer experiments, optimization is a task to be fulfilled in the course of working out the next version of the simulation system.

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FORMATION OF LANDSCAPE UNITS
(EXEMPLIFIED BY THE NORTH-ESTONIAN COASTAL AREA)

E. Linkrus

Some theoretical considerations

As is well known, physical geography and landscape science distinguish between three separate levels - planetary, regional and local or topological (Сочава, 1974, etc.; Исаченко, 1982). According to several investigators the key unit linking the regional and local levels is the geographical landscape. As they say, proceeding from the top of the hierarchy the geographical landscape is the first geocomplex not lending itself either to zonal or azonal division, and at the same time being the last unit which in general outline reveals the structure of the whole region. The divisions of the level below the geographical landscape do not do this. Owing to the low degree of their individuality and autonomy they have been called intra-landscape or topological (local) units (Солнцев, 1949; Исаченко, 1961; and others).

Those authors who do not recognize the geographical landscape as a taxonomical unit in their hierarchic system usually treat the physico-geographical (landscape) district as the corresponding unit. At least in the case of low relief they are regarded as equal in rank. Without denying the possibility of a key unit, the present author has based her treatment on the concept of physico-geographical districts.

Another disputable question is the part played by the geologico-geomorphological factor in the formation of a geographical landscape (or a landscape district) and its subdivisions. Some authors clearly assert the importance of this factor, whereas others rather grudgingly recognize the leading role of landforms and deposits. They are against singling out any one of the components, landscape units being known to have a complex nature. There is no denying that all landscape units are complex in character, having arisen and developed and functioning as a result of the joint action of all their components. At the same time it is clear that the biotic components were preceded by the abiotic components (the geologico-geomorphological base, the surface and ground waters, the climatic processes, etc.). A. Isachenko conditionally calls them primary components (Исаченко, 1982). This evolutional succession is the reason why, at least during the initial period in the development of any region, the above-mentioned components (factors) played a decisive role.

Besides the climate the geologico-geomorphological factor is of particular significance. It is not in vain that the existance of a common geological (morphostructural) basis is stressed as the chief characteristic of a geographical landscape. This is the basis on which under similar climatic conditions and in case of similar development a certain complex of medium and small relief forms will come into being (Солнцев, 1949; Васильева, 1973). The alteration of differing landforms and groups of them gives rise to a number of ecologically different sites and habitats. They constitute the basis for the development of the spatial and functional structure characteristic of a definite geographical landscape (landscape district).

The following discussion will deal with some of the links between the geologico-geomorphological base, the development of a region, and the horizontal structure of the geographical landscapes in North Estonia. The treatment is based on the physico-geographical (landscape) regions that have already been distinguished earlier (Varep, 1964, etc.).

The main features of the paleogeographical development of the Estonian territory and its landscape regions

The chief differences in the landscapes of the Estonian SSR result from the peculiarities of the paleogeographical formation of its territory. Usually distinction is made between the Pre-Glacial, Glacial and Post-Glacial periods of development. The Pre-Glacial Period gave rise to the large forms of the ancient relief of Estonia - the uplands, plateaus, depressions, plains, vales and valleys. They have essentially influenced later geomorphological processes, forming the basis for the development of higher-ranking landscape units. During the Glacial Period the Estonian territory was covered by Continental Ice Sheets several times. The present appearance of the landscapes of the republic, however, has been immediately influenced only by the most recent one, the Valdai Glaciation. The retreat of the Continental Ice Sheet from the territory of Estonia started about 13,000 years ago. The age of the North-Estonian marginal formations dating from the Pandivere and Palivere stages is considered to be 12,050 and 11,200 years respectively (Раукас, Ряхни, Мийдел, 1971). It was approximately 11,000 years ago that the Estonian territory was completely freed from the Continental Ice Sheet. But after its reatreat extensive areas remained submerged by glacial lakes and later by the gradually receding waters of the Baltic Sea.

The paleogeographical processes of the Post-Glacial Period changed the relief, but did not destroy it altogether. The pre-glacial relief and formations created by the Continental Ice Sheet have played an important part in the shaping of the present geocomplexes also in the areas submerged during the Late-Glacial Period and the Holocene. In comparison with the higher regions of the republic, which were not flooded after the retreat of the Continental Ice Sheet, the differences in the formerly submerged area are still so conspicuous that on this basis the Estonian territory has been divided into two large parts - Upper Estonia and Lower Estonia, or in other words, the superaquatic area and the subaquatic area. The first to introduce these divisions was A.Tammekann in the third decade of the present century (Tammekann, 1929). These regions have been fully recognized and applied by representatives of many specialities.

Upper Estonia is made up of two subregions - South Estonia and the Estonian Watershed. Lower Estonia includes four landscape subregions: North Estonia, West Estonia, the Depression of Lake Peipsi-Pihkva, and the Depression of Lake Võrtsjärv (Varep, 1964, etc.). The North-Estonian Coastal Plain, a landscape district which will be dealt with in greater detail below, forms part of North Estonia (Fig. 1).

Most of North Estonia is made up by the North-Estonian Limestone Plateau. This large form of the bedrock relief has come into being in the area where Ordovician and Silurian limestones and dolomites occur, which were much more resistant to denudation than the northern zone. In the north the plateau terminates in an escarpment known as the North-Estonian (Baltic) Glint (Tammekann, 1940).

The North-Estonian Limestone Plateau as a geological form includes several landscape districts distinguished on the basis of the uplands and depressions of its surface relief. The North-Estonian landscape subregion consists of the North-Estonian Limestone Plateau, the Kõrvemaa Area, the North-East-Estonian Limestone Plateau and the Alutaguse Landscape District. The North-Estonian and North-East-Estonian plateaus are typologically similar units and, therefore, they have sometimes been treated as one district. The main characteristic feature of both districts is the occurrence of a limestone bedrock near the surface, which gives rise to several peculiarities of the landscape.

The two plateaus form separate units only because they are split apart by the Kõrvemaa Landscape District, which like a wedge between them reaches up to the Coastal Plain in the north (Fig. 2). The Kõrvemaa Area as well as the Alutaguse District have been formed above flat depressions in the bedrock. The bedrock lies comparatively deep down there. The prevalent geocomplexes have been formed on fluvioglacial and limnoglacial deposits, mainly sands. There are also numerous peatlands in these places. A large part of the districts has remained under forests, bogs and swamps to this day.

The "roots" of the landscape districts, as we have seen, go back to rather distant past, depending on definite parts of the large forms of the bedrock relief and the geomorphological complexes formed later upon them. There is no doubt about the existence of those connections, which in some localities appear more clearly, while in others they are somewhat less easy to distinguish.

A particularly eloquent example is the landscape district of the North-Estonian Coastal Plain situated between the North-Estonian Glint and the sea, along the southern edge of the pre-glacial denudation depression in the area of the Gulf of Finland. The bedrock here is chiefly made up of Vendian and Cambrian sandstones, siltstones, and clays (Fig. 2 and 3). The aim of this article is to offer a more detailed description of this narrow territory. It will be discussed as a kind of example, with special attention paid to the relatively wide central part of the Coastal Plain, which is bordered by the Kõrvemaa Area and two landscape districts of the Limestone Plateau in the south (Fig. 2).

The landscape structure of the North-Estonian Coastal Plain and its origin

The breadth of the Coastal Plain ranges from a few scores of metres to under twenty kilometres, including the peninsulas. The most indented and broadest section of the Coastal Plain is the one which falls within the boundaries of the Lahemaa National Park. To the west of Tallinn and in North-East Estonia the Limestone Plateau extends in places practically up to the seashore (Fig. 1). Another wider strip of the Coastal Plain appears on the banks of the River Narva, which actally is more closely related to the Lower Luga Landscape Area in the Region of Leningrad (Исаченко, Дашкевич, Карнаухова, 1965).

On the border of the districts of the Limestone Plateau and the Kõrvemaa Area the southern boundary of the Coastal Plain is very clearly distinguishable at the Glint headlands ending in steep scarps (Fig. 2). Between them, in the southern parts of the Glint bays, on the other hand, it is possible to distinguish the boundary between the adjoining districts only on the basis of indirect marks, such as the occasional outcrops of limestone in river valleys, the abundance of springs characteristic of the Glint line, etc.

The Glint bays, indenting the edge of the Limestone Plateau were originally mouths of primeval valleys (Tammekann, 1940). Later they were altered by the glacial and fluvioglacial processes and after that by the action of the sea. The edge of the Plateau is especially indented by Glint bays at Lahemaa.

Between the ancient depressions and valleys there are several elevations of the bedrock trending from the north-west to the south-east or from the north to the south, which are actually cut-off lobes. Such cut-off lobes mostly also constitute the nuclei of the peninsulas in this region. Such elevations are known to occur in the vicinity of Tallinn and in the Lahemaa National Park, which is particularly rich in peninsulas and bays.

The thickness of the Quaternary deposits in the Coastal

Fig. 1. The landscape regions of Estonia (according to E.Varep).

LOWER ESTONIA: I. North Estonia. 1. The North-Estonian Coastal Plain and the Islands of the Gulf of Finland. 2. The North-Estonian Limestone Plateau. 3. The Kõrvemaa Area. 4. The North-East-Estonian Limestone Plateau. 5. The District of Alutaguse. II. West Estonia. 6. Hiiumaa Island. 7. Saaremaa Island. 8. Ruhnu Island. 9. The West-Estonian Lowlands. 10. The Pärnu Lowlands. III(11). The Basin of Lake Võrtsjärv. IV(12). The Basin of Lake Peipsi.

UPPER ESTONIA: V. The Estonian Watershed. 13. The Pandivere Uplands. 14. The Türi Drumlin Area. 15. The Central Estonian Plain. 16. The Vooremaa Drumlin Area. VI. South Estonia. 17. The Sakala Uplands. 18. The South-East-Estonian Plain. 19. The Otepää Heights. 20. The Väike-Emajõgi Vale and the Valga Basin. 21. The Karula Hills. 22. The Hargla Basin and the Vale of Võru. 23. The Palumaa Area. 24. The Haanja Heights.

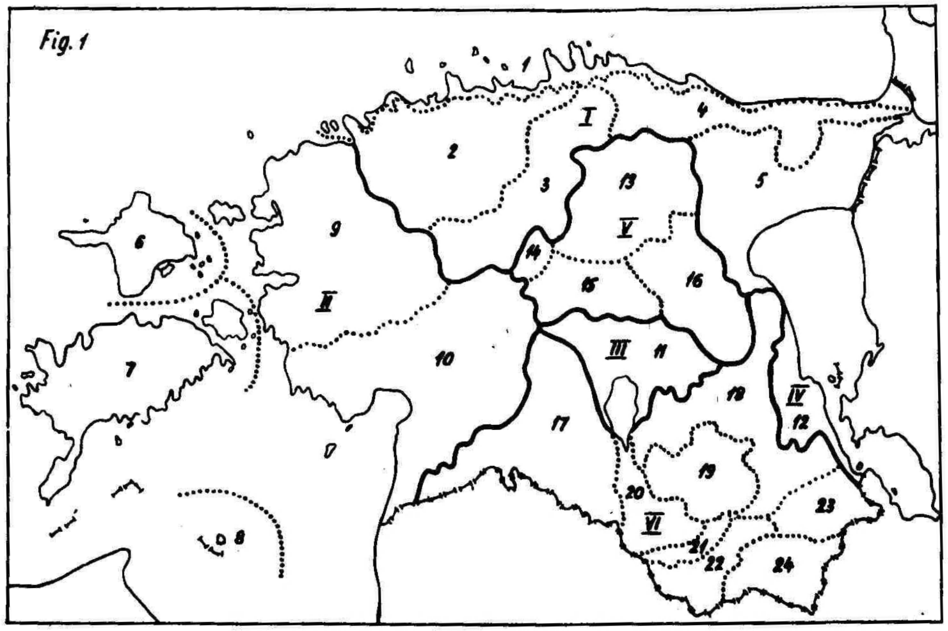

Fig. 2. Landscape districts of the central part of the coastal area of North Estonia.

1 - the North-Estonian Coastal Plain, 2 - the North-Estonian Limestone Plateau, 3 - the North-East-Estonian Limestone Plateau, 4 - the Kõrvemaa Area, 5 - the North-Estonian Glint forming a distinct demarcation line between separate landscape districts, 6 - the Glint line covered with surface layers forming a conditional boundary between landscape areas, 7 - other more significant scarps, 8 - the location of profiles (Figs. 3 and 4).

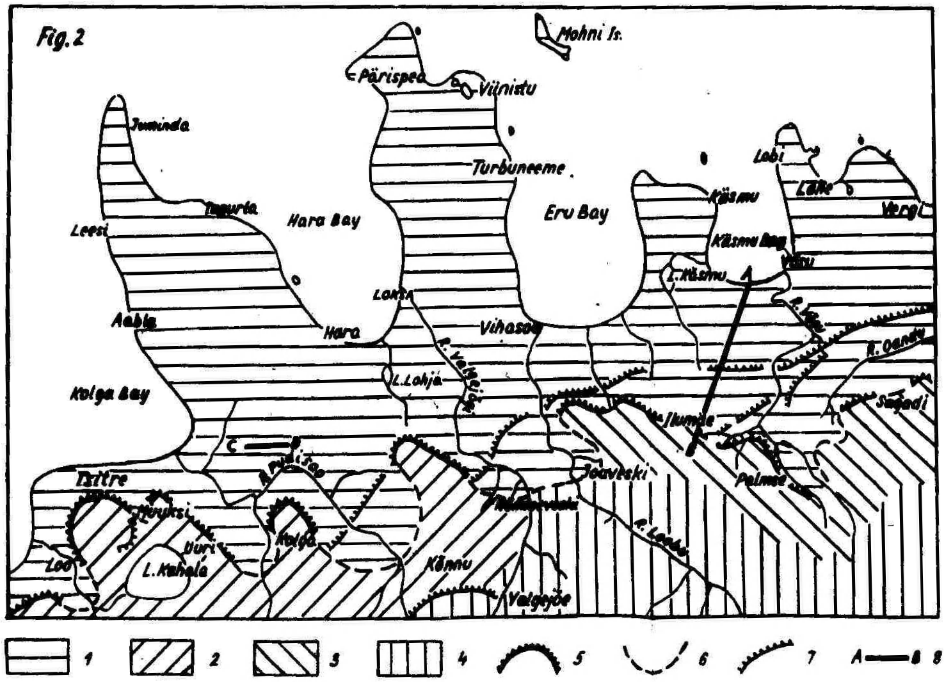

Fig. 3

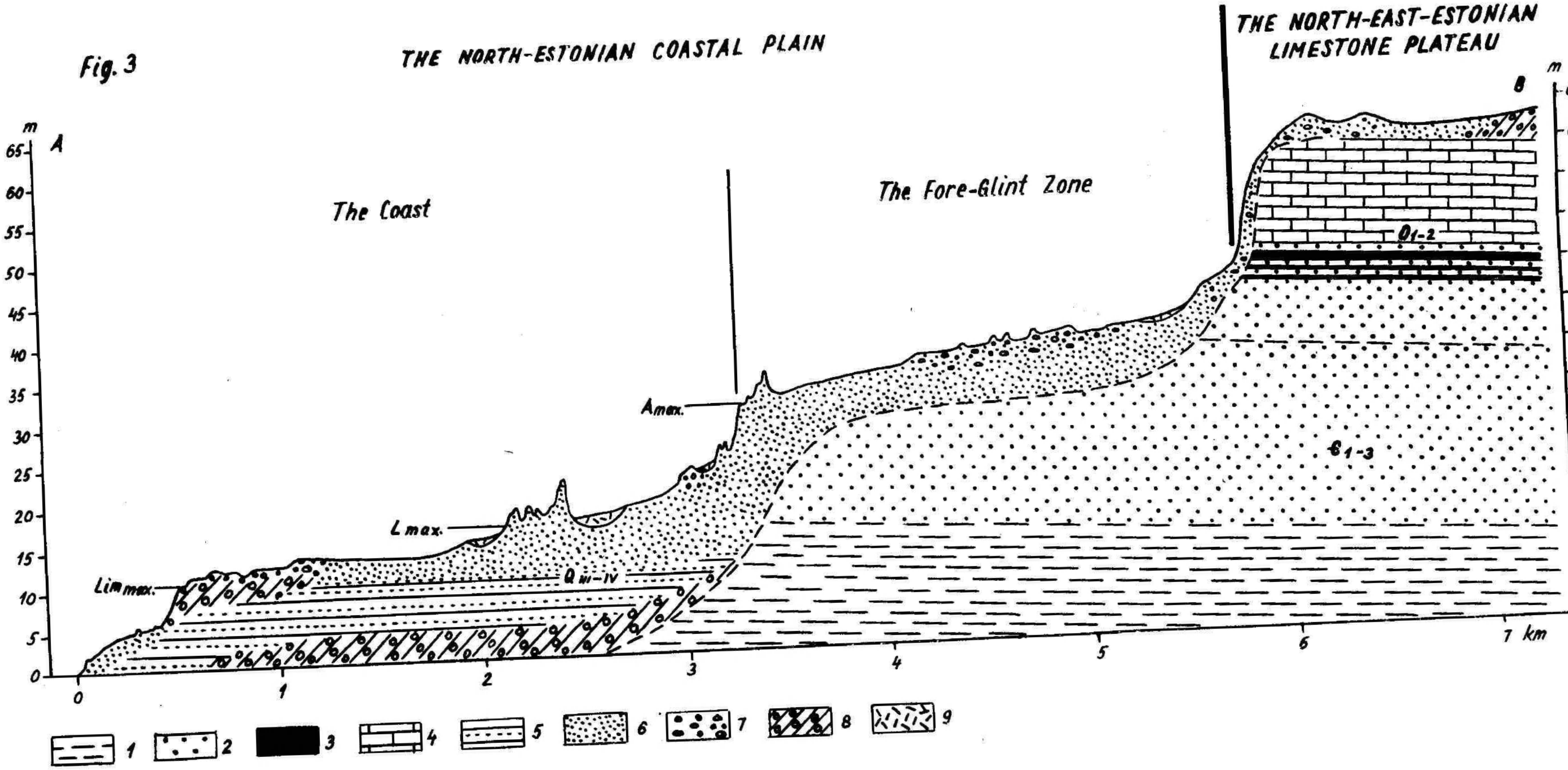
THE NORTH-ESTONIAN COASTAL PLAIN
THE NORTH-EAST-ESTONIAN LIMESTONE PLATEAU
The Coast
The Fore-Glint Zone
A
B
m
Amax.
Lmax.
Limmax.
Q III-IV
O 1-2
Є 1-3
km
1 2 3 4 5 6 7 8 9

Fig. 4

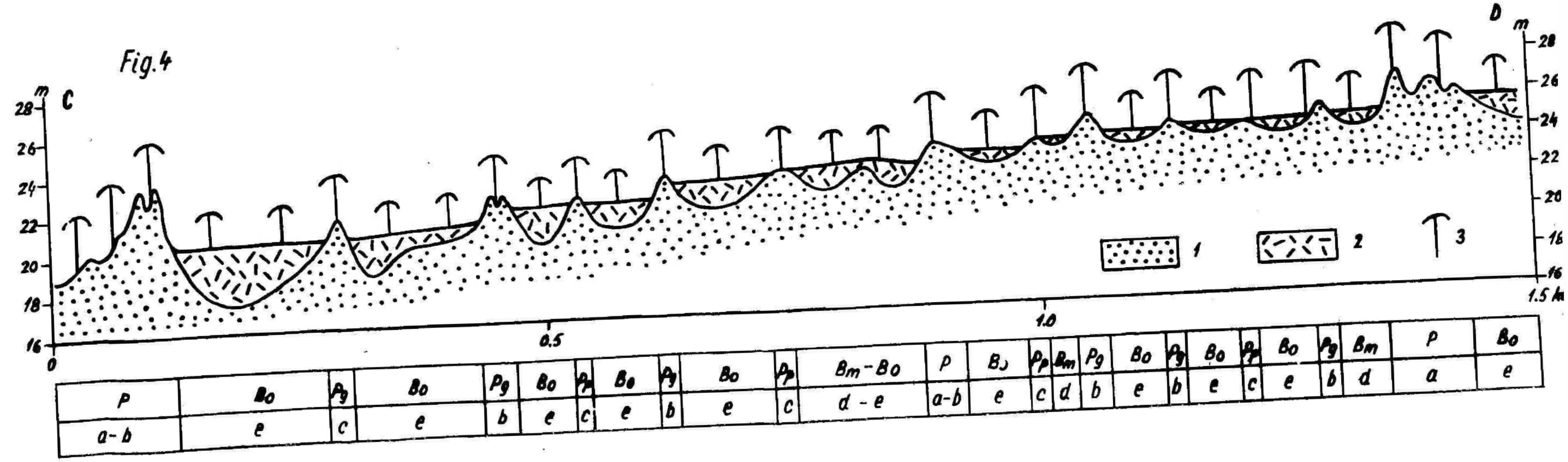
C
D
m
1.5 km
1 2 3
P Bo Pg Bo Pg Bo Pp Bo Pg Bo Pp Bm-Bo P Bo Pp Bm Pg Bo Pg Bo Pp Bo Pg Bm P Bo
a-b e c e b e c e b e c d-e a-b e c d b e b e c e b d a e

Fig. 3. The geologico-geomorphological base and large landscape units in the central part of the coastal area of North Estonia.

Paleozoic rocks and deposits: 1 - clay, 2 - sandstone (with interlayers of siltstone and clay), 3 - argellite (the *Dictyonema*-slate), 4 - limestone. Quaternary sediments: 5 - aleurite (partly of varved structure), 6 - sand, 7 - pebble-and-gravel material, 8 - till, 9 - peat. $A_{max.}$ - the maximum extent of Ancylus Lake, $L_{max.}$ - the maximum extent of the Littorina Sea, $Lim_{max.}$ - the maximum extent of the Limnea Sea.

Fig. 4. Small landscape units in the Coastal Zone.

Geocomplexes: 1 - marine and eolian accumulative forms predominantly composed of sand, under pine forests (site types and soils are given below); 2 - mesotrophic and oligotrophic bogs; 3 - pine stands.

Soils: P - podzols, Pg - gleyed podzols, Pp - gley- and peaty podzols, Bm - mesotrophic bog, Bo - oligotrophic bog.

Forest site types (according to E.Lõhmus, 1974): a - *Cladonia* site type, b - *Calluna* site type, c - *Vaccinium uliginosum* site type, d - mesotrophic bog site type, e - oligotrophic bog site type.

Plain is different. There are places where the bedrock reaches up to the very surface (in the environs of Tallinn, here and there in the Lahemaa National Park, in the vicinity of the town of Kunda, etc.). Elsewhere the Quaternary cover can be 20–40 metres thick, in ancient valleys over 100 metres, in the environs of Lake Harku approximately 140 metres (Тавет, Раукас, 1982). As to their origin, the Quaternary layers date back to the Upper Pleistocene and the Holocene. The essential genetic types in the Coastal Plain are the tills, which are very rich in erratic boulders, fluvioglacial and limnoglacial deposits (the latter occurring in the form of both sands and clays, including the typical varved clay), marine sands and gravels, and also eolian sands and peat.

The main features of the landscape structure of the Coastal Plain were already determined by its pre-glacial and glacial relief (the Glint bays and Glint headlands, the present-day peninsulas and bays, the bedrock terraces and the fluvioglacial deltas at the foot of the Glint, etc.). However, the indented character imparted by the abundance of small forms chiefly originates from the Post-Glacial Period. The most essential among them are the various coastal formations. They, in their turn, have influenced the formation of the river valleys and the development of peatlands. Especially continuous zones of coastal formations conspicuous by their size have come into being during the transgressive stages of the development of the Baltic Sea in the first phase of Ancylus Lake and during the initial period of the existence of the Littorina Sea, i.e. 8400–8200 years ago and 7000–5800 years ago, respectively (Кессел, Пуннинг, 1969). The heights of their feet differ in different parts of the Coastal Plain. In the central section of the northern coast the above-mentioned formations are 28–30 metres and 16–19 metres above sea level. Thus, the major part of the Coastal Plain has emerged from the sea in the course of the last 5000–6000 years. These figures show how young the geocomplexes found here nowadays actually are.

Already in some of her earlier papers (Linkrus, 1976) the present author has made distinction between two larger west-east-trended subdivisions of the Coastal Plain in the Lahemaa Area called the Coast and the Fore-Glint Terrace (in the narrower sense of these words, Fig. 3). Besides them the concepts "Coastal Landscape" and "Fore-Glint Landscape" have been used on the stipulation that "landscape" does not have any definite taxonomic meaning in the given context. The same divisions can be applied elsewhere, provided the Coastal Plain is relatively wide.

The Coast is the most indented part of the Coastal Plain and, owing to the peninsulas, bays and islands in the pre-shore sea, also the most characteristic area in the region. This zone stretches along the whole Coastal Plain and can be regarded as the main subdivision of the landscape district discussed. As a rule the height of the zone does not exceed 20-25 metres. Still, in exceptional cases it can extend over 30 metres (in the central and eastern parts of the Lahemaa Area). The greatest part of the zone is taken up by geocomplexes dating from the stages of the Littorina and Limnea seas.

The prevailing landforms in the area under consideration are of marine origin. But they are clearly linked with the original glacial relief. In several localities (in the environs of Tallinn, at Lahemaa, etc.) also the influence of pre-Quaternary forms is noticeable. In the case of accumulative coastal formations, which often occur in the lower parts of the original relief, the layer of marine sand and gravel is so thick that earlier deposits have been of no significance in the formation of the present-day landscape units. In abrasion areas and also in accumulation-abrasion areas, on the other hand, the character of the geocomplexes has been determined by more ancient deposits (till and varved clay, in places the Cambrian clay and sandstone). It is common for older deposits to be covered by a thin layer of marine sand and gravel.

The places where clay and till occur, and also the localities where they are covered with a thin layer of littoral sediments, are characterized by sod-podzolic gleyed soils and gley soils. In areas where the surface cover is made up of sand and gravel, podzols and sod-podzolic soils prevail, which, too, are often gleyed. As the coastal formations running parallel to the seashore have prevented the outflow of water, bogs and mires are numerous. In clayey areas the most common type is eutrophic mire occuring in isolated spots, on sandy soils mesotrophic peatlands and raised bogs prevail, which in many cases occur in the shape of peculiar strips between and behind the coastal forms(Fig.

4).

A large part of the Coast is under forest. The areas covered with fluvioglacial and marine sand and gravel are overgrown with dry pine forests; quite frequent are moory pine forests. In abrasion areas (covered with till and clay) the prevailing type is pine-spruce mixed forest. Spruce forests, which require better soils, are less abundant, but still relatively frequent compared to the part of the Coastal Plain at the very foot of the Glint. The main growth sites of the spruce are the northern parts of the peninsulas. In the vicinity of villages alder woods and young stands of mixed forest with birch, spruce, alder and aspen occur. In places also ash-trees and isolated oaks can be met. Here and there patches of coastal meadows are to be found. All the settlements have been concentrated on the seashore.

The northern parts of the peninsulas were still islands in the recent geological past. They were not joined to the mainland till the intermediate or even the last phases of the Limnea Sea, i.e. about 3000-2500 years ago. The most characteristic geocomplexes here are those formed on varved clay and till as well as their variants covered with a thin layer of marine deposits. Besides them there are also units formed in plains of marine sand, dune complexes above ancient shores, etc. Owing to the variety of the surface cover the geocomplexes in the northern parts of the peninsulas are rather complicated in structure.

In the southern part of the Coast, on the other hand, the mutual relation of the geocomplexes of the accumulation and abrasion areas is contrary to that in the northern parts of the peninsulas. Here the dominant landscape units are those formed on sandy marine accumulation plains. In comparison with the northern parts of the peninsulas dune complexes are more numerous; also peatlands account for a larger proportions of the area. The prevailing types are mesotrophic and oligotrophic bogs, which in many cases have been formed behind the coastal formations. They reveal very clearly the strip-like structural type caused by the coastal forms (Fig. 4).

<u>The Fore-Glint Zone</u> lies at the southern edge of the Coastal Plain (Fig. 3). To a large extent it remains within the Glint bays, but it also occurs as a terrace in front of the Glint, which follows a more or less straight line. The

papers dealing with the Lahemaa National Park refer to this zone as the Fore-Glint Terrace. This term is not quite exact, as actually there are more than one terrace. Therefore, it is more appropriate to speak of the Fore-Glint Zone. In comparison with the Coast the Fore-Glint Zone constitutes a less clear-cut entity. At the Glint headlands reaching far north the zone either breaks up or is reduced to a narrow strip at the foot of the Glint.

The most characteristic geocomplexes of the Fore-Glint Zone are those formed on fluvioglacial and limnoglacial sands. Because of them this zone has also been called the Landscape of the Fore-Glint Fluvioglacial Delta. Larger expanses of sand and gravel fields can be found in the environs of Tallinn and on the territory of the Lahemaa National Park. It is interesting to note that some of the fluvioglacial deltas on the Glint line or near it have been formed by streams flowing from the south. Quite definite proof of this has been found in the Lahemaa National Park. The sand fields in the Coastal Plain occur most often at a height of 40-50 metres above sea level. In places they are lower, but the lower levels have undergone essential alterations caused by later coastal processes (Linkrus, 1976). In the north these fluvio-limnoglacial plains often terminate in a scarp 10-20 metres high. The precence of a scarp very clearly indicates the boundary between the Coast and the Fore-Glint Zone. Some of the higher sand and gravel fields stretch from the Coastal Plain onto the Limestone Plateau, especially in the southern parts of the Glint bays. In such places there is no clearly discernible line of demarcation between the North-Estonian Coastal Plain and the landscape districts to the south of it. In places where no fluvioglacial deltas have been formed, the Glint bays have been filled with deposits of the more ancient stages of the Baltic Sea instead of the limnoglacial and fluvioglacial sands.

As the surface cover is prevalently made up of sands, podzols dominate in the Glint bays. Besides them there are also peaty podzols, peaty gley soils, bogs, etc. Almost the entire Fore-Glint Zone is overgrown with forests. The Glint bays with a sandy surface cover are characterized first and foremost by pine heaths (*Cladonia* and *Calluna* site types).

In many cases the rivers flowing along the Glint bays divide them into two or more parts. As a general rule the valleys are deep. In the fluvioglacial deltas the depth of the valleys reaches 20–30 metres, in places even a little more. The breadth of the valleys does not usually exceed a few hundred metres.

Another characteristic feature of the Fore-Glint Zone is the existence of landscape units formed on sandstone terraces. They often lie more or less at the same height as the fluvioglacial deltas. For example, an extensive sandstone terrace occurs north of the Limestone Glint following the line of the villages of Sagadi, Vihula and Karula (in the eastern part of the Lahemaa National Park). The breadth of the terrace is 1.5–2 kilometres, its height mostly 35–40 metres above sea level. The thickness of the Quaternary deposits, both here and in other analogous localities, is less than one metre, often only half a metre so that there is no doubt about the influence of sandstone on the formation of the geocomplexes. The sandstone terraces are mostly overgrown with pine forest; in many places it tends to become peaty. People call such forests "sandstone heaths". There are also young stands of alder and mixed forest, which have grown on the sites of former wooded meadows. In many places there is a strip of alder swamp forests and euthropic mires fed by springs at the foot of the Glint.

The lower levels of the Fore-Glint Zone are somewhat more complicated in structure than its higher ones. This results from the larger number of coastal forms occuring here.

Summary and conclusions

As we have seen, the landscapes of North Estonia, and especially of its coastal area, are rather varied, having been affected by numerous factors during the course of their development. In this region it is easy to follow the influence of the formations of earlier stages on the processes of the subsequent periods.

In broad outline, the main structural units of the territory discussed are the North-Estonian Limestone Plateau and the Coastal Plain. The latter, in its turn, is divided into zones and subzones (Fig. 3). The trend of units from north to south (from north-west to south-east) is followed by the Glint bays and Glint headlands, the river valleys and the present-day peninsulas and bays. Of course, a closer study of the natural complexes would prove them to be much more complicated than it appears at first sight, for the larger zonal divisions are in their turn subdivided into numerous units of a lower rank. Those, having been formed in conditions of gradual land uplift, in many cases occur as parallel or concentric strips.

The region under consideration fully proves the thesis about the decisive role of the geologico-geomorphological basis in the formation of the spatial structure of landscape units. The North-Estonian landscape districts, as well as many of their subdivisions, have been determined in broad outline by landforms which have taken shape during some earlier periods of development. This is a phenomenon in the case of which K. Gerenchuk (Геренчук, 1956) has applied the concept of relict structure. For that matter, the structure of landscape units, being determined by the geologico-geomorphological base, inevitably contains always certain relict features. This is particularly peculiar to newly-developed regions. In the course of development there is a tendency towards the disappearance of the relict features, but this process is usually rather slow.

We can also concede the fact that the larger and the higher in rank a unit is, the more ancient is the surface relief on the basis of which it has been formed. As we have seen, the North-Estonian landscape districts are linked through their base with such an ancient stage of development as the Pre-Glacial one. True, the "roots" of some of the smaller units also go back to that period, but this fact does not change the general development trends. The surface forms created by the Continental Ice Sheet have laid the basis for the formation of the characteristic features determining the broader divisions of the landscape districts. The Glacial relief in its turn influenced the course of the marine processes and has had an effect on the formation of the landscape units connected with the next stage of development. Hand in hand with the retreat of the sea waters valleys developed, dune complexes were formed, many lakes disappeared, and swamps and bogs came into being. The appearance of peatlands has had two contrary effects - on the one hand, it has added variety to the landscape, on the other hand, it has lessened it. This is easily noticeable in the case of the marine accumulation plains intersected by beach ridges (Fig. 4). The formation of strips of oligotrophic bog between the beach ridges during the first stage of the development of the plains makes the structure of the locality more complicated. Later on, however, the accumulation of peat first partially, and then completely, buries the ridges and, as a result, the geocomplex of the plain becomes less varied. Actually the second stage means the disappearance of the relict structure on the level of the small units.

Of course, the direction of natural processes can be drastically changed by man. North-Estonian landscapes, too, bear traces of prolonged human activity (Varep, 1972). They are particularly noticeable in the Plateau districts. In comparison with them the Coastal Plain and the Kõrvemaa area have been affected much less by human activities. Owing to their surface cover made up of sand and gravel, the numerous peatlands and stony areas, these districts have been rather unsuitable for agricultural exploitation. Thanks to those circumstances these parts of North Estonia have preserved up to now their original natural appearance to a fairly high degree. In recent times the values of this have been increasingly appreciated.

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SOCIOGEOGRAPHY AS A DISCIPLINE
AT TARTU STATE UNIVERSITY

T. Raitviir

Since the 1979/80 academic year the 5th-year students majoring in economic geography at Tartu State University have been read a course in sociogeography with the fundamentals of planning social development. It is a 60-period course (40 periods of lectures and 20 periods of seminar classes) meant for the 10th term.

I. Preconditions for arranging a course in sociogeography

The decisions of the 26th Congress of the CPSU provide for a rise in the quality of higher education. This calls for expanding the range of the training of geographers, to this end the speciality of economic geography should be replaced by that societal geography, comprising sociogeography.

To meet the needs of our country, research into sociological, psychological, cultural et al. spheres of the life of the society is required. Without discussing all the drawbacks of the curriculum and measures to overcome them, let us observe only those underlying the introduction of the course in sociogeography.

Soviet students specializing in economic geography do acquire profound knowledge of the social categories, theories and their practical application in improving territorial systems. But at the present time new disciplines of a social character, as sociogeography, social psychology and sociology, social management and social methods in geography should be included into the curriculum. All these disciplines would supplement the already established set of social (societal) sciences.

Social management might form a part of the course of sociogeography, or be incorporated into the highly needed course of the fundamentals of management. The fate of a course in social methods in geography might be the same. This course might exist as a separate part of sociogeography, though it would better form a part of the course in the methods of societal geography. [I]

Today the course of sociogeography offers the students concentrated data on the regularities and factors concerning the territorial organization of the phenomena connected with the spheres of services and recreation, too.

We try to compensate for the fact that sociogeography is not sufficiently backed by other social disciplines by discussing the principal terms and notions within sociogeography itself.

Because of the novelty of the sociological aspect in various societal sciences in general, and specifically in societal geography, there is so far no consensus in several theoretical questions. The volume of empirical socio-territorial research is small, and its results are scattered in numerous publications of various branches of social sciences. Territorial variability of some social phenomena and processes in general is investigated neither empirically nor theoretically.

Moreover, a course in sociogeography would expand the general mental outlook of the students of economic geography, being thus of considerable help in compiling course, diploma and competition theses in the field of societal geography. Therefore, a course in sociogeography is indispensable from the standpoint of creating an integral idea of the reality as well as fulfilling the social order for such knowledge.

2. The general principles of the course in sociogeography

[I] At present the future economic geographers are introduced to sociogeographical methods in a disconnected way. Such disciplines as economic cartography, methods of field investigations, statistics, mathematical methods in geography and methods of aerial and space research are taught.

The temporal as well as territorial scope of the course depends on the level of our knowledge and the availability of information on the objects involved, and likewise on the number of periods devoted to this course. Modern times are naturally of major interest, as far as possible (or necessary) data on the past and forecasts for the future are also dealt with.

The socio-geographical topics constituting the course are treated on different territorial-hierarchical levels: an administrative raion (a town), an oblast, a union republic, the USSR as a whole, and the foreign countries divided into two groups - socialist and capitalist. The main emphasis is laid on the information and materials of the Estonian SSR. Firstly, such an approach is easily understandable to our students. Secondly, in numerous empirical investigations belonging to various spheres of science, the territorial sampling techniques developed at the Chair of Economic Geography of Tartu State University are applied. Socio-geographical problems of consumption, services, some aspects of culture, rural and urban life as well as problems of the way of life have been studied rather thoroughly in the Estonian SSR.

Theory is of great importance in the course of sociogeography. Students are required to master the fundamentals of the general theory of sociogeography.

The course consists of eleven major subdivisions:

I. The objects, methods, structure and tasks of sociogeography.
2. The formation and development of Soviet and foreign sociogeography.
3. Human needs as the motive power of man and society.
4. Social policy and sociogeography.
5. The geography of the "man-environment" system.
6. The geography of behaviour, perception and estimates.
7. Sociogeographical variation of work, consumption and the spheres of services and culture.
8. The geography of the way of life.
9. The geography of welfare.
10. The planning of social development.
II. The forecasting of social phenomena.

The line of reasoning that led to the given structure of the course is the following. The needs of people and possibilities of meeting them depend on the society's development level, on the effect of the scientific and technological revolution, industrialization and urbanization processes, as well as on the properties of man (a group, a community) and those of the environment. Whether to consider some phenomenon or circumstance favourable or unfavourable in man's life is assessed in the course of comparing the reality with social as well as economic and demographic policy. The "man--environment" system has an effect on man's behaviour and consciousness, and, ultimately, on the way of life. Relying on the results of investigating the way of life, we can study consumption, welfare, social development and, infinitely, social and territorial management and forecasting.

3. The main theoretical and methodological principles of the programme

Social geography as a science can be understood in a wide as well as a narrow meaning. In its wide meaning social geography is the geography of society (societal geography). According to the systems approach suggested by U. Mereste (Мересте, 1982), societal geography is a science studying societal-geographical systems which comprise all societal (social) objects and their geographical interrelations. In the narrow sense social geography is sociogeography or sociological geography. It studies sociogeographical systems which comprise sociological objects and their geographical interrelations. Societal geography is formed in the course of efficient integration between the science of geography and various social sciences; sociogeography is formed as a result of efficient integration between geography and sociology.

In our course sociogeography as a study subject does not fully coincide with sociogeography as a science: the phenomena and interrelations treated within our course go beyond the boundaries of sociogeography as a science with psychological, cultural-geographical et al. problems discussed as well.

I. The methodology of sociogeography as well as that of other sciences can be classified proceeding from at least three aspects. Firstly, its classification may be accomplished on the basis of the level to which it is generalized and theoretical: laws and categories of philosophy, political economy, scientific communism and the general theory of sociogeography; methodological principles and approaches (systemic, comprehensive, etc. principles, functional and comparative approaches, etc.); methods (cartographic, statistical, mathematical, analysis of documentary information, observation, questionnaires, etc.); techniques (ways of mapping, mean values, indices, factor analysis, ways of compiling scales, questioning procedures, etc.). Secondly, stages of empirical research may serve as basis for a classification. Thirdly, socio-geographical methodology can be classified on the basis of interdisciplinary relations (historical approach, sociological approach, etc.).

The task of sociogeography consists in elucidating socio-territorial regularities. This is how sociogeography is connected with practice. One of the most important ways of introducing the results of sociogeography into practice is through research into territorial problems of socio-economic and, specifically, social development.

2. Geographers in the Soviet Union as well as in the West are paying increasingly more attention to social problems. However, the factors underlying the formation of sociogeography, and sometimes even the stages of its evolution differ in different countries. In Soviet Union an intensive development of sociogeography started in the early 1970s. Differences are also observed between individual trends of sociogeography in the capitalist countries and the Soviet Union.

3. A critical analysis of the types of human needs allows us to distinguish the following hierarchy: level I - physical (the lowest) needs; level 2 - the same physical needs, but already affected by social relations connected with the quality, fashion, etc.; level 3 - social needs, among them needs of contacts as well as socio-economic and socio-political needs; levels 4 and 5 - intellectual needs (of passive and active character, respectively). Ways of measuring human needs are studied. From the standpoint of sociogeography, difficulties arise in connection with matching individual needs with public ones in a given region. Sometimes they coincide, though they may be even contradictory or conflicting. Regional differences between human needs are quite considerable.

4. Social policy provides standards for estimating real

social life. These standards determine what is to be considered favourable and what unfavourable in social life, and what goals to pursue in the future. The subject of social policy is the state, management bodies and public organizations, its object is the population, its groups and every human being. Part of the social policy in our country is general (fixed e. g., in the Constitution of the USSR), while another part is differentiated by demographic groups (children, senior citizens) and by spheres of public activities (work, social insurance, etc.). The object of social policy seems to be regionally differentiated to a considerably stronger degree than social policy itself. Social policy is closely connected with the planning of social development.

5. A lot of attention is paid to the system of man and environment[I] (man - environment, a group - the environment of the group, the population of the country - the environment of the population of the country). The system itself as well as both of its components is of a hierarchic character, and they are to be studied on all the hierarchy levels of the society. The two components as well as the whole system are characterized by various properties: demographic, cultural, economic, etc. Territorial sampling is based on data about the man - environment system. Skilful practical sampling is highly appreciated.

Both the components of the man - environment system are treated together and separately. Attention is paid to geographical distribution of socio-demographic and socio-economic structures of the population (age, sex, social status, income, health, etc.). A lot of attention and time is devoted to the class and socio-professional structure of the population, i. e., to one of its principal characteristics. In this connection also territorial problems concerning the social structure are treated. This subdivision of the programme comprises also problems of socio-psychological differences between territorial population groups. The variation of the environment in different types of settlements, in rural and urban localities, in city microregions is studied. Environmental quality is also investigated. It is possible to dis-

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[I] The principle of the unity of man and environment serves as basis for treating various objects in the subsequent divisions of the course.

tinguish real, perceived, standard and ideal environment.

6. Human behaviour is explained through the system of the spheres and types of people's activities. The geography of human behaviour and man's perception of his environment enjoys a high level of development abroad. It has been elaborated as a result of research into people's preferences of the place of residence, service firms, transportation facilities, etc. However, the psychological ego of man is often overestimated there. Problems of behaviour, perception and value estimates require special attention in such territorial socio-economic systems which are undergoing major changes or shifts (sites of big construction projects, the migration of rural population, etc.). Local clashing situations due e. g. to a disharmony between the conditions of the population, the environment and possibilities for the desired behaviour might be studied.

7. Within the course of sociogeography the complex character of work is treated in connection with meetins man's needs as well as with man as a participator in production. Territorial and sectoral social problems of work (production) have direct and indirect effect on the development of territorial systems, and vice versa, social problems of territorial systems influence the spatial and sectoral conditions of work (production). This is here where preconditions for the emergence of socio-geographical and administrative differences between workers' collectives can be found.

Socio-geographical variations of localities are discussed in detail, mostly on the basis of the level of servi es, culture and recreation. The sphere of services should be geographically in harmony with the population's needs.

The types of consumers of different groups of goods vary regionally in their own way, however, here also general trends can be observed.

Regional differences in the sphere of culture are ascertained on the basis of people's spare time activities, among them reading, amateur art activities, etc. In recent years a lot of attention has been paid to the problems of recreation, especially to its natural prerequisites, however, its sociological and socio-psychological aspects have been but modestly investigated.

8. The way of life is a generalizing, synthetic object of sociogeography. The way of life characteristic of a given

group of individuals is the concrete way in which their needs are satisfied through everyday behaviour in the given environment. By means of the types of the way of life, in their turn, the standard of people's welfare anf the level of social development of territorial units can be measured. The way of life can be studied aiming at different geographical goals. Typological differences of the way of life lead to the problems of specific regionalization on its basis. This kind of regionalization of the urban way of life has been practiced by architects and designers in recent years. As compared to regional approach research into the way of. life by settlement types is more widely spread.

9. The category of people's welfare characterizes the degree to which their needs are satisfied. In observing the population's welfare, it is advisable to combine individual and social approaches. People's welfare in separate territorial systems can be treated also by means of comparing the respective types of life ways. The way of life and welfare are the main outcomes of the functioning of territorial socio-economic systems.

IO. An important idea in the planning of socio-economic development is that of equal rights of social and economic aspects. The most advanced as well as traditional theoretical and practical experience accumulated in the field of territorial planning of social development (the structure of the plan, its main parameters, the methods applied) is discussed, and the views best substantiated scientifically are suggested. The similarity and difference of the plans of the social development of an enterprise (also an agricultural one), city and town, city microregion, rural raion, oblast and republic are treated. Little light has so far been shed upon the geographical problems concerning the resources of social development and social efficiency. In the Soviet Union the planning of the social development of territorial systems is carried out on a wide scale, however, this is usually not done from the geographical aspect.

II. The drawing up of the forecasts of territorial organization of consumption, services, environmental quality, the way of life, social development, etc., is a geographical task. Such forecasting without a consideration of the parameters of territorial units is not substantiated scientifically.

In outline, the typological methods of the social forecasting consist of the following stages: I) orientation before forecasting; 2) the construction of an initial (base) model; 3) the collection of data on the background of the forecast; 4) the construction of a search (an expected) model; 5) the construction of a normative (desired) model; 6) the checking of the reliability of both forecasting models; 7) the working out of recommendations for the planning of social phenomena and processes and management on the basis of comparing the two forecasting models.

Certain difficulties in planning and forecasting social development ensue from the lack of criteria for differentiating essential indicators from unessential ones. Development indicators should be considered essential. In planning and forecasting social development in spatial systems it is the typology of the way of life that is essential.

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At present time our knowledge and experience in sociogeography is not yet sufficient in every respect for perfect teaching of this discipline. Should we wait until the sociogeographical science matures and every controversy disappears? It is well known that our national economy is short of specialists in sociogeography; moreover, they are badly needed there.

The author is of the opinion that under these circumstances the teaching of sociogeography is justified already at the present time: if we are afraid of difficulties we can never expect to achieve good results.

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TEN SEMINARS DEVOTED TO NATURE CONSERVATION

E. Varep

Since 1974 Moscow and Tartu State Universities have arranged yearly nature conservation seminars for young scientists. Their aim has been to improve the educational work in the field of nature conservation carried out among the undergraduates and young scientists of our universities. Up to the present time ten such seminars have taken place, which allows us to draw certain conclusions about their character and results.

The idea of arranging nature conservation seminars was suggested by the members of the Council of Young Scientists of the Faculty of Geography of Moscow State University. The Council has also been the organiser of the seminars on behalf of Moscow State University. On the part of Tartu State University the organiser has been the Geography Department of the Faculty of Biology and Geography. The aim of the seminars has been to improve and render more purposeful the research done in the field of nature conservation by young scientists at both universities and to exchange the experience obtained through pracitcal activities in this sphere. First and foremost the seminars have been meant for young scientists - postgraduate students, junior research workers, engineers, laboratory assistents, probationers, and students of senior courses who are at the threshold of their scientific careers. The participants have included not only young geographers, but also young specialists in biology, geology, forestry, agronomy, chemistry, architecture, economics, law, etc., as well as people actually engaged in the field of nature conservation. In addition to them the seminars of nature conservation have been attended by journalists and workers of publishing houses, the radio and television, in a word, by people who in one way or another are concerned with the protection of the natural environment and nature conservation.

Most of the papers read at the seminars have been presented by young scientists themselves, who first and foremost have spoken about the results of their own research. In the case of basic problems the speakers have also been professors from the Moscow and Tartu Universities and representatives of other research institutions as well as leading officials of nature conservation bodies. An important role has been played by discussions,exhibitions, film shows and demonstration of other audio-visual materials. The programmes of all the seminars have included excursions to nature reserves and other protected areas. The participants have also been shown various natural monuments and many places of historical or cultural interest.

The first nature conservation seminar for young scientists was opened on May 13, 1974, in the assembly hall of Tartu State University (Photo 1). After that the participants proceeded to the Kääriku Study and Sports Base of the University where they worked up to the 19th of May. The seminar was devoted to general problems of nature conservation. The subject singled out for more thorough treatment was the relations of man and his environment through the ages. Excursions (Photo 2) were made to nature reserves in South and Central Estonia (Lake Pühajärv, the Primeval Valley of the River Ahja, the hills Suur-Munamägi and Vällamägi, the Lake District of Rõuge, the Vooremaa Drumlin Area) as well as to several single objects under state protection. The seminar was a great success and this inspired the organisers to arrange more of them in the following years.

The second nature conservation seminar was also held in Estonia - in the town of Kingissepa on Saaremaa Island from May 25 to 31, 1975. This time attention was chiefly given to the protection of the flora and fauna. Excursions were organised to nature reserves in West Estonia - to the Viidumägi and Matsalu nature reserves, the Kaali meteorite craters (Photo 3), etc. as well as to single protected natural objects. Of great interest were also numerous objects of historical and cultural importance to be found in this region - ancient strongholds, mediaeval fortified churches and the episcopal castle at Kuressaare (now Kingissepa), the village of Koguva - an ethnographic reserve, etc.

The third seminar took place in the town of Pushchino near Moscow on September 13-17, 1976. Here the main subject under discussion was the rational use of natural resources. Attention was also paid to problems of nature conservation in areas which have been under the impact of human activity for a very long time. Excursions were arranged to the Biological Centre of the Academy of Sciences of the USSR in Pushchino, to the Terrace Reserve on the Banks of the R. Oka (Photo 4), to the museum of the famous writer L. Tolstoi at Yasnaya Polyana, and to that of the well-known painter V. Polenov. The programme also included the historical and cultural monuments in the towns of Serpukhov and Tula.

The fourth seminar was devoted to the relations between nature conservation and recreation. It was held at a sports base of Moscow State University near the township of Pitsunda on the Caucasian coast of the Black Sea in the Abkhasian Autonomous Soviet Socialist Republic from May 22 to 29, 1977. In the course of the seminar the participants were acquainted with the problems of nature conservation in the recreation zone along the Caucasian coast - in the area of the seaside resorts of Pitsunda (Photo 5), Gagra, Adler, Khosta and Sochi. Trips were made to the Ritsa nature reserve as well as to the Khosta branch of the Caucasian nature reserve. The participants of the seminar were greatly impressed by the visit to the caves of Novy-Afon.

The fifth seminar was held from May 28 to June 3, 1978, in the Lahemaa National Park in North Estonia, the first of its kind in the Soviet Union, set up in 1971. The subjects under discussion included the classification, types and regimes of protected natural areas as well as problems concerning the maintenance of different reserves. The participants were acquainted with various zones of the Lahemaa National Park (Photo 6), with its nature study paths and its historical and cultural sights. Excursions were also made to several other reserves in North Estonia - to the Neeruti and Kõrvemaa landscape reserves and to single natural monuments put under state protection. The programme also included visits to the Memorial Museum of the eminent Estonian writer A.H. Tammsaare and to places connected with the life and activities of outstanding Russian scientists (K.E.v. Baer) and seafarers (A.J.v. Krusenstern).

The sixth nature conservation seminar was held in the town of Valday (Novgorod Region) on May 21-26, 1979. The agenda was devoted to problems concerning the protection of inland waters. Excursions were arranged to the State Hydrological Laboratory in Valday and to the Biogeocoenological Forest Centre of the Institute of Geography of the Academy of Sciences of the USSR in the neighbourhood of the town. A trip was made to Lake Valday and to the historical monuments of the region. The guests were greatly impressed by the ancient town of Novgorod with its numerous historical and architectural monuments, highly appreciating the efforts made to investigate, protect and restore them.

The seventh seminar was again arranged in South Estonia, this time at the former manor of Sangaste, from the 14th to the 19th of September, 1980. The subject under discussion was the educational work in the field of nature conservation. The reports delivered by the speakers dealt with the teaching of the principles of nature conservation at schools as well as establishments of higher education. Attention was also given to other aspects of ecological education, including that carried out by lectures, the press, the cinema, the television, museums, etc. Excursions were made to acquaint the participants of the seminar with the activities of the model forestry centre of the Krabi eight-year school, with the old school in Uderna, now a branch of the Elva Museum of Local Lore, and with the new nature reserves recently set up in South Estonia (the landscape reserves of Otepää, Karula and Haanja). Visits were also paid to the Struve Observatory of Astrophysics and Geophysics at Tõravere and to the Limnological Station on Lake Võrtsjärv, both belonging to the Academy of Sciences of the Estonian SSR.

The eighth seminar took place in the town of Khust in the Transcarpathian Region (the Ukrainian SSR) on May 15-21, 1981, and was devoted to the role of forests in environmental protection. The participants of the seminar had opportunities to go sightseeing in the city of Lvov and the picturesque Carpathian landscapes (Photo 7) with their unforgettable beech and spruce forests, the Valley of Narcissi near Khust, and the Carpathian Nature Reserve.

On May 23-27, 1982, the ninth seminar was held in the town of Viljandi in Estonia on problems of nature conservation in areas of intensive agricultural exploitation. In the course of the seminar the participants had opportunities to pay visits to several state and collective farms in Viljandi District including the large production centres operating there. Special attention was paid to the measures of environmental protection and landscape management in this district as well as to the changes that have taken place in its rural settlements. The guests were also taken to the schools and research centres of the district and to several places of cultural (Photo 8) and historical interest (the stronghold of the Estonian national hero Lembitu, the homestead-museum of C.R. Jakobson, an outstanding figure of the period of the Estonian national enlightenment, etc.). One of the papers read at the seminar was delivered in commemoration of the 350th anniversary of the foundation of Tartu University, which celebrated its jubilee in 1982.

The tenth seminar held in the town of Zvenigorod near Moscow from May 23 to 27, 1983, was devoted to problems of environmental protection and nature conservation in urban settlements. The guests were shown both historical architectural monuments and modern buildings (the holiday centre of the Academy of Sciences of the USSR) in Zvenigorod. Of great interest was the visit paid to Zelenograd, a new satellite town of Moscow built according to modern principles of architecture to provide the inhabitants with an optimum environment for life and work.

As can be seen from the brief survey given above, the seminars have dealt with a number of essential problems of environmental protection and nature conservation. At ten seminars that have taken place so far about 250 papers have been read, mostly by young scientists working at the Moscow and Tartu Universities and the Academy of Sciences of the Estonian SSR. Lectures have also been delivered by many well-known scientists: professors A.Ryabchikov, N. Gladkov, A.Cheltsov-Bebutov, T.Zvonkova and others from Moscow State University, Professor V. Masing and others from Tartu State University, Professor E. Kumari from the Academy of Sciences of the Estonian SSR. The list of the speakers includes the head of the Nature Conservancy Board of the Estonian SSR H.Luik, the deputy chairman of the Nature Conservation Society of the Estonian SSR J. Eilart, the editor-in-chief of the journal "Eesti Loodus" (Estonian Nature) L.Poots, and many other activists of the nature conservation movement. The young scientists who have taken a particularly active part in organizing the seminars include V. Chizhova, F. Avilova, E. Golubeva, M. Gunina, L. Kazakov, D. Kavtaradze and several others from Moscow State University. As to the Estonian participants who have played an important role in arranging the seminars, mention should be made of H. Hallemaa, I. Kala, T. Kallaste, E.Linkurs, Ü. Mander, U. Peterson, A. Ristkok and a number of others. The curators of the seminars on behalf of Moscow State University have been Prof. N. Gladkov (the first and second seminars), Prof. A. Cheltsov-Bebutov (the third and fourth seminars), and Prof. A. Voronov (beginning with the fifth seminar). From the very beginning their counterpart at Tartu State University has been the author of the present survey.

The number of the participants of the seminars has been 60 people on an average, but their total number exceeds three hundred. Of course, depending on the subject, the time and the place of the seminars there have been certain variations in the composition of the participants, but there are a large number of people who have taken part in the seminars fairly regularly. There are some who have been present at all ten of them. Participants have come from very many different institutions and organisations,prevalently,of course, from the Moscow and Tartu State Universities. Some have also come from the Latvian, Lithuanian,Byelorussian and Ukrainian Soviet Socialist Republics as well as from Leningrad and other parts of the Russian Soviet Federative Socialist Republic. At almost every seminar in addition to scientists the participants have also incluced people from institutions and organisations concerned with the practical implementation of environmental protection and nature conservation measures.

The papers read at the nature conservation seminars have been printed in a series entitled "Научные труды по охране природы" (Scientific Papers on Nature Conservation) published by Tartu State University in Russian with English summaries. So far eight collections have come out on the following subjects: "Man and His Environment" (1978), "Protection of Man-Made Landscapes" (1978), "Recreation and Nature Conservation" (1981), "Natural Protected Areas" (1981), "The Lahemaa National Park" (1982), "The Protection of Inland Waters" (1982), and "Forests and Nature Conservation" (1983). Two collections entitled "Nature Conservation in Agricultural Areas", and "Environmental Protection and Nature Conservation in Urban Settlements" will come out in the near future. Moscow State University has published a separate issue called "Training and Education in the Field of Nature Conservation" (1983). Several of the papers read at the seminars have also been published in the Estonian language in the journal "Eesti Loodus" (Estonian Nature) and in other magazines and newspapers. Surveys of the work done at the seminars have been published in "Вестник Московского университета" (Herald of Moscow University), in the journal "Eesti Loodus", and in university and local newspapers.

The most important aspect to be pointed out in estimating the work done at the seminars is the experience the young scientists participating in them have obtained by carrying out research and presenting and publishing their results. Several of the papers delivered at the seminars have later been developed into candidate's dissertations or some other serious investigation. However, the chief value of the seminars probably lies in having enabled young scientists working on problems concerning environmental protection and nature conservation to establish contacts with one another. Another aspect to be highly appreciated is the ample opportunities the seminars have offered to the participants to visit various protected areas in different parts of the Soviet Union and to get acquainted on the spot with the organisational, scientific and educational work carried out there. Attention has also been paid to problems of the rational exploitation of the natural resources as well as to questions of landscape management. At the seminars, and especially during the excursions arranged in connection with them, the ideas of environmental protection and nature conservation have invariably been linked with the need of protecting historical and cultural monuments.

To sum up we can say that the seminars have proved successful, and have certainly played an important role in popularising the ideas of nature conservation among students and the young generation of scientists at our universities.

The publications
containing the investigations presented at the seminars

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Охрана природы окультуренных ландшафтов. Научные труды по охране природы, 2. Ученые записки Тартуского государственного университета, вып. 475. Тарту, 1978. 152 с.

Рекреация и охрана природы. Научные труды по охране природы, 3. Ученые записки Тартуского государственного университета, вып. 495. Тарту, 1981. 180 с.

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Охрана внутренних вод. Научные труды по охране природы, 6. Ученые записки Тартуского государственного университета, вып. 614. Тарту, 1982. 152 с.

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Сельское хозяйство и охрана природы. Научные труды по охране природы, 8. (In print).

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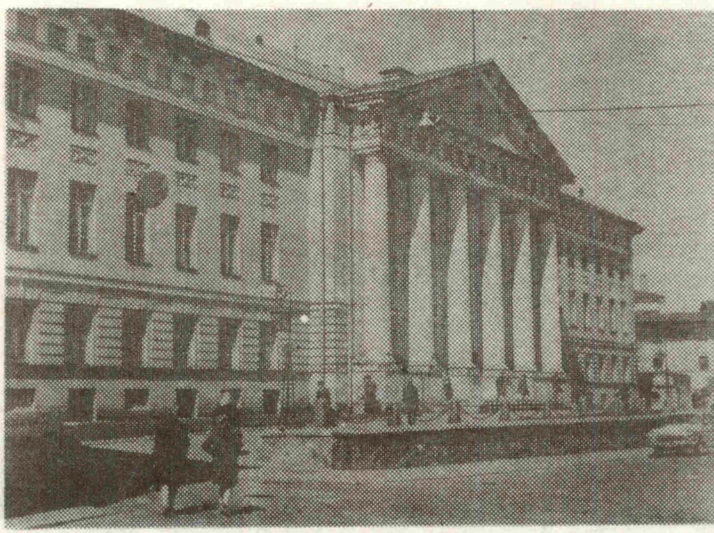

Photo 1. The main building of Tartu State University,where the first nature conservation seminar for young scientists in 1974 was opened. Photo by E. Sakk.

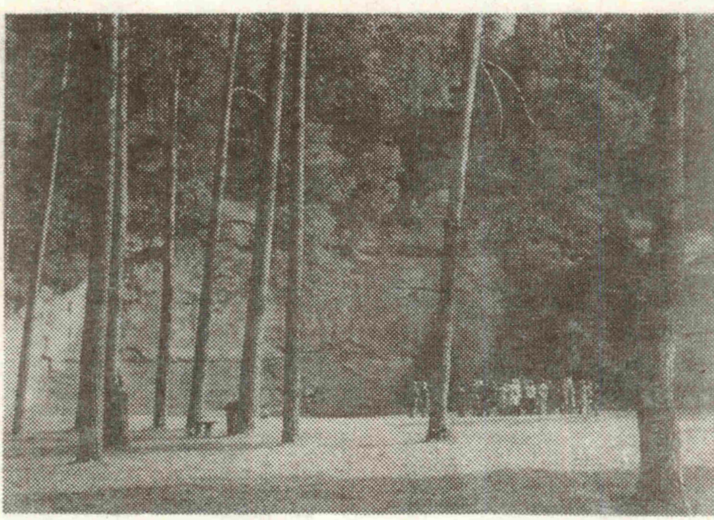

Photo 2. The Primeval Valley of the River Ahja - a landscape reserve in South Estonia. Participants of the first seminar in front of Devonian sandstone rocks at Suur Taevaskoda. Photo by T. Kallejärv.

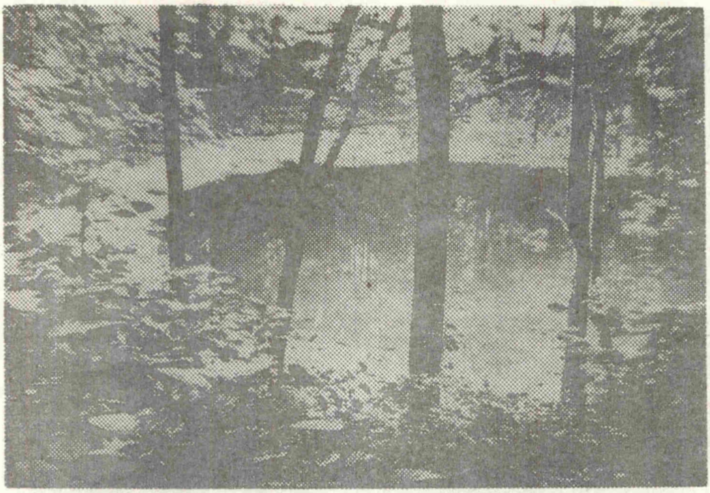

Photo 3. Lake Kaali - a meteorite crater on the Island of Saaremaa (West Estonia). Photo by V. Hang.

Photo 4. European bisons (Bison bonasus) in the Terrace Reserve on the banks of the River Oka (Moskow Region). Photo by E. Smirnova.

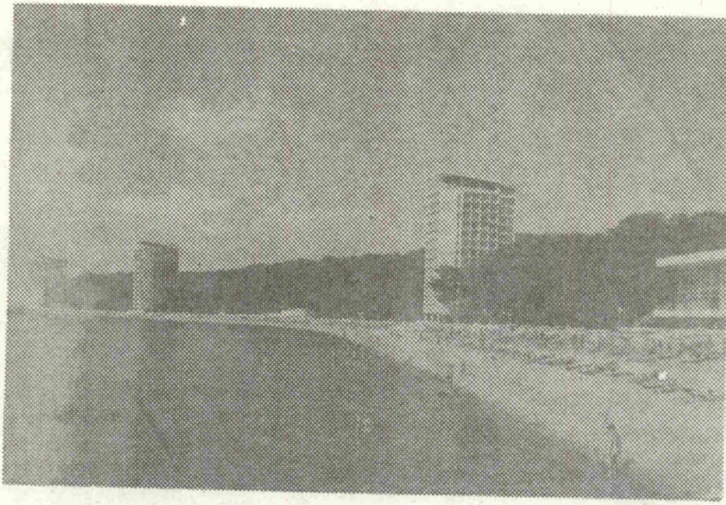

Photo 5. Cape Pitsunda on the Caucasian coast of the Black Sea. A stand of the relict pine species *Pinus pithyusa* and the seaside resort. Photo by Z. Belinski.

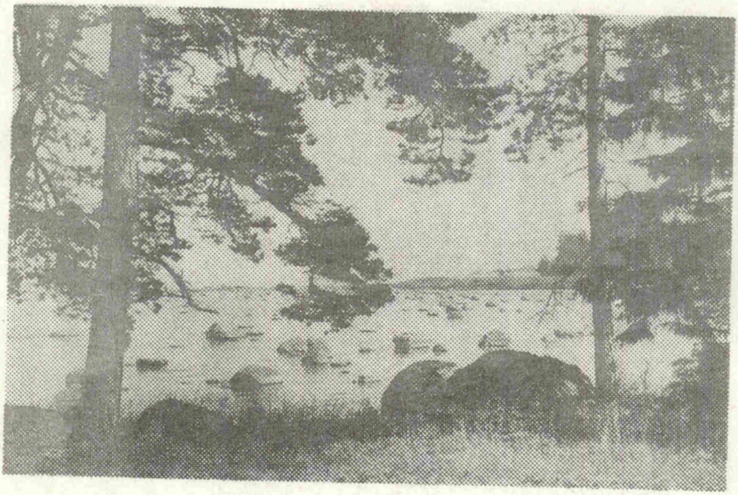

Photo 6. The Lahemaa National Park (North Estonia. Photo by E. Linkrus.

Photo 7. The Carpathian Mountains near Khust in the Ukraine. Photo by I. Kala.

Photo 8. Landscape near Viljandi (South Estonia). A drawing by Eduard Viiralt (1898-1964).

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