

# Polysystem Analysis and Synthesis

THE APPLICATION IN GEOGRAPHY

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The subject of the book is to develop a general methodology of a complex object (the Earth and peculiar to it phenomena and processes) exploration from various aspects (view points), in various system projections using the polysystem methodology, that arise from the logic of contradiction analysis, the notions and the laws of General Theory of Systems in an author's interpretation, as well as from nowadays mathematical paradigm of multidimension fibered spaces [bundles]. For each scientific view [projection] an axiomatic theory is being developed. The theory describes natural, economic, social structures and their changes with special system language [and in a through way]. About 20 theoretical directions were highlighted, which reflect various aspects of geographical phenomena investigation of various scales, structuring existing knowledge and allowing to obtain new explanation to [the] facts. A short analysis of the conceptual basis is presented for the directions; used mathematical formalism and tools are introduced; the arrived conclusions are illustrates by examples.

The book could be of interest to the researchers of various scientific fields, which deal with studying of theoretical knowledge formation foundations and development of a system methodology for concrete problem solving [investigation].

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# Preface of editor in chief

A peculiarity of the studies of the holistic picture of the nature had been elaborated as the logical foundation by XIX-th century (A. Humboldt (?), V. Dokuchaev and others): a whole visual identity of an uncertain [?unsystem?] form [corresponded] to a [representation] of natural objects as “many-in-one” had been used for interpretation the nature patterns [relation, relationships]. As the identities was visual, they were mapped; as they corresponded to concrete phenomena, they were interpreted [via] natural components and causalities. This contributed to sectoral branches of geography. Expectations to determination and description of the universal relationship of the phenomena and their object subordination were entrusted to the theoretical basis if the classical landscape science ([beginning–middle] of XX-th century). The notions ontologisation started providing the integrity of perception, resulting in prompt establishment [formation] of the nowadays geography, in particular, the research method for new facts acquisition and scientific conclusions verification. This gave the concrete results characterizing natural and social–economic formations in a new fashion, for example, in the zonal concept. The advance realized the necessary foundation to shift major geographical interpretations from the intuitive ranks to the rank of more precise ones.

In recent years, thanks to a number of objective reasons geography promptly switched from visual observations and generalizations to scientifically organized research in controllable environments. It adopts and develops methodological approaches based on contemporary instruments and new technologies for solving complex geographical problems. Various structures of geographical objects are involved in effects. The essence of the involvements is to be understood. How they should be analyzed? — As different independent structures followed by their causalities studies, or as whole straight away. Overcoming inertia of intrageographical way of reasoning, a general scientific approach to theory and practice of the complex objects operations have to be developed. A trend is being formed that imposes heavy demands to geography metatheory. It recognized disparity [contradictions] epistemological principles and new facts, that almost resulted in discrediting the naive epistemological foundation of classical geography. The known discontentment to its

postulates and the necessity perception of their replacement are the outcome of [the trend] as well.

The monograph of Professor A.K. Cherkashin in this regard has a distinctive character [nature?-]. This is an original effort of a scientist who on the base of the great personal experience of the research work in different knowledge areas seeks to formulate new problems emerging to the geographical science, and to trace ways and methods of their solutions. The center of author's attention is the theory and the methodology of polysystem analysis and synthesis. Their importance will be understood [by reader] when the objects of the geographical matter [reality] as complex formation, which cannot be described [interpreted] within one theory, has been accepted, with the polysystem analysis being the special field of the [a] constructive research of [the] complex objects. Its methods originated from theoretical and methodological basis of the general theory of systems, the formal and dialectical logics, which are successfully applied in various sciences. The idea of polysystem organization of nature together with social formations created by human being on the background of information lack on their properties, processes and states introduces new elements in the system research of the geographical environment. Firstly, the necessity appears to elaborate [create] a new [diverse] way of systemic qualities classification, methods of their description, recognition and fixation in the science practice. Secondly, and it is essential, in the system research, realizing the objectivity concept in recognition of the systems of various kinds, the informational barrier appears between qualitative and quantitative measurement [commensurability] of ambiguous, unequal and insufficient facts. That's why the informative study of the systems of a certain class must be completed with a set of the research [tools, ware] and methods supplying validity and regularity of the information in a knowledge system. Thirdly, a new approach of creation of an informational basis [base] of the [nature integrity] study and its formalization for description of the elements dependence and the system's outer relationships must be developed.

The ways of the knowledge acquisition and utilization [usage] are developed at the various levels [...of...]. In geography, the studies based on information [collection] techniques and the followed empirical data generalization are developed and still in an active development. Naturally, they will not come up to the total completion as the [any] experience should not [cannot] be interpreted in the abstract[ion] to [a] conceptual and logical basis, which enables the scientific interpretation. The fact of the sensory perception itself implies the activity of our consciousness, and it is the result not just "sensory signals" by (E. Mah??), but it involves the reasoning, which takes into account the multistage criterion of the [practice, experience] aggregating the facts of the reality not only as "naive" unsystematic and logically unformal interpretation, but as their dependencies. The consciousness performs a great selection and classification work, that results in necessity to find new, renew the traditional

or adopt taken from various sciences methodological ways, procedures and research operations. This investigation by A.K. Cherkashin is devoted to a methods systematization, definitive restructuring geography foundation and its sequential explicit formalization, as it had been [was] in other precise sciences, for example, in physics and mathematics, which are the reference point of new cognitively means.

He recognized important problems of knowledge acquisition experience generalization, using procedures and algorithms of various diversity of the research study, on the stage of transition from the empirical to the theoretical level. It is not just a question of necessity of separation [individualization] and application of the epidemiological operations to observable processes and natural phenomena, but operations over complex objects, which cannot be interpreted and predicted on the base of “common sense”, they [?objects?] require elaboration of complex multistage conceptual theories. The essence is that scientific geographical analysis in the beginning was “the science on nature”, where natural science facts delivered by human intelligence are fused inseparably, — intuition and logic [entered, infiltrated] from language of nature itself to descriptive geography. [The] Study of the logical aspects of [the] analysis was not actual. Now the conditions has changed, having to deal with the world of complex systems, it became difficult for geographers to match [the, such] theory [of such kind] with “the things of the material world” [themselves], and a special compass have to be constructed disallowing to be gone astray and directing the research along the right path. The strict logical method of reasoning staking a claim to the role of such compass. That’s why need for studying and application of the laws of logic increased substantially. The polysystem approach pays particular attention to modeling complex objects of nature and the usage of logical and mathematical methods. This important aspect of the objective development of geographical science is the main subject of the book [of A.K. Cherkashin].

The problem of interaction and communications of various fields of knowledge is in the author’s field of view. In particular, this is due to his great attention to the models and the conceptual base of the studies [research]. This approach has been applied to form a system of notions and to demonstrate manifold capabilities of manipulation of language elements of a theory — axioms, notions, definitions — according to precise rules of logic with argumentation of the validity of the obtained results. Author has generalized the formalization methods of many sciences, their knowledge has been placed in the service to geography. This expresses the longstanding desire of geographers to consciously reflect the facts in notions of a wide coverage in recognizing and describing natural and socio-economic formations. In essence, he elaborated a multiaspect scheme [blueprint] of formalization of the geographical laws and patterns for recognition of the global [general] through directions of theoretical generalization of the study [research] results [and features of methodological operations in the concrete-science problems solving]. Their application capabilities are



demonstrated in geography and other sciences [as well]. By means of the representations modeling techniques and mathematical models conjugate to the meaningful geography of empirical generalizations in a natural way.

Of cause, one must realize that scientific problematics the book devoted to is complex, versatile and not well elaborated. Therefore, the transition of the present geography science to this direction is far to be finished, but it gives [presents] as it can be seen from A.K. Cherkashin's research the first useful results. The considered problems contain elements of doubtfulness [uncertainty] and discussion [question]. Understanding complex natural and other objects as a complex polysystems is rather difficult and multistage process [than thought before]. It involves the construction of many scientific concepts that have no prototypes in the real nature and cognitive situations. The concepts allow one to move from general philosophical categories to the concrete equations and evaluations, expressing logical origins of each pattern emergence [occurrence]. The research of A.K. Cherkashin allows to develop "extensive" interpretation of the structure of geography study via foundation of existence of levels and types of the initial information, acquired from various sources, which having been generalized with [unified] method, are reduced in the issue to equivalent interpretations of the scientific knowledge. This fills the gap between traditional investigation of the geographical phenomena and geography itself, coming to replace it.

Professor V.S. Mikheev, Geography Sciences

# Introduction

The main challenge [problem] of the contemporary science is the problem of comprehension of complex [objects]. Experience provides plenty of evidence to ensure that any complex phenomenon will not become simple whenever extending our knowledge, instead, it converts to something more complex and incomprehensible. Therefore, the complexity as an universal quality of objects should be discussed not with respect to our knowledge level, but it should be regarded with the same degree of reality as other fundamental properties of objects. This approach requires the researchers to use the corresponding methodology and the logic of thinking, to have new vision of the established notions on processed and phenomena.

In science, there are fields of knowledge that deals with complex objects, phenomena and processes, and it is the existence basis of their subject of investigation. They are ancient so called synthetic domains, which include in the first place history, medicine and geography. Known Latin adage “*historia est mater studiorum*” reflects the essence of the historical cognition as the starting point of any human knowledge.

Some reasons hider the holistic synthetic cognition of the complex processes and phenomena. Firstly, it is not clear what is to be synthesized. It seems that the scientific knowledge differentiation did not reach yet the necessary degree of desalination to recognize the bricks of scientific knowledge, which form the picture of the world from. Secondly, the principles of system synthesis did not well established yet. Thirdly, the logics and the methodology, which are necessary for the analysis and synthesis, are not sufficiently completed.

Historically the logic of the present science was founded more than two thousands year ago in the works of Aristotle on the formal logics. It is the formal logics become the ideal of the scientific thinking and primarily in mathematics and physics, which resulted to a great extent in their permanent progress. Nowadays computerization is [almost, the] explicit expression of the triumph of the formal logics as computers function [almost] exclusively on the base of the principles and the properties of binary calculi peculiar to it.

However the logic of life [nature] and human thinking goes far beyond the formal binary algorithms, it is demonstrated especially well by expert systems [software] development. The meaningful knowledge of the experts are realized as computer programs with difficulty, and the obtained software [usually] is inferior to the capabilities of the experts.

(page 16 follows)



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