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## ANTHROPOGENIC GEOMORPHOLOGY: QUESTIONS, PROBLEMS, TASKS

### 1. Preface

Geography is a scientific discipline able to explain and tackle the interrelationships of physico-geographic and socio-economic phenomena and processes in the period of the scientific-technical revolution whose attendant symptom is even the increasing pressure of the society on the natural milieu. Tackling of such an intricate complex task is accompanied with efforts of physical and socio-economic geographers for mutual understanding and application of their disciplines for the purpose of reaching their object, i. e. the identification, knowledge, explanation, suggestion of measures and prognosis of the future development of landscape transformation by human activities.

Although the problems of the effects of human activities on natural environment were paid increased attention as late as after World War II, works dealing with these problems are met in the world literature many years earlier. To the first generally appreciated authors belong the American scientist G. P. Marsh and the outstanding Russian geographer A. I. Vojekov who contributed to knowledge of the character, extent and impacts of the uncontrolled interference of man in natural processes as early as in the second half of the 19th century.

With time, even specialists of the individual sciences on Earth, above all geographers and geologists, have begun to take notice of the specific manifestations of the pressure of human society on natural environment. The German geographer E. Fisher (1915) points out the role of man as the youngest geological factor, numerous authors pay attention to anthropogenic transformations of geomorphological processes (R. L. Sherlock, 1923; K. Bryan, 1925; G. V. Jacks and R. O. Whyte, 1939; S. Pawlowski, 1923). Great upsurge as to the number of such studies can be registered in geographical literature since the fifties of this century up to the present times. An important contribution to the knowledge of the economic influence of man on the Earth surface was the work of the German economic geographer, E. Fels (1954). W. D. Thornbury (1969) devotes in his work the chapter „Applied Geomorphology“ to the utilization of geomorphological knowledge in hydrological applications, extraction of mineral raw materials, designs of technical projects, oil extraction and military application.

The geographers of socialist countries have too a significant share in this development paying their attention not only to the research within the frame of the different disciplines but even to the application of geomorphological knowledge in complex studies (A. S. Devdariani, 1954; J. Dylik, 1954; L. Zapletal, 1969; I. P. Gerasimov, 1970; J. Demek, 1973; F. N. Milkov, 1973, etc.).

It can be stated that geography as a whole responds to the necessity of investigations of the diverse effects of the society on the natural environment in two ways. On one side, new complex geographical disciplines are formed, such as complex physical geography or science on landscape, on the other side new scientific branches develop within the frame of the fundamental geographical disciplines (geomorphology, soil geography, biogeography, etc.).

## 2. Definition and delimitation of the subject of study of anthropogenic geomorphology

Anthropogenic geomorphology belongs to the youngest geomorphological disciplines. The author of the paper considers anthropogenic geomorphology a new branch of general geomorphology. Subject of its study are in the sense:

s.l.: all direct or mediate effects of human society on the relief of continents and oceans

s.s.: the study of the aspect, genesis and age of anthropogenic relief forms, as well as the space—time aspects of the registration, evaluation and prognosis of anthropogenic relief transformations of the territory discussed.

Although anthropogenic geomorphology is a discipline generally acknowledged in literature, its definition and delimitation can only seldom be found especially in geographical and/or geomorphological dictionaries. R. W. Fairbridge (1968, p. 525) mentions for instance the term of anthropogenic geomorphology only in connection with the elucidation of the role of man as a geological agent in the Holocene. In another place (pp. 15 to 18) he pays greater attention to the description of anthropogenic geomorphological processes. S. V. Kalesnik (1968, p. 19) does not give the definition of anthropogenic geomorphology either but specifies anthropogenic factors as a group of ecological agents including various forms of the influence of man on the flora and environment. F. D. Monkhouse and J. Small (1978, p. 14) define the subject of „anthropogeomorphology“ as the study of relief forms created by man (pits, quarries, dumps, lakes).

More attention is paid to problems of anthropogenic geomorphology and its different aspects in geomorphological textbooks and papers. Let us say — before a characteristic of the approaches of some authors to the problems forming in our opinion the subject of study of anthropogenic geomorphology — that some of them class a part of the problems of anthropogenic geomorphology with the discipline called „environmental geology“ (Flawn P. T., 1970; Tank R. W., 1976). This fact proves even the effort of the other sciences on Earth to contribute to the solution of the effects of man on the modification of the Earth surface and the related processes. It is impossible not to see that in most cases „environmental geology“ only introduces physico- and socio-economic geographical aspects of the interrelations man — environment, the complex expression of which by geographers is not always available. An important part is played even by the fact that in some Anglo-American countries geomorphology is considered a part of geology. The subject of study of „environmental geology“ is therefore often integrated in that of anthropogenic geomorphology or „environmental geomorphology“ which I consider synonyms. Let us prove now the statements mentioned by opinions of some authors about the role played by geomorphology in the study of reciprocal effects of man and environment.

D. G. Panov (1966, p. 6) mentions anthropogenic relief forms to human activities conditioning even the dynamics of geomorphological processes.

J. Pilawska (1968) arrives in her considerations concerning the changes of the geographical milieu by mining at the conclusion that, besides geomorphology, such transformations must be tackled even by other geographical disciplines. The investigations which had formerly only a space aspect have even a branch aspect at the present time.

I. P. Gerasimov (1970, p. 13) demands that the knowledge of anthropogenic effects on geomorphological processes results in their prognosis and, simultaneously, in measures which 1) will reduce the effects of destructive elemental processes and 2) will lead to the formation of natural-technical systems. Mapping of the consequences of anthropogenic influences is necessary too.

P. T. Flawn (1970) specifies in the preface to his book „environmental geology“ as a part of ecology dealing with the relationship of man to his geological locality.

R. U. Cooke and J. C. Doornkamp (1974) consider „environmental geomorphology“ a discipline dealing with the geomorphological aspects of human influence on natural milieu. They suppose that the revival of interest and the specialization of geomorphologists in these problems is caused by the exploitation of natural resources and its consequences which have to be solved by society, and 2) the transformations of geomorphology as a whole, because the latter must work in the solution of the problems of environment in context with social, economic and technical sciences i. e. sciences with which the exchange of information is mutually relevant. The knowledge resulting from the analysis of individual geomorphological processes is also of use in environmental management.

F. N. Milkov (1974, p. 4) suggests to regard anthropogenic geomorphology as an independent science or as „a special part of general geomorphology“. He considers as subject of study of anthropogenic geomorphology anthropogenic morphosculptures and its task — the study of direct and attendant anthropogenic forms with the registration of the effects of economic activities on the modelling of natural relief forms.

P. F. Molodkin (1976, p. 77) defines anthropogenic geomorphology as a part of general geomorphology studying the anthropogenic relief of the Earth surface, its structure, development and genesis. As method of study he considers the anthropogeomorphological analysis investigating the mechanism of natural and anthropogenic processes in the modelling and development of the anthropogenic relief.

R. W. Tank's (1976, p. 2) delimitation of the characteristics of the geological environment is based on the conception of ecology as a science dealing with the relationships between organisms and environment.

J. C. Frye (1976, pp. 3—6) takes interest in the task of the sciences on Earth in tackling the environmental problems which he divides into five groups. 1) gathering of data for planning practice with respect to physiognomy, surface and sub-surface characteristics especially in extension of urban areas (in utilization of topographical and geological maps, knowledge of engineering geology, soil mechanics, prognoses of potential landslides, etc.), 2) determination of factors affecting the security and stability of surface and subsurface waste dumps, 3) provision of information for planned utilization and ensurance of water resources for the population, 4) identification of perspective natural resources, 5) recognition of man as the main geological factor by monitoring of the changes he evokes in environment and preventing the consequences of these activities.

From the review submitted it follows — besides the knowledge mentioned above — that 1) most authors study anthropogenic relief transformations for the

needs of research in the sphere of the formation and protection of environment; continuity with other geographical disciplines is elaborated only slightly, reserves exist above all in the application of the knowledge of the complex discipline dealing with the relationships between society and natural milieu — the landscape science. 2) some authors (P. T. Flawn, 1970, R. W. Tank, 1976) slightly suppress in their approaches the principle of regionalism (in I. P. Gerasimow's conception — 1976) in behalf of the principles of anthropogenism and ecologism. 3) some authors (D. G. Panov, 1966, W. D. Thornbury, 1969) attribute the solution of numerous problems of anthropogenic geomorphology to applied geomorphology. In spite of the fact that the author of this paper considers applied research as one of the most important criteria the results of the discipline to social needs, he believes that applied geomorphology makes use only of a partial knowledge of geomorphological branches and, accordingly, even of knowledge resulting from the study of anthropogenic relief transformations. This means that applied and anthropogenic geomorphology are different disciplines of geomorphology.

### 3. Contribution of Czechoslovak geomorphologists

The works of authors dealing in Czechoslovakia with some aspects of anthropogenic geomorphology can be summarized in 3 groups. The works of first group deal with theoretical problems and result usually either in general systematic classifications of anthropogenic relief forms or delimit the effects of man on the Earth surface (L. Zapletal, 1969; J. Demek, 1973; M. Hrádek, 1976). The second group consists of works devoted to the geomorphological analysis of a certain territory with application of its basic method — geomorphological mapping. The maps belong by their conception to general geomorphological maps, including besides genesis, aspect and age of relief forms even an information on anthropogenic relief forms. These forms are in large, medium and small-scale maps represented almost exclusively by conventional extra-scale symbols. Works drafted in this way have — as to number — the upper hand to both further groups (J. Demek, 1959; V. Král, 1969; B. Balatka et al., 1972; T. Czudek, 1971; A. Ivan, 1975). The third group is represented by works investigating and recording exclusively the effects of man on the relief. They present either: a) a review of anthropogenic forms and interferences with the relief (J. Loučková, 1969, 1974) or of forms and transformations of the relief by a certain type or gamut of economic activities (O. Stehlik, 1971; L. Zapletal, 1976 a, b) or evaluate the effect of economic activities on the relief in the whole complex (O. Stehlik, 1975).

### 4. Means of expression

Traditional, effective and still basic means of expression of the results of geomorphological studies are their cartographical interpretations in the form of thematic maps and cartograms.

The geomorphological map is considered an information system which is a model of really existing geomorphological geosystems. Owing to the increase of information on the relief, its full recording in a geomorphological map is still more difficult if the criteria of correctness, objectivity and lucidity are to be respected. This is why other, special geomorphological maps develop whose contents is determined by the purpose of application. In my opinion, these maps only

elaborate a certain part of the information system which has already been recorded in the general geomorphological map. The general geomorphological map keeps, therefore, its fundamental significance, irreplaceable so far.

From the point of view of the tasks imposed on geomorphology by the problems of the interrelations of society and environment, geomorphological maps can be divided into two groups. The first group of maps supplies information on the character of the relief and its suitability for utilization by a certain type of human activities. Sufficient information of this kind can be derived from general geomorphological maps characterizing the aspect, genesis and age of the relief, or from partial geomorphological, above all morphographic and morphometric maps (e. g. maps of vertical dissection, density of dissection, density of erosion network, valley depths, etc.). The second group represented by special maps makes possible the evaluation of the economic activities of man with respect to the relief which lead in most cases to the disturbance of the natural dynamic equilibrium of the relief, resulting in a transformation and modification of the course and intensity of geomorphological processes (erosion, development of landslides, etc.).

The author of this paper attempted to compile such a special map in the region of the Boskovická brázda (Boskovice Furrow) (M. Konečný, 1978). In the original of the map he represented by contour lines and conventional symbols with differentiation in colour the individual anthropogenic relief forms and by flat tint the probable soil erosion in mm per year for the whole area covered with agricultural land.

A great advantage of these maps compared to general and partial geomorphological maps is the possibility of the expression of the prognosis of geomorphological processes on the basis of the preceding development and the present-day state of the relief.

Difficulties in the application of general and special geomorphological maps are caused by the length of their preparation and the various demands of the map users who often lack training in utilization of such maps. In the first case, much can be improved by automation of map construction, in the second case by elaboration and stabilization of the respective legends of general and above all special geomorphological maps.

To satisfy the increasing demands of various institutions on a sufficient number of topical relevant information on the relationship man — environment, a progressive classification of information and a formation of information systems take place. Improved geographical and/or geomorphological information systems are becoming their organic components. I consider an information system — according to Langefors (B. Langefors, 1966) — a system involving elements for collection, transmission, preservation, processing and giving of information. A special feature of a geographical and, accordingly, a geomorphological information is its space and time character. A space information demonstrates the distribution of elements of certain properties and allows to study their interrelationships.

Data on the natural milieu are obtained in field research by the study and interpretation of air and space photos or by the combination of these methods. In information systems they usually refer to rectangular projections of certain space units (squares, hexagons) on a chosen topographical area. The space units become in this way the territorial carrier of information. The amount of the information carried is determined by the purpose and level of the information system. These criteria are valid also for the amount and structure of information supplied into the information system by the individual scientific disciplines. Pro-

cessing of gathered information is carried out in computers, making possible the printing of cartograms of the characteristics of the different elements or their various combinations.

Anthropogenic geomorphology supplies to such information systems data concerning anthropogenic transformations of the relief. Output information can inform on the individual anthropogenic relief forms, the modification of the course of present-day geomorphological processes including their prognosis and supply an idea of the degree of the anthropogenization of the territory.

## 5. Tasks of anthropogene geomorphology

In my opinion, the solution of the following tasks is absolutely necessary for a further intensive development of anthropogenic geomorphology and an increase of its significance for social practice:

- 1) elaboration of the theory and methods of research of the origin and development of relief forms and relief-forming processes owing to economic activities of society
- 2) elaboration of theoretic bases of anthropogeomorphological prognoses of relief development in dependence on the economic activities of society, regional-geographical and zonal-climatic conditions
- 3) delimitation of anthropogenic factors in the formation and transformations of the relief and elaboration of the typization and classification of anthropogenic relief transformations
- 4) selection, systematization and preliminary data processing for the needs of information systems on the territory.

## 6. Conclusion

The author of the paper submits a review of the main questions, problems and tasks of a new branch of general geomorphology — anthropogenic geomorphology. He believes that anthropogenic geomorphology will enrich the whole geomorphology with new knowledge elucidating the reciprocal relation and effects of human society on the relief and will utilize the possibility of tackling the fundamental problems of environment for which it has the necessary qualification.

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## R é s u m é

### ANTROFOGENNÍ GEOMORFOLOGIE — OTÁZKY, PROBLÉMY, ÚKOLY

Autor článku se zamýšlí nad otázkami, problémy a úkoly antropogenní geomorfologie. Za její předmět studia považuje v širším smyslu všechny přímé či zprostředkované vlivy lidského společenství na reliéf pevnin a oceánů, a ve smyslu s. s. studium vzhledu, geneze a stáří antropogenních tvarů reliéfu, jakož i prostorovočasové aspekty registrace, vyhodnocování a prognózy antropogenních transformací reliéfu daného území. Upozorňuje, že někteří autoři zařazují problematiku této disciplíny do tzv. „environmental geology“. Ve většině případů však jde o zavádění fyzicko- a socioekonomicko geografických aspektů vzájemných vztahů člověk — prostředí, které nejsou vždy od geografů k dispozici. Dále autor uvádí přehled některých názorů na pojetí antropogenní geomorfologie a věnuje speciální část rozvoji disciplíny v Československu. Za základní prostředek vyjádření výsledků geomorfologických studií považuje kartografickou interpretaci ve formě tematických map a kartogramů. Z hlediska úkolů, které před geomorfologii klade problematika vzájemných vztahů společnosti a prostředí, lze geomorfologické mapy rozdělit do dvou skupin. První podává informaci o charakteru reliéfu a jeho vhodnosti pro využití určitým typem lidské činnosti (Obecné a dílčí geomorfologické mapy). Druhá, reprezentovaná mapami speciálními, umožňuje hodnocení a prognózu hospodářské činnosti na reliéf. Autor upozorňuje i na úlohu geografických, resp. geomorfologických informačních systémů v informačních systémech o území a možnosti zpracování informací pomocí počítačů, jejichž grafická zařízení umožňují vytištění kartogramů charakteristik jednotlivých prvků, či jejich kombinací. Antropogenní geomorfologie poskytuje pro takovéto informační systémy údaje týkající se antropogenních transformací reliéfu.