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THE GEOCHEMICAL LANDSCAPE CONCEPT AND ITS USEFULNESS IN PHYSICAL GEOGRAPHY

Abstract: The article describes the theoretical foundations of the "geochemical school" of landscape studies and analyses its methodology. The scope of its usefulness in contemporary landscape research, both cognitive (pure) and focused on practice, is discussed.

Key words: Polynov, landscape geochemistry, complex physical geography, methodology of geography.

INTRODUCTION

The concept of a geosystem, currently referred to as "geochemical landscape," was first proposed at the beginning of the 20th century by Boris Polynov (1877–1952), a Russian pedologist and geographer. Polynov believed that this concept should serve as the theoretical and methodological basis for complex physical geography studies (Polynov, 1956). His hopes, however, proved vain. The "geochemical landscape school" remains one of many methodological approaches used in complex landscape studies (Richling, Solon, 2002). This article reviews the fundamental assumptions of the scientific approach that stems from Polynov's work and analyses its usefulness in contemporary physical geography research.

THE STUDY SUBJECT

According to Polynov (1956), landscape, as the subject of physical geography studies, is a dual concept: 1) it is the effect of interaction of natural processes; 2) it is a system that makes that interaction possible. Polynov distinguished three main types of the landscape processes: eluvial, superaqual, and subaqual.

The eluvial landscape process occurs on elevated relief elements. Groundwater penetrates deeper layers and has no impact on soil properties. Landscape matter delivery is slow and mainly of atmospheric origin. Infiltrating rainwater gradually depletes soil and the weathering mantle of easily soluble elements. Over the course of landscape evolution less soluble weathering products come to predominate. Vegetation must adapt to relatively harsh habitat conditions.

Substances from the eluvial landscapes are washaed out into the groundwater. Superaqual landscapes form in areas where the terrain surface is within range of the water table effects. The formation of superaqual landscape properties is strictly linked to the side inflow of matter and the qualities of capillar uprising water. Such landscape accumulates a variety of elements washed away from eluvial terrains. Subaqual terrains, formed as a result of side inflow of matter, are the final recipients of matter washed away from various landscape elements. In consequence, various landscape types may be analysed as components of a horizontal relationship through which their degree of autonomy may be identified. Eluvial landscapes occupy the uppermost position (autonomous), while super- and subaqual landscapes are subordinate. The connection between the particular units has been called landscape feedback.

Of course, Polynov's concept of landscape does not exhaust all the possibilities of coexistence and correlations between landscape units. It is rather a model which simplifies (idealizes) the examined geographic reality. This model regards matter migration as the main factor shaping landscape characteristics. Furthermore, it associates the path of migration, above all, with relief and the depth of the ground water table.

The model developed by Polynov well reflects the real characteristics of landscapes developed on permeable bedrock in humid climate. In other geographic conditions it proves to be less reliable. In later years, this model was improved and enhanced by, among others, Glazovska, 1964; Perelman, 1971; Perelman, Kasimov, 1999. The eluvial landscapes were divided according to the type of bedrock and new unit types appeared, e.g. transit, transit-accumulation, different kinds of landscape feedbacks were distinguished, e.g. ground-water, erosion, intra-soil. Much attention was paid to matter migration forms, i.e. mechanical, water, atmospheric, biological and the so-called migration barriers which generate matter accumulation in landscape, e.g. biological, mechanical and sorption barriers. Due to improvements and numerous enhancements, the concept of landscape as a system of elements conected by means of matter migration has achieved universality. It may be used in research of different landscape types, both on land as well as underwater, natural or altered by anthropopressure.

CHARACTERISTICS OF THE RESEARCH METHOD

The geochemical school of research has introduced numerous enhancements and adjustments to the methodology of physical geography and in particular, to complex physical geography, also known as geoecology or landscape geography. The enhancements comprise both the theoretical (logical) and operational[1] components of the scientific method. They include two main research areas of landscape geography, i.e. 1) delimitation and systematization of landscape units; 2) examination of the connection between components of landscape.

The methodology of delimitation of landscape units (geocomplexes) is based on an analysis of the so-called leading elements (Kondracki, 1976; Richling, 1982; Richling, Solon, 2002). The term “leading element” is understood as a landscape component which has significant impact on the other components. In the classical understanding of physical geography, this condition is fulfiled by stable components which undergo slow modifications, such as climate, substratum, relief. The reasoning of landscape issues is based on an analysis of these components. Less stable components such as water, soil, biota are presented as being subordinated, adapting to the character of the leading components. Of course, the reasoning also takes into account the opposite dependences, however it concentrates on the main direction of impact. Presentation of landscape as a structure of linked components in which change of one of the elements carries out changes of the others is the result. Borders of the particular landscape structures (geocomplexes) are determined by diffenrentiation of stable components. Analysis of the subordinated components has significance only in large scale (detailed) research.

The method of delimitation of landscape units initiated by Polyanov’s studies proposes a different hierarchy of landscape components. Active components, intensively shaping the course of the matter migration, are regarded as the most important. The biota is the leading component, regarded as the „motor” of the landscape processes. Therefore, borders of the main landscape structures refer to diversity of biomass production and quantity, the kind of plants etc. (Perelman, 1971; Perelman, Kasimow, 1999). Characteristics of water circulating in landscape, e.g. its chemical properties, are also significant to the designated borders. The stable components, e.g. substratum, however, are treated as being passive, less important to the landscape processes. Thus, they are only analyzed on a large scale, i.e. on lower level of the unit taxonomy. Typical is also the difference in approach to soil examination. In the classical geographic approach, detailed investigations of this component is not regarded as an indispensible element of the

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[1] The operational component of the research method comprises the principles of using research techniques and instruments, e.g. measuring equipment. The logical component comprises the logical principles used during argumentation and justification, e.g. types of reasoning (Chojnicki 1999).

landscape mapping procedure. The subordinate place of soil in the geosystem allows to reliably (deductiv) conclude about its properties. In Polynov's viewpoint, however, detailed identification of soil characteristics has the key significance. Soil is a specific "material evidence", proof of functioning of all components. Knowledge of soil characteristics allows to carry out reliable (inductive) conclusions about the whole landscape system. Differences in the delimitation effects of landscape units, obtained by application of the leading element method, are the result of differenes in the component hierarchy. These differences increase as a result of using dissimilar formal and logical methods of systemizing units. Landscape geochemistry, as in the case of pedology or botany, uses extended systems of taxonomic units (standards) to which the examined object (landscape unit) is qualified. Less developed systematics are most often used in landscape geography. The number of standards to which the examined unit is compared usually amounts to one. The object of systematics, however, differs. Depending of the scale of research, it may be an ecotope (on a large scale) or an association of ecotopes (on a small scale). In consequence of the described differences, geochemical landscape maps may show, and usually do, completely different unit borders than geocomplex maps.

A very significant characteristic of the Polynov's method is the way to research of interdependence between landscape elements, i.e. components of nature and spatial units. It is based on identification of the chemical composition of particular components (plants, soil, waste-mantle, water, etc.). The quantity and the quality of the matter streams, moving between landscape components vertically and horizontally is characterized on this basis. Therefore, the scientific research developed by Polynov may be called "complex chemical geography". The name of "landscape geochemistry", however, has been universally accepted.

THE RANGE OF USEFULNESS OF THE CONCEPT

Introduction of the „ion" level of landscape research has numerous methodological advantages (Ostaszewska, 1992). It lets unify the research method of all the components, regardless of their diversity on the macroscopic level. In a significant manner, it reduces the subjectivity of landscape research and increases the comparability of results. It directs the researchers' attention to the measurable landscape characteristics which facilitate construction of dynamic models and forecasting landscape development in time. Despite serious benefits, the "Polynov School" did not eliminate other concepts and research methods from landscape geography. The reasons for the relatively limited reception of the School's achievements may be divided into two groups. The first stems from external reasons in regard to the geographer community and the second from internal reasons. The latter are both subjective and objective.

The external reasons stem from the impact of the surroundings of the scientific system[2] on diffusion of innovation and achieving progress in knowledge. In the beginning, the language barrier was the key obtrusion in popularizing Polynov's concept amidst the international geographers' society. Later on, isolation of scientists living on both side of the "Iron Curtain" was also a significant reason. In consequence, landscape geochemistry in its "geographic" (Polynov's) version was, above all, well known in nations of the so-called "Eastern Block". The adaption of the concept to the geographers' scientific practice had no assistance on the part of its "chemical", quantitative character. The need to carry out measurements and laboratory markings depends the knowledge progress not only on ingenuity and laboriousness of geographers but also on their instrumentarium and, indirectly, on the financial resources being at their disposal.

Among the internal causes an important place is occupied by, more or less justifiably, anxiety on the part of geographers who feared the possible reduction of landscape research to chemical research. It is worth noting that in Polynov's concept reductionism is, at most, of pragmatic (instrumental) character and not idealogical, i.e. on principle removing landscape geography and in its place introducing landscape chemistry as a much more fundamental science. It is possible to simply state that the methodology of landscape geochemistry enriches itself and facilitates geographic application. On the basis of a similar principle, analysis of body fluid composition enriches and facilitates diagnosing patients.

An important obstacle in accepting Polynov's concept as the basis for landscape research seems to be the limited scope of research issues generated by it. Not all issues, traditionally raised by landscape geographers, may be resolved on the basis of Polynov's theory. Above all, they include intermediate issues of physical geography and socio-economic geography, such as assessment of the usefulness of landscape for recreation, assessment of the aesthetics of landscape, etc.

The usefulness of "Polynov's School" appears most fully in research on landscape dynamics. Such research is conducted within framework of both the cognitive (pure) and applied (practical) trend of landscape research. In the first case, landscape characteristics are obtained, regarded as a geosystem in which individual elements are connected by currents of moving matter. The quantitative and qualitative aspects of matter migration and its results, observed on the micro and macro levels, are explained. Examples of studies representing this trend at the Faculty of Geography and Regional Studies in Warsaw are numerous studies by Wicik, devoted, among others issues, to geochemical landscape characteristics of the temperate zone, as exemplified by Poland (e.g. 1986, 1992, 2000) and Bulgaria (1985), the arid steppe zones, as exemplified by Mongolia (1981, 1999), and the hot zone, as

[2] According to Chojnicki (1999), the surroundings of the scientific system includes the natural, cultural-technical and social environment.

exemplified by Cuba (1988). Attempts to use the landscape-geochemical methodology in physical-geographic research of the cognitive character were undertaken by Ostaszewska (1987), Ołdak (1988) and Harasimiuk (1997). The practical (applied) trend of landscape-geochemical landscape research is represented by assessment of environmental hazards and degradation as the result of different forms of anthropopressure (Malinowska, 1997; Ostaszewska, Harasimiuk, 1990). In recent years, together with an increase in the popularity of quantitative and systemic research, has increased the number of studies using and modifying chosen aspects of the landscape-geochemical methodology. Studies on geosystem modelling (Richling, Lechnio, 2005) as well as on the methodology of delimitation of spatial units (Ostaszewska, 2008) constitute such examples.

SUMMARY AND CONCLUSIONS

Polynov's landscape concept is a typical example of the systemic approach. In place of the traditional research problem enquiring what *is* the world *like*, it asks: "how *does* this world *function*". It is worth underscoring that the discussed concept was created long time prior to dissemination of the system theory.

Among the key merits of Polynov's concept are: 1) dynamic treating of research object; 2) uniform manner of studying the component connections. Polynov's methodology functions well in research on landscape dynamics. Explanations achieved with this methodology distinguish themselves by large precision as well as universality. It is also useful in studies directed practically, among others, at research on landscape degradation in consequence of erosion, changes in water conditions, changes of land use, climate changes, impact of air pollution, etc. Usefulness constraints of disscused physico-geographical concept become visible at the meeting place with socio-economic geography, especially with humanistic geography. They regard some issues (landscape assessment) for which traditionally delimited geocomplexes are a better point of reference (e.g. assessment of landscape aesthetics).

The aforementioned examples indicate that landscape research, fruitful and useful in other disciplines, must be carried out in numerous directions. There is no one universal unit of reference for them (Richling, Ostaszewska, 1993; Ostaszewska, 2002). Cognisance of this fact gains particular significance in the face of challenges and opportunities which landscape researchers face because of the implementation of the European Landscape Convention, ratified by numerous countries, including Poland. In accordance with article 6 of this Convention, parties are obliged to: 1) identify and analyze characteristics of "their own landscapes": 2) analyze forces and pressures transforming landscapes; 3) train specialists in the area of landscape assessment, its protection and planning. To a large degree, the success of each of these measures depends on the use of the over one hundred year-long experience of landscape geography, including its landscape-geochemical school.

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