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DEVELOPMENT OF ENVIRONMENTAL MAPPING

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SUMMARY

Development of environmental mapping is divided into four periods: the map making of land use; the problems of nature protection; the formation of creative concepts of environmental maps, specification of the content and the rise of classification systems; the trend of associating environmental information and the start of automatization in the preparation of comprehensive environmental iformation. The definition of the map of environment is defined with more precision. The project of the conception of the regional atlas of environment is proposed. It contains ten thematic blocks: generally geographical maps, synthetic geographical maps, maps of natural resources and their utilization, maps of social resources and their utilization, maps of the deterioration and improvement of the state of natural components of the environment, maps of negative and positive phenomena in social components of the environment, limiting geographical environmental maps, comprehensive maps of environment, synthetic maps of environment and maps of environmental protection.

INTRODUCTION

The cartography of the environment, developing for half a century, is very closely connected with the geographical research into the environment, constituting one unit with it. Cartographical works inform about the results of geographic studies oriented on the environment in the most instructive way, and thus they have their broad application in practice, above all in decisive and repair measures and in further optimalization of utilizing natural resources.

The origin and development of environmental cartography is immediately connected with mapping natural resources and their utilization by man. The course of the industrial, scientific and technical revolution has quite frankly put before mankind the possibility of threatening its further existence in connection with uncotrolled and scientifically not directed interventions into the environment. For recognizing the mechanism of functioning and development of the environment those investigations are essential that study the environment as a hybrid natural and anthropogenic system of functionally interconnected components (the topic aspect), territorially articulated (the choric aspect) and variable in time (according to Mazúr, Drdoš, Urbánek 1983). Environmental cartography links up in a documenting and prognostic way with comprehensive studies of the environment and nowadays it is already able to portray as a map and in a suitable way to transfer information about all the above aspects of the environment from the sphere of fundamental research into the sphere of social and economic practice.

It is very difficult to evaluate the development of environmental mapping both for the variety of conceptual approaches and for the objective lack of leading lite-

rary and map sources, since in many countries those materials are prevented from being published by the interest of the state. Accessible information dramatically influence every evaluation; that is why the following chronologization of the development of environmental mapping must be taken as a retrospective approach.

DEVELOPMENT OF ENVIRONMENTAL MAPPING

Typical of the first period of environmental mapping (end of the 1930's to the 1950's) is *the map making of land use characteristic* from the beginning of its development by an instructive (conspicuous) differentiation of those forms of land use that effect negatively the aesthetic perception of man. Attention of land use map making was not oriented to the results of the improper use of a territory, but at that time the existence of extensive and anthropogenically variously differentiated areas was logically reflected in the respective maps. The objective of map making was the representation of the invented information from areas of interest without further processing both from the point of view of the real content, ana the development of ways of cartographic representation. Nevertheless, the act itself of cartographic classification and representation of the individual forms of land use in the concept of a uniform map has permanently been included into fundamentals of environmental mapping.

Among important works of that period the French "Atlas National de l'Aménagement du Territoire" can be mentioned. It appeared in 1935—40 and was edited by Émile de Martonne (Bertin et al. 1972). Similar map works were also made in further countries where an intense process of inventarization of resources of the national territory was going on, such as in Great Britain, Sweden, Canada, the U.S.A., Japan, etc.

In the second period (from the end of the fifties to the end of the sixties) *the problems of the nature protection become significant in map making.* Aspects of the evaluation of the results of man affecting nature, including their economic feedback become the object of representation. In that period modern fundamentals of sciences about rational environment use and protection were assentially formed and in cartography attention is paid to expressing and processing the first information, above all results of nature protection on the one hand and the most harmful consequences of human activities on the environment on the other hand.

Besides France, the cartographical schools of the U.S.S.R. and Poland registered progress in the sphere of environmental mapping in that period, thus giving rise to the first so-called "evaluation maps" of the environment and/or sozological maps of Walery Goethel (Viktorov 1968, Gaussen et al.1972, Isačenko 1975, Waksmundzki 1980). In the late sixties there arose a need of international cooperation in solving problems of the environment on a scientific basis. The organizational instigation for the development of environmental mapping was the foundation of the SCOPE comittee (Scientific Comittee on Problems of the Environment) as a part of the International Council of Scientific Unions (ICSU) and the working group of the ICA (International Cartography Association). One of the main tasks of science was also the cartographic representation of a number of changes which had taken place in the environment or which threatened to take place. For that purpose a survey of hitherto experience in making maps about the deformation of the environment, their classification as well as the possibility of their utilization in the planning practice and environment protection was made (White 1976).

The third period (from the beginning to the end of the seventies) is typical by an enormous growth of the interest in the problems of the environmet and their representation in maps. The development brought *the formation of creative concepts of environmental maps, specification of the content and the rise of classification systems of environmental mapping.* Above all the interest in further questions connected with the environment increased (natural conditions and disasters, social aspects of the environment) and specialization of cartographic making took place. It was made possible by a sufficient supply at that time of information of fundamental research and a further development of processional and representational processes.

Environmental mapping is constituted as a branch of thematic cartography and first complete definitions of environmental mapping are formulated (Sočava 1973, Neef 1974, Leszczycki 1976, Vasjukova 1976, Drápela 1978, Demek 1978. etc.). An effort at the unification of the content is reflected in the conceptual arrangement of well thought-out keys with original graphic sings (Journaux 1975, Flatres 1976). The scattering of keys failed to be overcome, but essentially a number of schools respect at least the determination of basic colour shades for content groups of the mapped elements of the environment (Journaux et al. 1978, Portman 1980). Stressing the task of geography in the investigation of the environment was reflected in environmental mapping as well as in conceptual problems. Partial physicogeographical disciplines investigating the individual components of the environment took over also the creation of fundamental inventarization and evaluation maps of the environment — maps of anthropogenic transformations of the individual components. In polycomponent, the so-called comprehensive environmental maps, effects of the Soviet, German, and partly also French geographies were reflected in a comprehensive geosystem basis, where anthropogenic transformations are related to the unified natural (geoecological) structure of the landscape. At the same time the conception of representation on the thematic basis in the form of a land use map kept its importance and, besides, particularly in France (and in Switzerland) environmental maps based on general information maps with a number of stressed physicogeographical, socioeconomic and natural historical elements (Flatres 1976) acquired a broad assertion. In a number of cases there is a percolation of different conceptions according to the purpose and the scale of maps (e.g. Götz et al. 1975). In the content of environmental maps prognostic elements appear as well as the representation of optimalization measures (Journaux 1975, Schönfelder 1979). A sufficient number of examples of heterogeneous maps resulted in the elaboration of thorough classifications of environmental maps according to different criteria (Sočava 1973, Neef 1974, Lehmann 1975, Leszczycki 1975, Berljant 1978, Drápela 1978, Isačenko, Isačenko 1978, Kugler 1978).

The fourth period (since the end of the seventies) means a conspicuous *intensification of the trend of associating environmental information.* Present-day cartographic works from the sphere of the environment follow the objective of giving comprehensive data of the area of interest important for the control, protection and planning of the environment. The effort at the comprehensive character also follows the yielding of such underlying materials as would allow to judge system connections between the components of the environment and their relation to human activity. The recognition of conditions and causal-consequential relations among all components of the hybrid system of the environment aims at the intensification of the prognostic acpect of environmental mapping (Kolejková 1984). The need of a well-arranged representation of a considerable amount of information results in forming

a set of environmental maps (Zaruckaja 1980, Vostokova et al. 1982) and environmental maps with a thematically divided leaf (Haase, Richter, Benedikt in Kolektiv 1981). Besides, within yielding comprehensive data, environmental maps become standard parts of national atlases, such as in the GDR (Kolektiv 1981), the USSR (Kolektiv 1983), the SSR (Kolektiv 1980), the CSSR (Kolektiv 1986).

The end of the seventies and the eighties are characterized by *the start of automatization in the preparation of comprehensive environmental information and its cartographic presentation* (Kolektiv 1986, etc.), which is very advantageous, particularly from the point of view of updating the content of environmental maps according to very dynamically changing actual state of the environment.

DEFINITION OF THE ENVIRONMENTAL MAPS

Present-day environmental cartographic production is very extensive and, because of a considerable variety of transferring information, it is very difficult to specify which map is environmental map and which map has a more or less free relation to this problem. The environment of man is the landscape sphere of the Earth, that is, all maps are, in the broadest understanding of the problem, "certain environmental maps". Due to this fact it is necessary to specify the sphere of making environmental maps more narrowly, even though it is impossible to make it quite unambiguous in view of the complexity of the problems. Environmental maps can certainly include the production of those map works representing anthropogenic modifications of environmental parameters. It is questionable whether also maps containing negative (for man) features of quite natural processes can be included in them. Natural disasters of different sizes are doubtlessly a factor realsitically deteriorating the quality of man's environment. Environmental maps also include complex map works including analytical underlying factors into system or territorial connections or time connections or evaluating them. The prognosis of phenomena in the environment can also be expressed in the map, of course in one belonging to environmental maps.

Another aspect of the environment is the relation of man to the surroundings immediately built by him, whether it be the material aspect or the psychological one. Here can be included different special and economic characteristics of the living standard (the quality of housing, commuting, household equipment standard, incomes, culture, etc.) and a number of social phenomena (criminality, divorce rate, illness rate, etc.). Not always can in them be proved a connection with the rate of change of the natural environment or with the character of the natural environment itself. As a rule, maps representing mostly negative signs of the environment of the above phenomena of economic and social origin (less frequently positive sings) are ranked among environmental maps. That means that environmental maps as a rule represent the most limiting factors for man of the two subsystems of the environment, i.e. the natural and the socioeconomic ones in their dynamics.

More difficult is the ranking of those maps that represent the value or the suitability of different properties of above all the nature environment for further development of social activities (such as maps of potentials, particularly the natural ones). These maps as a rule do not follow the objective of expressing a certain harmfulness for the life of man or its endangering (or making it easier), or the rate of possibility of further exploitation of the environment (without the life being immediately affected in health by the environment).

The maps of different "suitabilities" are an essential starting point for a planning or a warning prognosis of the environment as a whole or its parameters. Potential maps thus have only a conditional character in relation to the environment, whereas the materialization of the environment in its narrower understanding is the result of man's activities. For that reason potential maps as evaluating maps cannot be excluded from the group of environmental maps.

For practical purposes (a rational exploitation of the landscape) maps of a very broad spectrum are necessary. The above complexity of problems when delimiting the concept of an "environmental maps" is reflected also in the definition proper of the environmental map.

The most frequently quoted in this country, but to a certain extend simplified is the definition by E. Neef (in Demek 1978), according to which environmental maps represent a specific type of thematic maps aimed at the representation of the system of the environment and containing information broadering our knowledge of the state and relations in that system. J. Demek (1978) adds that those maps of the environment must contain "aimed" information that cannot be given by usual branch thematic maps.

In Polish cartographic and geographic literature the term "sozological map" took up. The man who coined the expression "sozology" and "sozological map" is Professor Walery Goetel (Waksmundzki 1980). He established a place to nature protection among natural, technical and social sciences, calling it sozology. According to his definition it is "a branch of science dealing with the protection of both living and non-living nature as a habitat of man" (in Skřivánek 1980, p. 569). A similar definition of sozology is also given by Stanikiewicz (1983). Recently, Dziadek and Zieliński (1985), though differentiating between sozological maps and those of (environmental) pollution, judge that those maps constitute one group of maps subdivided into analytical, synthetical and comprehensive maps of absolutely equivalent contents, such as environmental maps known from other cartographical or geographical schools.

The most extensive and exhaustive is the definition of an environmental map by the authors of the encyclopedia Kartenkunde (Kolektiv 1982, p. 616). Unfortunately, however, even this extensive definition does not accept those effects of the activity of the human society that, on the other hand, result in a favourable — for man — transformation of the environment or in repairing preceding damage.

An environmental map in the narrower sense of the word *can be called a map work expressing spatial and temporal aspects of positive and from the point of view of living nature and above all of man primarily negative results of anthropogenic transforming activity in the geographical sphere with evident or potential effect on the biological and social life of man and on his activities and works.* In a broader understanding *environmental maps can also include map works evaluating objective conditions from the point of view of human activities forming his environment.*

From hitherto development of environmental cartographic activity it follows that it is necessary to continue solving the problems of conception and contant of environmental maps and the forms of those cartographical works for broad needs, because the requirements of social practice objectively look for the centre of gravity in information given by environmental maps and their logical sets. The real complexity of the system of environmental maps forces all their users to respect the broadest possible complex of nodal properties of the environment.

REGIONAL ENVIRONMENTAL ATLAS

Due to the fact that the amount of information about the environment or some information related to it in a certain way is at present very extensive, it will be necessary to pass it above all in the form of regional atlases or sets of environmental maps. A regional environmental atlas should consist of a series of blocks linking up with each other; maps constituting it will then necessarily differ by their conception and, of course, by their contents. In a considerable part of the considered environmental maps the thematic content is subject to large time changes and the user must be informed by means of possibly the latest data. A change, the innovation of the information and its early cartographical representation can be carried out effectively when utilizing automatization, by connecting environmental cartography with the automatization of cartographic activity it is possible to achieve a reasonable fulfilment of tasks of the theoretical and the practical developments of cartography (Vahala 1985). The conception of maps (main and secondary) must be partly adapted to the problem of utilizing automatization in the considered regional environmental atlas in the sense of the maximum unity of the information basis (i.e., to maximally atlas in the sense of the maximum unity of the information basis unify the territorially input and output data according to geoecological and social economic units), modification of map leaves (minimalization of the number of map scales used) of main and secondary maps and the standardization of means of expression. At the same time it is necessary to progress towards a reasonable compromise between the needs of automated production and the aesthetics of the performance.

A regional environmental atlas can contain a succesion of ten thematic blocks in the draft:

1. GENERALLY GEOGRAPHICAL MAPS. In this part the physical map of the territory mapped should be in the traditional design and the administrative map with the level of official division determined ahead should be processed in the form of a cartogram.

2. SYNTHETIC GEOGRAPHICAL MAPS. This group represents general starting points to which it is necessary to relate environmental themes of further maps. They are maps of geoecological types of the environment, i.e. natural (and in this country mostly reconstructed) landscape units and map of socioeconomic types of the environment (homogeneous units from the point of view of economics and housing structures). This group further includes also the map of land use of the given territory.

3. MAPS OF NATURAL RESOURCES AND THEIR UTILIZATION. They are represented by a set of maps of potentials of the individual natural components of the environment and by introducing the rate of their suitability for the sequence of economic functions in areas of geoecological types of the environment. It is necessary to relate to similar areas the information about the ways of utilizing the potentials and also the intensity of their utilization, probably by means of the characteristics of productivity (and/or effectivity) of the economic function.

4. MAPS OF SOCIAL RESOURCES AND THEIR UTILIZATION. The block should be set up from potential maps of geoeconomic components of the environment, important in relation to the environment being above all that information having relation to the living standard, health, population incomes, to the material, energetic,

spatial and manual requirement of production and its dependence on natural conditions, to providing services to settlements, etc. The necessary data must be related to the areas of socioeconomic types of the environment, and/or to the territorial units within which they have been obtained.

5. MAPS OF THE DETERIORATION AND IMPROVEMENT OF THE STATE OF NATURAL COMPONENTS OF THE ENVIRONMENT. They represent all anthropogenic and negative natural changes in natural components of the environment. It is necessary to differentiate and to represent in a different way the sequence of environmental information in the series "conditions—causes—consequences" (Kolejková 1983). This group also includes maps of the negative action of natural components of the environment on man. Provisions to repairing the state and/or its ammelioration are an integral part of the individual branch maps.

6. MAPS OF NEGATIVE AND POSITIVE PHENOMENA IN SOCIAL COMPONENTS OF THE ENVIRONMENT. They are to represent those characteristics of production, consumption and population life which are immediately reflected or potentially can strongly affect the quality of the environment, such as the representation of work places of hazard production, production of wastes, location of dangerous intermediates, unfavourable demographic phenomena, etc.

7. LIMITING GEOGRAPHICAL ENVIRONMENTAL MAPS. Their objective is to inform about the spatial distribution of decisive natural factors of the environment according to areas of geoecological types of the environment, decisive socioeconomic factors of the environment and decisive deforming factors, i.e. man-induced unfavourable phenomena in the surrounding, originally unaffected environment.

8. COMPREHENSIVE MAPS OF THE ENVIRONMENT. Their objective is to thematically summarize and locate anthropogenic changes of the environment caused gradually by individual branches of economy.

9. SYNTHETIC MAPS OF THE ENVIRONMENT. They are to give summary evaluating information about the state of the environment in different places of the territory studied according to all accessible parameters.

10. MAPS OF ENVIRONMENTAL PROTECTION which represent objects of natural as well as artificial origins being in different degrees of protection and objects of high ecological or historical values requiring either protection or another way of controlling their utilization.

The maps included in the first block correspond conceptually to traditional processes. Maps of the 2nd (with the exception of the map of land use), the 7th and the 9th blocks should start from the results of narrower physicogeographical and comprehensive geographical syntheses. Maps of the 3rd and the 4th blocks can potentially be considered to be the results of the evaluating of the set of underlying by means of partial syntheses, maps of the 5th and 6th blocks are based on the conditional analysis of underlying information. The 8th and the 10th blocks include maps whose conception starts from land use maps and inventarized information of the branch character.

CONCLUSION

The regional environmental atlas, due to its high requirement on the amount of input data, technology of procession and a variety of approaches, is based on

multidisciplinary team of processors and can only be a team work. The task of the cartographer consists in the coordination of team cooperation and in conceptual, aesthetical and/or processing standardization of the activity.

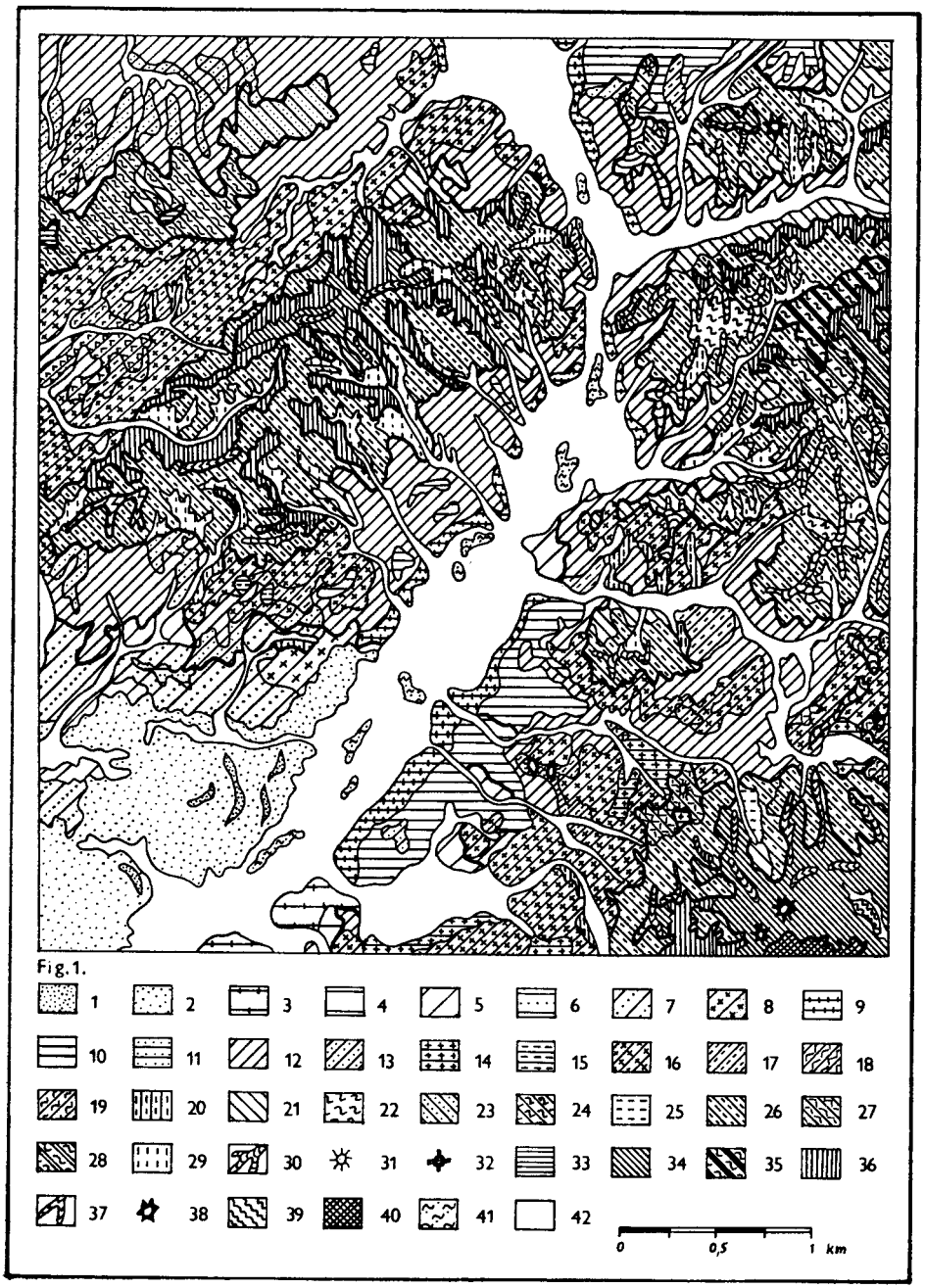

Fig.1.

Fig. 1. Geosystem map as a basis for environmental map production

TYPES OF GEOSYSTEMS:

Very warm landscape with oak forests

1. Sandy dunes with arenosols
2. Sandy cover with arenosols and arenic mollisols
3. Higher river terraces with mollisols
4. Loess plateaus with mollisols
5. Gentle loess slopes with mollisols
6. Denudational plateaus with mollisols on neogenic weak rocks
7. Gentle erosional-denudational slopes with mollisols on neogenic weak rocks
8. Gentle erosional-denudational slopes with mollisols on paleogenic

Warm landscape with beech-oak forests

9. Higher river terraces with argiluvisols
10. Loess plateaus with argiluvisols or mollisols
11. Denudational plateaus with argiluvisols or millisols on neogenic weak rocks
12. Gentle loess slopes with argiluvisols or mollisols
13. Gentle erosional-denudational slopes with argiluvisols or mollisols on neogenic weak rocks
14. Sediments on paleogenic flysh hard rocks with argiluvisols or mollisols
15. Denudational plateaus on paleogenic flysh hard rocks with cambisols
16. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with argiluvisols and mollisols
17. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with cambisols
18. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with pararendzinas
19. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with pelosols
20. Steep erosional slopes on paleogenic flysh hard rocks with cambisols (pelosols)

Moderately warm landscapes with oak-beech forests

21. Gentle slopes on loess and slope deposits with luvisols
22. Wett gentle slopes on loess and slope deposits with pseudogleysols
23. Gentle erosional-denudational slopes on neogenic weak rocks with luvisols or argiluvisols
24. Gentle erosional-denudational slopes on neogenic weak rocks with pelosols
25. Sediments on paleogenic flysh hard rocks with cambisols
26. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with cambisols
27. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with pararendzinas
28. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with pelosols
29. Steep erosional slopes on paleogenic flysh hard rocks with cambisols (pelosols)
30. Expressive ridges on paleogenic flysh hard rocks with cambisols
31. Expressive monadnocks on paleogenic flysh hard rocks with cambisols
32. Expressive monadnocks on neovolcanic hard rocks with cambisols

Moderately cold landscapes with beech forests

33. Denudational plateaus on neogenic weak rocks with pelosols
34. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with cambisols
35. Gentle erosional-denudational slopes on paleogenic flysh hard rocks with pelosols
36. Steep erosional slopes on paleogenic flysh hard rocks with cambisols (pelosols)
37. Expressive ridges on paleogenic flysh hard rocks with cambisols
38. Expressive monadnocks on paleogenic flysh hard rocks with cambisols
39. Gentle slopes on slope deposits with pseudogleysols

Cold landscapes with fir-beech forests

40. Steep slopes with dystric cambisols on paleogenic flysh hard rocks

Flood plain landscapes

41. Flood plain depresions with gleysols on fluviatile clays
42. Other flood plain areas with fluvisols and mollic gleysols on lower terraces and holocene loams

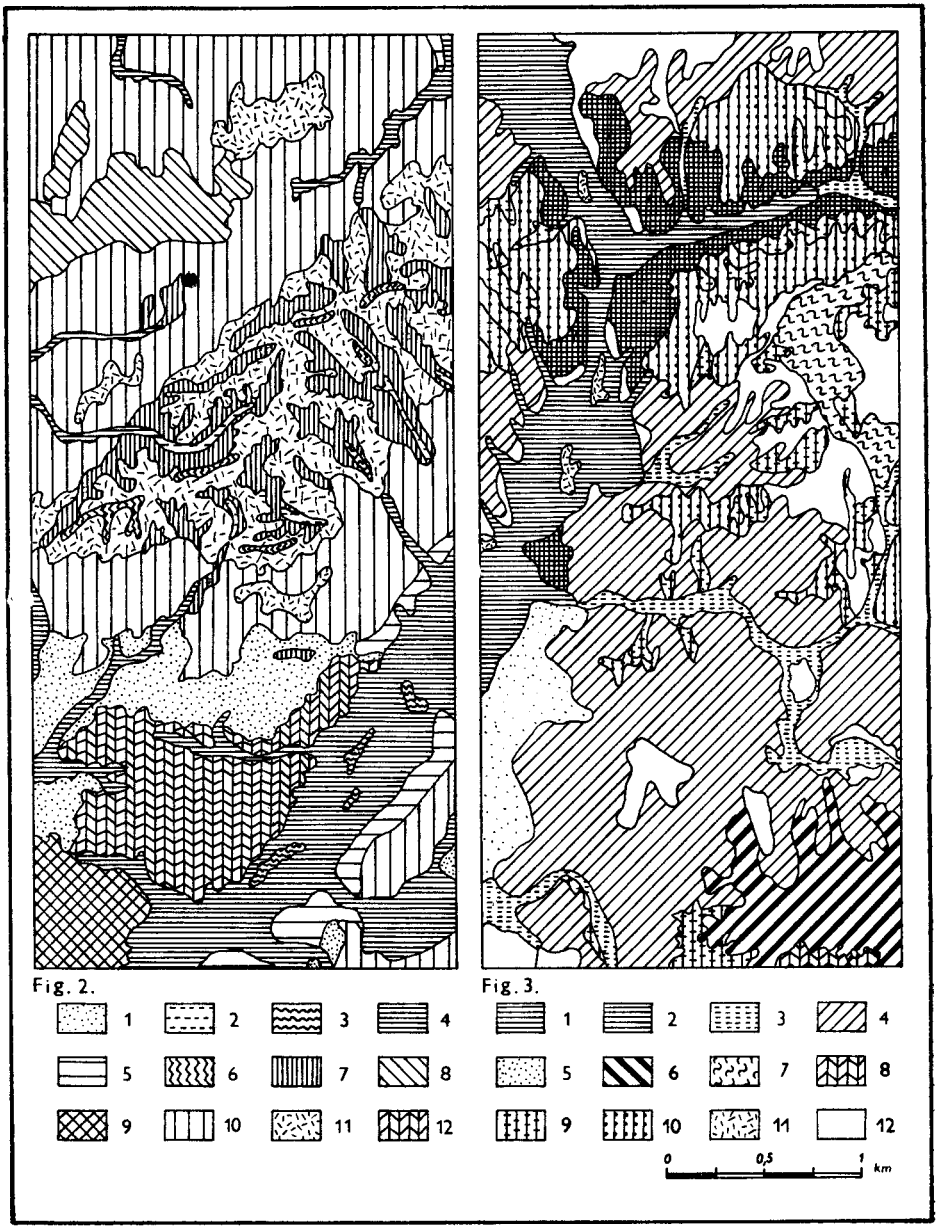

Fig. 2. Limiting natural factors of environment in geosystems (left)

LIMITING FACTORS:

Atmospheric:

1. Precipitation deficit
2. Inversions

Hydrologie:

3. Swamps — wetting
4. Seasonally high level of underground waters
5. Dry areas with high infiltration into sands and gravels

Morphologic:

6. Endangering position
7. High slope declination
8. Unstability of slopes

Geologic:

9. Occurrence of raw materials

Pedologic:

10. High fertility of soils
11. Barrenness of soils

Vegetational:

12. Soil stabilizing forests

Fig. 3. Limiting man-made factors of environment in geosystems (right)

LIMITING FACTORS:

Atmospheric:

1. Air pollution

Hydrologic:

2. Water pollution
3. Water preservation

Pedologic:

4. Water erosion
5. Wind erosion
6. Special techniques of agriculture in protected areas

Morphologic:

7. Landslide danger

Vegetational:

8. Protected forests
9. Soil protecting forests
10. Recreational forests

Zoological:

11. Occurrence of troublesome insect

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12. Other areas of geosystems without special problems or provisions in environment

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