EMPIRICAL-SCIENTIFIC MODEL OF GEOGRAPHY

Zbyszko Chojnicki

Adam Mickiewicz University, Institute of Socio-Economic Geography and Spatial Management, Poznań, Poland

Manuscript received April 15, 2011
Revised version June 13, 2011

Chojnicki Z., Empirical-scientific model of geography. *Quaestiones Geographicae* 30(2), Bogucki Wydawnictwo Naukowe, Poznań 2011, pp. 7–22, DOI 10.2478/v10117-011-0014-0, ISBN 978-83-62662-62-3, ISSN 0137-477X.

Abstract: The article presents a philosophical-methodological conception of an empirical-scientific model of geography as an empirical science. It consists of an introduction and two parts. The introduction discusses the notion of philosophical-methodological models of geography and philosophical orientations. Part one addresses the philosophical-methodological foundations of the model, which are three successive philosophical streams: empiricism, logical empiricism (neo-positivism), and scientific philosophy. Part two offers a characterisation of the empirical-scientific model in terms of the principles of scientific philosophy embracing three chief problem areas: ontological, epistemological and methodological.

Key words: empirical-scientific model, empirical sciences, logical empiricism, scientific philosophy, ontological, epistemological and methodological problems

Zbyszko Chojnicki, Institute of Socio-Economic Geography and Spatial Management, Adam Mickiewicz University, ul. Dzięgielowa 27, 61-680 Poznań, Poland

1. Introduction

The article seeks to present an empirical-scientific model of modern geography. It is a basic philosophical-methodological standard of geography which defines it as an empirical science. It accommodates cognitive properties of geography which describe and determine its scientific character.

Philosophical-methodological models of geography are fundamental elements of a meta-scientific study of geography. They give the characteristics of those philosophical aspects of geography that are considered essential in terms of the philosophical assumptions adopted. Those assumptions derive from various philosophical streams or trends that form philosophical orientations of geography.

According to Maik (2007: 31), "The dispute over the right methodology of geography went on for the entire 20th century. Methodological discussions greatly contributed to the development of our discipline [geography], especially in the second half of the 20th century. (...) When sketching the general methodological panorama of the research in this field, one can find that methodological progress did not involve a replacement of older research paradigms by new ones; rather, it was a result of an inflow of new philosophical-methodological solutions".

The philosophical studies undertaken by geographers seeking to determine the cognitive nature of geography focused on various directions or streams of philosophy as philosophical assumptions. In the 1960s there appeared various philosophical-methodological orientations of geography. Thus, the choice of a concrete direction of philosophical meta-scientific study of geography determines its notional framework and principles of its philosophical orientation. In reflections on the philosophical foundations of geography several orientations were distinguished, including empiricism, positivism and neo-positivism, humanism, phenomenology, idealism, structuralism, Marxism and neo-Marxism, postmodernism, and feminism (cf. Chojnicki 1985, 2004; Cloke et al. 1991; Peet 1998; Fotheringham 2006).

While I do not propose to discuss those orientations in detail, let me emphasise that their role in the shaping of philosophical-methodological models of geography has been neither unequivocal, nor uniform. The individual orientations do not determine the character of the models in a straightforward way. Some, like postmodernism or feminism, do not work out philosophical-scientific models in the proper sense, i.e. as cognitive-scientific standards. Rather, they offer a world view – an opinion about the world containing some philosophical-ideological elements only marginally connected with science.

Philosophical-methodological models of geography should be seen as including only those standards that define the nature of geographical inquiry and knowledge. Their assumptions are established on the ground of the philosophy of science, i.e. philosophical reflection concerning science and scientific cognition. On this basis two models of contemporary geography have been worked out: empirical-scientific and humanistic. They differ fundamentally. The empirical-scientific model places geography among empirical sciences, which embrace both natural and socio-economic disciplines, and concerns the research fields of physical and socio-economic geography. The humanistic model, in turn, rests on the philosophical assumptions of the humanities and their cognitive conceptions. This largely restricts its area of study to human (socio-economic) geography.

Unlike the above, doctrinal orientations, like Marxism and neo-Marxism, and ideological ones, like postmodernism and feminism, do not provide a philosophical basis for the construction of philosophical-methodological models of geography. They focus on a radical transformation of society, as in the case of Marxism and neo-Marxism, or on the rejection of research methods in favour of an approach to knowledge as an analysis of texts and a variety of discourses of equal validity, as postulated by postmodernism, or in favour of differentiating the cognitive and practical character of geographical knowledge by the criterion of gender (feminism). What is characteristic of those orientations, mostly popular in American geography and with reference to 'human geography', is the perception of various philosophical streams and conceptions as a source of a fundamental reconstruction of geography in opposition to the empirical approach.

It should be emphasised that the adoption of doctrinal and ideological orientations as philosophical assumptions of geography means an *epistemological break-up*, i.e. a process of a radical transformation of the cognitive nature of geography as a result of which it can no longer appear in the role of an empirical science. Therefore one should defend the conception of geography as an empirical science by demonstrating that its empirical-scientific model is the right and productive basis offering an insight into its cognitive character and the directions of its development.

In the modern system of sciences, empirical sciences are taken to include natural sciences (physics, chemistry and biology, including the earth sciences), social sciences (economy, sociology, political sciences, linguistics, cultural sciences, and law) as well as cross-disciplines and mixtures (anthropology, ecology, psychology and geography) (cf. Bunge 1983). While empirical sciences were at first identified with natural ones, the conception has been extended to include those dealing with human beings and society whose methodologies assumed an empirical character; this has been termed methodological naturalism. Thus, the notion of empirical sciences offers a broader framework for the study of reality than that of natural sciences while preserving the specificity of natural and social sciences, largely determined by their subject matters and research problems.

2. Philosophical-methodological foundations of the empirical-scientific model of geography

The empirical-scientific model of geography has formed under the influence of *empiricism* as a philosophical stream. This influence was not continuous and differed in its forms and intensity in the course of development of geographical thought.

The effect of empiricism proclaiming the opinion that notions and knowledge rest on sensory experience and observation could be found in 19th-century geography. Boven (1981), who traced the influence of empiricism on the conceptions of geography in the 19th century, demonstrated that empiricist philosophy determined the path of understanding of geography as an empirical science. She ascribed an important role in this to Alexander von Humboldt and his conception of examining the whole of nature in a geographical approach (1981: 258–259). Empiricist philosophy did not have a decisive effect on the formation of the empirical-scientific model of geography, but it made itself felt in a variety of versions as an opinion stressing the role of observation and the creation of an empirical base as a source of description in the geographical research procedure.

It was only *logical empiricism*, also called *neo-positivism*, that considerably influenced the formation of the empirical-scientific model of geography; it became the chief basis of philosophical and methodological analysis in science. Logical empiricism is considered the leading direction in the 20th-century philosophy of science (Kołakowski 1966; Czarnocka 1995; Chojnicki 2000). Its effect was not doctrinal; it manifested itself primarily in the adoption of 'scientificity criteria' grounded in it to define the methodological standard of geography.

It is believed that the first study to apply the assumptions of logical empiricism (neo-positivism) was Schaefer's (1953), who suggested regarding geography as a science formulating laws governing the spatial distribution of phenomena on the Earth's surface, thus making their explanation possible (cf. Unwin 1992: 113). The fundamental work based on the methodological assumptions of logical empiricism (neo-positivism) is thought to be Harvey's *Explanation in geography* (1969). As the title suggests, it focuses on the notion of explanation as the chief goal of scientific activity. The basic means of achieving this task are scientific laws, theories and explanation-oriented conceptual models. Those issues are discussed in terms of a formal analysis of the language of geographical knowledge, geometry and the theory of probability, and description methods of systems analysis. Harvey's work can be treated as the first attempt to present an empirical-scientific model of geography. However, the philosophical-methodological assumptions underlying *Explanation in geography* are not restricted to those of logical empiricism; they also include Popper's (1965) conceptions of critical rationalism and deductivism. This manifests itself, among other things, in inductive reasoning being supplemented in the book with the deductive falsification method. It may also be emphasised here that claims about Popper's views belonging to logical empiricism (made by some philosophising geographers) are wrong. As Wójcicki maintains (1991: 91), Popper was less a continuator of neo-positivism (logical empiricism) than its gravedigger. Later Harvey (1972) adopted the Marxist and the radical orientations in his study of the nature of geography, which, however, does not invalidate the significance of his contribution to the development of its empirical-scientific model.

In geographical inquiry, the conception of logical empiricism found expression in a programmatic recognition of inductive inference in making generalisations with the help of quantitative, especially statistical, methods, since the methodological core of logical empiricism is the opinion of inductivism about the fundamental role of inductive reasoning in formulating scientific laws and theories. According to Wilson (1972: 32), "The inductive method involves theorizing from a mass of observations. In its most refined form, this is more or less coincident with statistical analysis". This adoption of quantitative, especially statistical, methods, or the co-called quantitative revolution in geographical research, manifested itself mainly in spatial analysis concentrating largely on the examination of spatial structures and processes (cf. Berry & Marble 1968; Chojnicki & Marble 1973). With reference to socio-economic (human) geography, this approach was termed 'spatial science', although this conception was not kept up (cf. Cloke et al. 1991).

Logical empiricism aroused widespread criticism, both internal and external. Internal criticism focused on the one-sidedness of the statistical-inductive approach and its poor contribution to the process of formation of the theoretical aspect of geography. It is worth noting, however, that both the quantification of geographical knowledge and its theorisation were not closed processes and drew from a number of new post-positivistic conceptions put forward in the philosophy of empirical sciences.

External criticism concentrated on questioning, or even rejecting, the conception of geography as an empirical science. First of all, the opinion identifying the neo-positivistic orientation with the foundations of the philosophy and methodology of science should be rejected. This opinion was and is a result of a superficial acquaintance with the modern philosophy of science. Today's empirical-scientific model of geography does not rely on the assumptions of logical empiricism. Logical empiricism, despite its substantial contribution to the philosophy of science – the working out of a conceptual apparatus of the methodology of sciences and the introduction of logical analysis, a new style of practising the philosophy of science – is a historically closed orientation. The present-day character of science eludes the assumptions and theses of logical empiricism, and the modern philosophy of science cannot be identified with logical empiricism, which is only a fragment of its development.

Since the 1970s, the external criticism of neo-positivistic orientations has been accompanied by efforts to reconstruct geography, especially its socio-economic (human) branch, within the framework of philosophical orientations formed outside the philosophy of science, mainly doctrinal-ideological ones, like Marxism, postmodernism, and feminism.

Further development of the empirical-scientific model of geography has gone far beyond the assumptions of logical empiricism. Today its philosophical-methodological foundations are thought to be various *post-positivistic* assumptions of the philosophy of science proper to analysis in empirical sciences. This approach, which can also be called critical-empirical, displays a kind of philosophical-methodological pluralism which consists in making use of some streams of the philosophy of science, like Popper's critical rationalism and hypothetism, Lakatos' methodology of research programmes, Kuhn's paradigms, transcendental realism, and other (cf. Bird 1993).

It would be hard to give even an outline of the notions and principles of those streams that are components of the modern philosophy of science (cf. Chojnicki 2000). Efforts to employ their conceptions to determine the philosophical-methodological nature of geography have failed to produce its reasonably uniform characterisation as an empirical science. They are a source of conceptual principles and categories which underlie models of empirical sciences.

What I assume to be the foundations of the empirical-scientific model of geography are largely the principles and notions of scientific philosophy as a philosophical orientation, and on this basis I seek to determine its integrated model (Chojnicki 2004: 199). Scientific philosophy approaches the modern philosophy of science as a whole, which allows grasping and presenting the cognitive character of empirical sciences in a relatively consistent way. Within its conceptual framework it was possible to concretise the assumptions and conceptual categories of the empirical-scientific model of geography.

A conception of scientific philosophy and its synthesis was formulated and worked out by Mario Bunge in his *Treatise on basic philosophy* (volumes I-VIII, 1974–1989). In a different approach it was also presented by Grzegorczyk (1993). It can be characterised succinctly as follows: "Scientific philosophy is closely connected with scientific knowledge. And while it provides a basis for the philosophical inquiry into science, it has a scientific character itself, because it meets the criteria proper to scientific knowledge and must be consistent with it. (...) Thus, scientific philosophy does not obey its meta-scientific character and does not dominate over science. This requires the use of some formal logical tools of the theory of logical syntax and semantics, as well as the theory of definitions and inferences. However, chief emphasis is put here on making notions precise, on argumentation and justification, rather than on a formal logical analysis of the scientific character of knowledge and its axiomatic-deductive structure. Such an analysis is a necessary but not predominant (...) element of a study of science" (Chojnicki 2004: 200). The subject matter of scientific philosophy embraces both, methodological assumptions as well as ontological and epistemological ones. According to Bunge (1983: 204), "There is no science without some ontology and some epistemology. To begin with, all the fundamental concepts of science, such as those of thing and property, state and change of state, possibility and actuality, space and time, life and mind, artifact and society, are ontological. Secondly, when exploring some unchartered territory, a scientist is tacitly guided by a number of ontological and epistemological principles. For one thing, he presupposes that the most general known laws hold in the new territory, and that the most general methodological principles will help him to explore it. (...) If he believes in objective possibility, he will investigate things-in-their-environment instead of trying to account for their behavior exclusively in terms of environmental agencies. If he believes in randomness, he will try stochastic models, otherwise he will limit himself to deterministic ones. If he is an inductivist, he will collect as many facts as possible before hazarding any hypotheses. If he is a deductivist, he will prefer exploring the logical consequences of hypotheses presupposed by others."

The empirical-scientific model of geography and its character as an empirical science is not an object of much interest and philosophical reflection today. This is due, on the one hand, to the nihilistic criticism of the usefulness of conceptions of the philosophy of science in the meta-scientific study of geography, and on the other, attempts to employ humanistic and ideological-radical orientations to reconstruct geography, especially socio-economic (human) geography.

3. Philosophical-methodological characteristics of the empirical-scientific model of geography

The empirical-scientific model of geography defines its properties as an empirical science. Its characterisation in terms of assumptions of scientific philosophy embraces three main problem areas: ontological, epistemological and methodological.

Ontological problems involve the substantive structure of 'the world of geography', or the fragment of reality it addresses in its research. Epistemological problems deal with the cognitive nature of geographical inquiry. Methodological problems include the research procedure and activities (methods) as well as the structure and function of geographical knowledge. The characterisation of each problem area of the empirical-scientific model of geography contains theses that are concretisations of the basic principles and notions of the philosophy of science and that present specific philosophical-methodological properties of geography as an empirical science.

3.1. Ontological problems

According to Benton & Craib (2001: 5), "Each discipline has its own regional ontology, its own way of listing, describing and classifying the range of things, relations or processes it deals with; this is the range of things which it claims to give us knowledge of."

Ontological problems of geography involve primarily the definition of its subject matter. Within the framework of scientific philosophy, this can best be done on the ground of ontological realism, which presupposes the existence of the world independently of the investigating mind. Ontological realism leads to the assumption (opinion) that the subject matter of empirical sciences is their domain, which consists of objects of some kind, their properties, and relations holding among them. It is assumed that it determines the research scope of the given science and the subject matter of its inquiry.

The issue of the subject matter of geography and its scope is highly debatable and poorly rooted ontologically. The approach to it presented here is a modification of an earlier one (Chojnicki 2005). In the empirical-scientific model, the problem of the domain of geography looks as follows.

In sciences in which knowledge has a theoretical character and takes the form of basic theories, the domain of a given discipline is defined by the subject-matter models those theories comprise. Subject-matter models contain conceptual constructs of objects and relations examined by those theories and their research assumptions. Hence, the development or creation of new basic theories changes their domain. Owing to the absence of basic theories in the structure of geographical knowledge, subject-matter models defining the domain of geography are contained in separate pre-theories. The models in those pre-theories denote objects and their properties or relations that are the subject matter of geographical inquiry. Among the major pre-theories one can list the systems, chorological, landscape, environmental, interactive, and regional ones. Their content and problems have not been given uniform definitions, so they occur in a variety of versions (cf. Maik et al. 2005).

Without going into the details of those pre-theories, let me mention that the one worth special attention among them is the systems approach. It allows perceiving the domain of geography as a variety or concretisation of the notion of a real system, which is a basic ontological category. In 'systems philosophy' reality is a highly complex "world of systems" (cf. Bunge 1977). A substantive interpretation of the systems approach in geography was first given by Chorley (1962), and then by Haggett (1965) and Chapman (1977), who laid the foundations for a systems pre-theory. It offers a conceptual framework for a wide spectrum of systemic subject-matter models of basic significance for determining the subject matter and research field of geography with reference to its empirical-scientific model.

The pre-theories can be treated as competitive subject-matter hypotheses giving geography a different character and scope, i.e. defining its research field in various ways. Their competitiveness can be assessed with the help of criteria determining (1) the field of the empirical research of geography and its research procedure, and (2) its growth potential. By the first criterion, the most constructive cognitively will be that of the pre-theories which defines its research field in the broadest way possible. The adoption of the other criterion gives preference to those pre-theories that offer greater opportunities for innovation and development in research methods and for the examination of new aspects of reality.

The division of geography into two basic sub-disciplines: physical (natural) and socio-economic (human), highlights their subject-matter differences, i.e. it reflects differences that occur in the spheres of reality they investigate – nature and society – and differences in the regularities that underlie them. The recognition of their deep separateness shifts the issue of the subject matter of geography from a monistic to a dualistic perspective that this division presupposes (cf. Maik 2004).

In connection with the division, there can be various ways of approaching the subject matter of the two sub-disciplines. One involves the adoption of a pre-theory, common to both, which fulfils strong criteria determining and explaining their substantive scopes. For example, the systems approach can be a common substantive basis for both physical and socio-economic geography. Another approach consists in working out separate pre-theories in physical and economic geography which would describe their respective fields of inquiry. The subject-matter approach to geography is criticised. According to Lisowski (2007: 46), there is a growing doubt about the classical conceptions of what constitutes the geographical subject matter which mostly springs from the criticism of the chorological conception.

The approach to this issue changes completely when the focus shifts from the subject matter of geography to its research problems, i.e. priority is given to problems over the substantive scope. This is the opinion presented by Perzanowski (1989: 232), who claims that "with a focus on research problems, attention is paid to what is investigated and the choice of notions is made an instrument, while talking of a domain leads to a confusion as to what is investigated and what results are expected. Concentrating on research problems enduring and evolving over time offers a fuller insight into the history and continuity of the domain than a description of its objects and notions".

Still, I believe that the substantive scope of geography is determined by mutual relations holding between its domain and its research problems. The scope of geography, as of any science, is not a 'ready-made good', and difficulties involved in determining it are not specific to geography; they are widely found especially in social sciences. Thus, the conception of the empirical-scientific model by itself does not settle the question of the substantive nature of geography. Its framework allows a variety of approaches to the domain of geography, though always closely connected with its subject matter and research field (Chojnicki 2007: 21).

3.2. Epistemological problems

Epistemological problems are those concerning the cognitive character of geographical knowledge. I shall restrict my analysis to two issues involving geographical knowledge and standpoints proper to its empirical-scientific model: 1) the adequacy of this knowledge, and 2) its sources. It is worth noting that an analysis of those issues is closely connected with methodological problems.

The standpoint I adopt as a basis for characterising the *adequacy* of geographical knowledge is that of critical, or cognitive, realism. In principle, apart from the view that reality is cognoscible with the help of notions, it assumes that this cognition seeks to find the truth, i.e. to formulate truthful statements. While I shall not discuss the various conceptions of truth, especially its classical definition, let me quote what Wójcicki (1991: 1) has to say on this matter: "If we assert that our knowledge or some part of it concerns an independent reality, we claim something that can be expressed as follows. Reality, or at least those of its fragments that can be objects of our cognition, is endowed with a structure: it consists of some kinds of objects possessing some characteristics and connected by some relations. We are able – and this in fact is the task of science – to grasp this structure of reality correctly and, by working out a suitable conceptual apparatus, to give its description that will be true in the literal sense".

Let me emphasise that this is what fundamentally differentiates this model from doctrinal philosophical conceptions: neo-Marxism, idealism, and especially postmodernism, which generally adopt an anti-realistic position and preach instrumentalism, or the opinion that "there is no one true way of viewing the world" (Wójcicki 1991: 2). Cognitive realism seems to be an essential element of the scientific status of geography. The defence of realism has not been given much attention in the philosophical-methodological analysis of geography, and the problem itself gained some significance with the appearance of co-called transcendental realism (cf. Bhaskar 1975; Sayer 1985). Transcendental realism is a philosophical-methodological stream based on assumptions which, when applied to the cognitive foundations of geography (mostly its socio-economic sub-discipline), are in opposition to the empirical-scientific model owing to their anti-empirical nature (cf. Cloke et al. 1991; Chojnicki 2000: 67).

As to the *sources* of geographical knowledge, it should be emphasised that the empirical-scientific model involves rejecting the thesis – initially accepted in geography – about preference for an empirical base of geographical knowledge. An empirical base, which is a set of observational statements derived from objectivised perceptions, is to be an independent and basic source as well as a component in the building up of geographical knowledge. The preference means that observational statements are supposed to guarantee their own truthfulness or falsehood, so that there is no need for non-observational, theoretical statements to do this (cf. Gregory 1978: 55; Chojnicki 1985: 5). The consequence is a distrust of theories and resistance against theory building. Equal epistemological validity of observational and theoretical statements, or an elimination of this division, is a crucial condition of the development of geography.

3.3. Methodological problems

Methodological problems are at the core of the empirical-scientific model of geography. It employs the full, wide apparatus of methodological assumptions and notions of the modern philosophy of science. This makes possible both, a methodological reconstruction of geography and the presentation of significant programmatic postulates intended to give it the characteristics of an empirical science. Because of the vastness and differences in the interpretation of this matter, I shall limit myself to the presentation of the chief methodological issues of geography specific to this model. They include:

a) theorisation of geographical knowledge,
b) establishment of facts as a basis of the empirical nature of geographical knowledge,

c) symbiosis of inductive and deductive procedures,
d) complementarity of quantitative and qualitative approaches,
e) share of axiological statements in geographical knowledge and inquiry,
f) recognition of explanation and forecasting as the main cognitive functions of geography, and
g) growing importance of the practical function of geographical knowledge.

3.3.1. Theorisation of geographical knowledge

There is a fairly widespread opinion that geography does not possess a developed body of theoretical knowledge. This gives it a pre-theoretical character and limits its potential for explanation and forecasting. Empirical theories are generally identified with a collection of theoretical (non-observational) statements, especially scientific laws, related and arranged logically and thematically and justified empirically, which refer to a domain. In the formal logical approach represented by logical empiricism, scientific theories are termed axiomatic-deductive systems. Elements constituting those theories are built using logical means and form deductively closed sets of statements.

Because of difficulties with the formalisation of statements at a low level of abstraction, attempts to build theories in geography in the form of axiomatic-deductive systems produced results that were trivial in cognitive terms (cf. Amadeo & Golledge 1975). This also concerns social and biological sciences in which, within the post-positivistic model, more liberal methodological standards of theory were adopted that abandoned the principle of its structural-logical formalisation (cf. Bunge 1996).

Thus, further advances in the theorisation of geographical knowledge require some re-thinking of the conception of theory accommodating the specific subject matter and research problems of geography. This, of course, is a task far exceeding the scope of this paper. Still, there are a few associated issues worth considering. I shall restrict myself to two: (1) the 'liberal' methodological standard of theory, and (2) cognitive functions of theory in geography.

Re 1. The liberal methodological standard of theory in geography contains the following conditions:

– Theories include not only scientific laws, but also general statements which are supposed to serve, or which do serve, as premises for explaining, anticipating or forecasting empirical facts. Because of difficulties involved in the formulation of scientific laws, theories are to contain descriptions of regularities underlying the structures or mechanisms that govern the studied phenomena, as well as social trends and rules. As Wójcicki (1991: 13) states, "theories appear when we manage to grasp, at least in a preliminary way, at least in a very general outline, the structure or mechanism (...) of a class of phenomena".
– The substantive reference of a theory (i.e. the fragment of reality that the theory addresses) should display a measure of conceptual consistence (real systems, events and processes), i.e. should offer a good conceptual outline of the whole. It can be presented in the form of subject-matter models, i.e. idealised images of fragments of reality concentrating on some of their properties, usually significant ones.
– The logical links among statements belonging to a theory should ensure it coherence and consistence based on logical or mathematical proof. Mathematical instruments need not be highly refined and can be restricted to mathematical statistics.
– The empirical justification of a theory rests on facts derived from its field. Its individual components should not be justified and verified empirically independently of one another because of the integral nature of the theory.
– In principle, it is assumed that theories are universal in nature. However, since geographical studies concern the spatial heterogeneity of the world, there arises the problem of a local or regional character of some geographical theories. Both the substantive reference of the examined phenomena, especially systems (e.g. geocomplexes, territorial systems), and various mechanisms and regularities have a geographically limited spatial (or spatial-temporal) range, which often gives their theoretical examination a local character. This is a highly controversial problem requir-

ing careful consideration, the more so as the notion of universality itself can be understood in relative terms.

Re 2. Theories in geography perform two kinds of function: autonomous and instrumental. Autonomous functions concern the role that theories play in the research process. Three issues are involved:

- Theories codify and systematise the existing body of knowledge, reveal connections between its fragments and gaps in the current image of the world, and enhance the accumulation of research results.
- Theories facilitate an empirical verification of knowledge because they make it possible to test some statements indirectly, through their links with previously tested statements.
- Theories are a factor initiating further research by posing new problems and indicating new research directions.

The instrumental function appears when the role of a theory goes beyond the framework of the research process, namely when it performs an explanatory and a prognostic function, and indirectly a practical function.

In the theoretical development of geography, at an earlier stage of theory building the chief role was played by autonomous functions. However, of fundamental importance in the theorisation of geographical knowledge is the construction of theories performing instrumental functions because they lay down the basic cognitive aim of scientific knowledge. Theories in geography have not got a uniform character, hence they display a variety of approaches which fulfil the conditions of theory building to a greater or lesser extent and which perform various cognitive and/or practical functions. This issue, however, would need to be explored in more depth.

3.3.2. Establishment of facts as a foundation of the empirical nature of geographical knowledge

Empirical facts are of fundamental importance in building up geographical knowledge. In a broad understanding, facts are states of things or changes in those states (cf. Bunge 2006: 17). According to Wójcicki (1995: 162), "Facts are not identical with any sentences. (...) They are what we reach as a result of suitable empirical activities, like observation in the simplest case, and what we strive to convey using sentences". Facts can be both, single states of things (individual events or processes) and regularities (empirical laws of a limited temporal-spatial range).

In geographical inquiry the basic cognitive practice (method) for ascertaining empirical facts is observation. It is a research procedure seeking to establish a state of things or its change, i.e. an empirical fact, either directly, on the basis of observations made, or indirectly, using instruments or information obtained from respondents in the form of interviews and questionnaires. However, establishing facts is not autonomous because it always rests on some theoretical presuppositions. Establishing empirical facts is determined by the process of the objectivisation of results that occurs in the course of observation, which involves various aspects of the research procedure, and generally the researcher's competence in making the observation. In geography this primarily concerns fieldwork. It must be strongly emphasised that especially in fieldwork much weight should be attached to the researcher's well-developed competence and practical skills in employing the right diagnostic techniques, both in direct and indirect observations.

Today the establishment of empirical facts is extended to include experimental simulation studies, especially digital simulation modelling. It leads to an expansion of the substantive scope and research problems of geography in both its natural and socio-economic sub-disciplines, and improves the accuracy of the results obtained, the set of which provides the empirical basis of geographical knowledge.

The new tools and methods expanding the empirical base of geographical knowledge include aerial photography, satellite-borne remote sensing, the Global Positioning System, and the Geographic Information System (Ciołkosz 2007). They are the basis and instruments of the informatisation of geographical knowledge. Informatisation is understood as a rational use of data stored in instrumental systems which involves not only the processing of those data, but also their 'production' in some generalised forms. This definition does not exhaust the full semantic content of the term, but aptly describes the character and role of GIS, which is not only a set of operators and research techniques, but also a research method going beyond the building of an empirical base.

From a methodological point of view, an especially interesting issue is how GIS changes the character of geographical knowledge and its functions. Some geographers, e.g. Widacki (2004: 164 ff.), see GIS as an instrument of a radical reconstruction of the nature and functions of geography. Even if one does not share this opinion, one must admit that GIS is a new, important instrumental-conceptual component of the building of geographical knowledge.

In conclusion, it should be emphasised that factual knowledge should not be interpreted as purely descriptive because it is also a fundamental component of theoretical knowledge which decides about its adequacy. Wójcicki (1995: 164) even claims that "a discipline (...) is a science if there is a sufficiently broad consensus among its representatives as to what is a fact in this discipline, and how the facts established in this discipline decide about the accuracy or otherwise of theoretical generalisations".

3.3.3. Symbiosis of inductive and deductive procedures

The acquisition of geographical knowledge of a high degree of generalisation is the chief postulate for giving geography the character of an empirical science. In empirical sciences there are two pathways for achieving this goal: inductive and deductive. Inductive reasoning was rooted in studies focusing on the description of individual objects and events or their spatially-temporally closed sets. Also the results of those concretising studies, called idiographic, could be a basis of generalisation by induction. However, the inductive pathway did not prove to be especially effective, either in discovering regularities or in theory building. Critics of this procedure pointed out that a much more efficient way of building up knowledge of a general type in theoretically advanced empirical sciences was the so-called deductive method. It involves testing hypotheses through empirical facts (test implications) with the use of confirmatory or falsifying procedures. The latter were considered by Popper (1965) to be logically efficient methods of verification.

It seems that geography with its attachment to factual knowledge can and should combine both procedures. Inductive generalisation is often the crowning of a descriptive research, and its efficiency increases with the use of methods of statistical inference and multivariate analysis. In turn, the use of mathematical modelling methods has opened the way to, and then reinforced, the deductive approach.

3.3.4. Complementarity of quantitative and qualitative approaches

The complementarity of quantitative and qualitative approaches is a significant aspect of geographical inquiry in the empirical-scientific model. At first no attention was paid in methodological considerations to the distinction between quantitative and qualitative aspects of geographical research, in spite of a wide use of statistical description. Also, the very notion of a qualitative approach is not unequivocal and hard to define explicitly, if only because of the vagueness of the categories of quantity and quality with reference to measurement scales and conceptual instruments of analysis. Hence, it is not correct to present a qualitative approach as a field of study in which the notional apparatus employed is one devoid of numerical values (quantities). Also, a closer description of 'qualitative research' goes beyond the framework of the empirical approach (Denzin & Lincoln 1998).

A breakthrough in the development of quantitative studies in geography was the formulation and implementation of the programme of application of mathematical statistics and mathematical models, which was termed a quantitative revolution (Burton 1963). Its result was a wide spectrum of applications of mathematics (including statistical methods) which far exceeded the original scope of the programme.

The quantitative approach does not imply any separate section of geography in the form of 'quantitative geography', although sometimes this term has been used. It is simply a set of statistical and mathematical methods employed in geographical research and in the building of geographical knowledge in the model and theoretical approaches (cf. Chojnicki & Wróbel 1961; Chojnicki 1971; Czyż 1973; Czyż & Ratajczak 1991). The present-day problems addressed in those applications go far beyond spatial analysis. They embrace a broad range of mathematical notions and analyses also employed in other empirical sciences (cf. Ratajczak 1998).

However, in methodological solutions concerning the research procedure, especially in socio-economic geography, the interest in mathematical methods has declined. This seems to be largely caused by the development of anti-empirical orientations in geography as represented by the humanistic and ideological-radical approaches, i.e. by a departure from the understanding of geography as an empirical science (cf. Fotheringham 2006: 246). Still, despite the diminished methodological interest in mathematical-statistical methods, they have become fixed in research practice as an indispensable component of the research procedure and the structure of geographical knowledge without which geography would loose its empirical science status. In geographical inquiry, both approaches – qualitative and quantitative – have an integral, and complementary, character (cf. Sechrest & Sidani 1995; Philip 1998). Research works regarded as qualitative usually also contain quantitative elements, if only in the form of quantitative information. The combination of the empirical approach to knowledge with the many-sided application of mathematics has brought about explosive development of empirical sciences. But one should better also remember Bunge's (1985: 85) warning: "Mathematics is a good servant, but a bad master".

3.3.5. Share of axiological statements in geographical knowledge and inquiry

In the empirical-scientific model of geography, axiological statements, i.e. values and value judgements, are recognised as a significant component of geographical knowledge and inquiry. This is due to the awareness of the character and role of those elements and their use in an evaluative description of the objects, events and processes studied. To avoid a misunderstanding, let me explain that I do not mean the recently discussed 'evaluation of geography', nor a focus on moral-ethical attitudes towards the world (moral geography) like e.g. social justice, although the latter problems are in the field of interest of geography in the humanistic approach. What I mean is the contribution of evaluative statements to the building of geographical knowledge. The neo-positivistic approach eliminates this issue from the substantive field of geography, because it holds that such statements have not got a logical value.

However, in their research practice geographers regularly use terms and statements evaluating both, some states of things and research practices themselves. From the philosophical-methodological point of view, an important question is to realise the role and weight of value judgements and evaluation (in the axiological sense) in knowledge building and the research procedure. I believe this issue to be an important element of the empirical-scientific model. The argumentation for this standpoint is too vast to present in a few sentences, so let me just mention two questions: (1) the sharp division between empirical facts and values preached by logical empiricism is not justified; and (2) several notions of geographical knowledge contain descriptive and evaluative expressions, e.g. capitalist economy, sustainable development, revitalisation, or climate warming, and to understand their sense one has to consider their evaluative load.

3.3.6. Explanation and forecasting: the main cognitive functions of geography

The notion of a function of scientific knowledge is identified with the role it performs in the understanding and transformation of the world. The chief cognitive functions of geographical knowledge are explanation and forecasting. Geographical knowledge has also got practical functions, which are expressed in what it helps to achieve in the practical sphere of activity. Recognising *explanation* as a basic function of geographical knowledge is a critical element in defining the cognitive character of geography as an empirical science, because the explanation of facts and regularities is the primary goal, as well as a development factor, of scientific knowledge, especially theory (Harvey 1969). As van Fraassen put it (1980: 157), "the search for explanation is ipso facto a search for empirically adequate, empirically strong theories."

In principle, explanation is understood as an answer to the question "Why is it so?", or the related "Why did the given fact occur?" and "What was the reason?" etc. A basic conception of explanation was presented by Hempel & Oppenheim (1948) in a so-called deductive-nomological model, later expanded by Hempel (1965) to include an inductive-statistical model. Thus, the crucial components of this model are scientific laws and theories as well as formal-logical inference. This conception attracted criticism because of its formal-logical nature and founding explanation on recognised scientific statements (cf. Woleński 1996: 252). The model presupposes that the fact being explained (the statement about the fact) follows logically (deductively), or with a high degree of probability, from explanatory premises, i.e. from scientific laws and initial conditions.

The difficulties involved in the application of structural-logical models in geography are caused not only by their functional limitations, but mainly also by poor development of nomological and theoretical knowledge. Hence a better basis for methodological explanation in geography is the heuristic or the relationistic conception. In the former, explanation assumes the character of an insight and does not just come down to justification according to the nomological-deductive scheme. It involves putting forward hypotheses to account for facts. The place of 'ready-made' scientific laws and theories is taken by theoretical hypotheses about the processes or factors responsible for the states of things presented in facts (cf. Mejbaum 1995: 128). On this reading, explanation – or better, the explanatory procedure – is simultaneously a way of building the theoretical kind of knowledge.

In the relationistic approach, the premises for the explanation of facts present the mechanisms which determine, or are a condition of, specific states, or change of states, that are facts. In geographical inquiry, the notion of a mechanism itself is understood broadly: it embraces both, various aspects (natural, socio-economic, ecological) and types of mechanism (causal, stochastic, interactive). Discovering those mechanisms and their theoretical description is a basis of explanation (cf. Bunge 1983; 1996: 138; Chojnicki 2002: 18 ff.). It should be noted that this conception is not only a programme, but also a report, as can be shown when analysing reflections on the explanation of facts offered in various geographical works.

Recognising *forecasting* as the chief cognitive function of geography besides explanation is connected with a great upsurge of interest in the future, also in the field of geographical inquiry (cf. Chojnicki 1970, 1977). Forecasting consists in anticipating future states of things or events. To forecast a state of things or an event is to give an answer to the question "What will it be like in the future?", and in particular, "What will this future moment be like?", "When will it be?", etc. Answers to those question, or forecasts, should be limited to statements offering a rational-empirical justification. In a narrower understanding, forecasts are statements about the occurrence in the future of a state or events referring to a specified moment or period of time whose truthfulness or falsehood is not known at the moment of their formulation (cf. Czerwiński 1975). On a broader reading, forecasts are statements with no temporal reference, which makes it practically impossible to assess their logical value.

Forecasting as a scientific procedure has to be based on rational foundations, and hence requires a justification which can be theoretical or extra-theoretical. The theoretical justification of forecasts springing from geographical knowledge is far from efficient owing to poor development of theories in geography and their low prognostic power. There are greater possibilities in the building of mathematical models, especially digital simulation ones, which can accommodate the high complexity of the events and phenomena being forecast. The extra-theoretical justification of forecasts resorts to various statistical extrapolation methods, correlation and regression analysis, and the construction of time trends (cf. Haggett 1973). Progress in this research, especially concerning highly complex geographical phenomena, heavily relies on the new possibilities offered by computer programs and information science.

Forecasting in geography plays two important functions: internal and external. The internal function involves the role of forecasts in the research process and consists in the empirical testing of theoretical knowledge, i.e. scientific laws and theories, through forecasts. Hence, it is a significant component of knowledge building with the help of hypothetical-deductive methods. The external or instrumental function, in turn, involves the role that efficient forecasts take on outside the framework of theoretical knowledge building in geography. It consists in anticipating experience and informing about events and phenomena that will occur in the future. Forecasts of unwelcome but controllable events function as warnings, because human action can prevent their detrimental effects. In this way forecasts become part of practical studies, i.e. ones focusing on effective practical action, especially planning. By efficient performance of its prognostic function, geography enters the field of application research seeking solutions to practical problems.

3.3.7. Growing importance of the practical function of geographical knowledge

Geography has always supplied knowledge that performed practical functions. Suffice it to mention the history of geographical discoveries and the processes of colonisation. Today, in the empirical-scientific model, the practical function of geographical knowledge refers to those of its research problems that involve facilitating practical activity. In principle, "practical action involves measures taken to produce or sustain a specified state of things in some natural or social system. (...) Practical action is not only one seeking to change the material surroundings or to transform material objects, but also one intended to maintain the existing state of things" (Siemianowski 1976: 51–52). In this approach, practical action is a design for the construction of a retentive reservoir and a spatial development plan, or the preparation of rules of a territorial reform of a country and a study of the geographical environment in a given condition.

The implementation of the practical function takes place via solving problems of the type "What to do in order to achieve this and that". Solving practical problems rests on the implementation of the function of efficiency, i.e. postulates describing optimum states, or states that are satisfactory by the given utility criteria and utility values. If this function is to be effective and socially comprehensible, it must rest on a type of knowledge which gives reasons for and ways of steering various factors present in the conceptual framework of geographical knowledge. In geographical inquiry, practice-oriented problems are, for example, those involving designing, planning, as well as spatial-economic and environmental (ecological) policy at the regional and local, and increasingly global, scales.

Geographical studies and knowledge perform their practical functions in two ways: indirect and direct. In an indirect way, geographical knowledge provides a basis for solving practical problems when used in a suitable, goal-oriented manner. This can involve: (1) studies of the character and possibility of steering of relevant factors and processes so as to attain the intended states of things; (2) diagnostic studies; (3) supplying information necessary for decision-making, especially in situations of conflict; (4) formulating warning, self-realising and self-destructive forecasts; and (5) formulating goal-oriented value judgements which can be defined, after Znamierowski (1957: 13) as follows: "A goal-oriented value judgement draws a picture of what our world should be, puts some standard before our eyes, (...) thus giving us a plan of what we are to do. Hence, a goal-oriented value judgement concerns favourably assessed states of things that have not come true yet". The direct role of geographical knowledge mainly involves the construction on its basis of optimum decision models and projects – plans and ways of their implementation.

It should be emphasised that the distinction between the cognitive and the practical functions of geography is not clear-cut. According to Parysek (2004: 119), "those functions are sometimes hard to tell apart sharply, since they intermingle and determine each other", and "the entire geographical knowledge can, and usually does, serve practical purposes, whether directly or indirectly".

The increase in practical significance derives from several factors. First of all, geographical knowledge when pursued as an empirical science assumes a more exact, general, as well as factually and theoretically richer character, which reinforces its cognitive functions and, in effect, its practical functions. This relation is often mutual, because solving practical problems requires cognitive knowledge. Another major factor is the expansion of the subject matter of geography to include issues of greater social significance, which by itself gives them a socially useful, i.e. practical, character. The conditions of the development of practical functions of geography include, according to Parysek (2004: 128), "the appearance of a social demand for geographical knowledge and the understanding by decision-makers of both, the value of the knowledge and the needs calling for its use. However, practical functions primarily require a special effort on the part of geographers to convince society (...) about the practical value of geographical knowledge and the possibility, or even necessity, of its application".

It should be added that the social utility of geography, which is among its practical functions, also embraces broadly understood geographical education (primary, secondary and higher) which makes it possible for society to get acquainted with a picture of the world seen from a variety of perspectives. Thus, its practical function should not be identified with the so-called 'environmental and social engineering' only, but also with a rebuilding of the social awareness in matters of a geographical outlook upon the world.

4. Conclusion

(1) The empirical-scientific model is the most efficient basis of development for geography. What justifies this thesis is that this model: (a) endows geography with the methodological properties necessary for it to be treated as an empirical science; (b) provides a basis for integrating scientific programmes of geography; (c) seeks the unity of geography in its empirical nature; (d) places geography in the community of empirical sciences; and (e) defines the character of physical and socio-economic geography on a basis common to empirical sciences.

(2) This model is characterised in philosophical-methodological terms on the broad ground of the philosophy of sciences, which provides it with foundations while making it unnecessary to draw from any individual philosophical orientations.

(3) The common fundamental methodological standards regulating research practice favour the type of criticism based on the postulate of clarity demanded by the analytical principles of the philosophy of science.

(4) Criticism requires adopting the same attitude towards models resting on different philosophical foundations. This especially concerns the humanistic approach, which places geography among the humanities rather than empirical sciences.

References

AMADEO D. & GOLLEDGE R.G., 1975. *An introduction to scientific reasoning in geography*. Wiley, New York.

BENTON T. & CRAIB I., 2001. *Philosophy of social science: philosophical foundation of social thought*. Palgrave, New York.

BERRY B.J.L. & MARBLE D.F. (eds), 1968. *Spatial analysis*. Prentice Hall, Inglewood Cliffs.

BHASKAR R., 1975. *A realist theory of science*. Leeds Books, Leeds.

BIRD J., 1993. *The changing worlds of geography*. Clarendon Press, Oxford.

BOVEN M., 1981. *Empiricism and geographical thought*. University Press, Cambridge.

BUNGE M., 1977. *Treatise on basic philosophy*. Vol. 3: *Ontology II: A world of systems*. Reidel, Dordrecht.

BUNGE M., 1983. *Treatise on basic philosophy*. Vol. 6: *Epistemology and methodology II: Understanding the world*. Reidel, Dordrecht.

BUNGE M., 1985. *Treatise on basic philosophy*. Vol. 7: *Epistemology and methodology III: Part I. Formal and physical sciences*. Reidel, Dordrecht.

BUNGE M., 1996. *Finding philosophy in social science*. Yale University Press, New Haven, London.

BUNGE M., 2006. *Chasing reality. Strife over realism*. University of Toronto Press, Toronto.

BURTON I., 1963. The quantitative revolution and theoretical geography. *Canadian Geographer* 7: 151–162.

CHAPMAN G.P., 1977. *Human and environmental systems. A geographer's appraisal*. Academic Press, London.

CHOJNICKI Z., 1970. Prediction in economic geography. *Economic Geography* 46 (2): 213–222.

CHOJNICKI Z., 1971. Metody matematyczne w geografii fizycznej (Mathematical methods in geography). *Przegląd Geograficzny* 43 (3): 297–310.

CHOJNICKI Z., 1977. Podstawy metodologiczne prognozowania w geografii ekonomicznej (Methodological foundations of forecasting in economic geography). *Przegląd Geograficzny* 49 (2): 247–261.

CHOJNICKI Z., 1985. Orientacje filozoficzno-metodologiczne geografii – ich koncepcje i modele (Philosophical-methodological orientations in geography: conceptions and models). *Przegląd Geograficzny* 57 (3): 255–281.

CHOJNICKI Z., 2000. *Filozofia nauki. Orientacje, koncepcje, krytyki* (Philosophy of science. Orientations, conceptions, criticism). Bogucki Wyd. Naukowe, Poznań.

CHOJNICKI Z., 2002. Wyjaśnianie w geografii społeczno-ekonomicznej w ujęciu relacjonistycznym (Explanation in socio-economic geography in a relationistic approach). In: Rogacki H. (ed.), *Możliwości i ograniczenia zastosowań metod badawczych w geografii społeczno-ekonomicznej i gospodarce przestrzennej*. Bogucki Wyd. Naukowe, Poznań: 11–23.

CHOJNICKI Z., 2004. Podstawy filozoficzne geografii – jakiej filozofii potrzebuje geografia? (Philosophical foundations of geography: What philosophy does geography need?) In: Chojnicki Z. (ed.), *Geografia wobec problemów teraźniejszości i przyszłości*. Bogucki Wyd. Naukowe, Poznań: 191–207.

CHOJNICKI Z., 2005. Problematyka metodologiczna przedmiotu geografii (Methodological problems of the substantive field of geography). In: Maik W., Rembowska K. & Suliborski A. (eds), *Geografia jako nauka o przestrzeni, środowisku i krajobrazie*. Łódzkie Tow. Naukowe, Łódź: 11–21.

CHOJNICKI Z., 2007. Geografia wobec problemów współczesnego świata (Geography in the face of problems of the contemporary world). In: Maik W., Rembowska K. & Suliborski A. (eds), *Geografia a przemiany współczesnego świata*. Wyd. Uczelniane WSG, Bydgoszcz: 15–24.

CHOJNICKI Z. & MARBLE D.F. (eds), 1973. *Perspectives on spatial analysis*. Geographia Polonica 25.

CHOJNICKI Z. & WRÓBEL A., 1961. Metody matematyczno-statystyczne w geografii ekonomicznej (Mathematical-statistical methods in economic geography). *Przegląd Geograficzny* 33 (4): 615–629.

CHORLEY R., 1962. *Geomorphology and general systems theory*. Geological Survey Professional Paper, 500 B.

CIOŁKOSZ A., 2007. Nowe narzędzia i metody badawcze w geografii oraz ich rola w rejestracji i wyjaśnianiu zjawisk i zmian w skali globalnej (New research tools and methods in geography and their role in the registration and explanation of phenomena and changes at a global scale). In: Maik W., Rembowska K. & Suliborski A. (eds), *Geografia a przemiany współczesnego świata*. Wyd. Uczelniane WSG, Bydgoszcz: 103–118.

CLOKE P., PHILO C. & SADLER D., 1991. *Approaching human geography*. Paul Chapman Publishing, London.

CZARNOCKA M. (ed.), 1995. *Dziedzictwo logicznego empiryzmu* (Heritage of logical empiricism). Wyd. Instytutu Filozofii i Socjologii PAN, Warszawa.

CZERWIŃSKI Z., 1975. Prognoza, plan, prawdopodobieństwo (Forecast, plan, probability). *Ekonomista* 1: 27–43.

CZYŻ T., 1973. Zastosowanie metod i modeli matematycznych w geografii polskiej (Application of mathematical methods and models in Polish geography). *Przegląd Geograficzny* 45 (1): 29–49.

CZYŻ T. & RATAJCZAK W., 1991. Metody matematyczne w geografii ekonomicznej (Mathematical methods in economic geography). In: Chojnicki Z. (ed.), *Podstawowe problemy metodologiczne rozwoju polskiej geografii*. Prace UAM, Seria Geografia 48: 273–300.

DENZIN N.K. & LINCOLN Y.S., 1998. *The landscape of qualitative research: Theories and issues*. Sage, Thousand Oaks.

FOTHERINGHAM A.S., 2006. Quantification, evidence and positivism. In: Aitken S. & Valentine G. (eds), *Approaches to human geography*. Sage, London: 237–250.

FRAASSEN VAN B.G., 1980. *The scientific image*. Clarendon Press, Oxford.

GREGORY D., 1978. *Ideology, science and human geography*. Hutchinson, London.

GRZEGORCZYK A., 1993. *Życie jako wyzwanie. Wprowadzenie w filozofię racjonalistyczną* (Life as a challenge. An introduction to rationalistic philosophy). Wyd. Instytutu Filozofii i Socjologii PAN, Warszawa.

HAGGETT P., 1965. *Locational analysis in human geography*. Arnold, London.

HAGGETT P., 1973. Forecasting alternative spatial, ecological and regional futures: problems and possibilities. In: Chorley R. (ed.), *Directions in geography*. Methuen, London.

HARVEY D., 1969. *Explanation in geography*. Arnold, London.

HARVEY D., 1972. Revolutionary and counter revolutionary theory in geography and the problem of ghetto formation. *Antipode* 6 (2): 1–13.

HEMPEL C.G. & OPPENHEIM P., 1948. Studies in the logic of explanation. *Philosophy of Science* 15 (2): 138–178.

HEMPEL C.G., 1965. *Aspects of scientific explanation*. Free Press, New York.

KOŁAKOWSKI L., 1966. *Filozofia pozytywistyczna* (Positivistic philosophy). Polskie Wydawnictwo Naukowe PWN, Warszawa.

LISOWSKI A., 2007. Przedmiot badań, funkcje i tożsamość geografii na początku XXI wieku (Research objects, functions and identity of geography at the start of the 21st century). In: Maik W., Rembowska K. & Suliborski A. (eds), *Geografia a przemiany współczesnego świata*. Wyd. Uczelniane WSG, Bydgoszcz: 39–53.

MAIK W., 2004. Główne płaszczyzny relacji między geografią fizyczną a geografią społeczno-ekonomiczną (Chief planes of relations between physical and socio-economic geography). In: Chojnicki Z. (ed.), *Geografia wobec problemów teraźniejszości i przyszłości*. Bogucki Wyd. Naukowe, Poznań: 9–24.

MAIK W., 2007. Geografia a współczesność w świetle tradycji myśli geograficznej (Geography and modernity in the light of the tradition of geographical thought). In: Maik W., Rembowska K. & Suliborski A. (eds), *Geografia a przemiany współczesnego świata*. Wyd. Uczelniane WSG, Bydgoszcz: 25–37.

MAIK W., REMBOWSKA K. & SULIBORSKI A., (eds), 2005. *Geografia jako nauka o przestrzeni, środowisku i krajobrazie* (Geography as a science of space, environment and landscape). Łódzkie Towarzystwo Naukowe, Łódź.

MEJBAUM W., 1995. *Wyjaśnianie i wyjaśnienie. Zarys teorii eksplanacji* (Explaining and explanation. An outline of explanation theory). Biblioteka „Nowej Książki", Szczecin.

PARYSEK J., 2004. Praktyczne funkcje polskiej geografii (Practical functions of Polish geography). In: Chojnicki Z. (ed.), *Geografia wobec problemów teraźniejszości i przyszłości*. Bogucki Wyd. Naukowe, Poznań: 119–132.

PEET R., 1998. *Modern geographical thought*. Blackwell Publishing, Oxford.

PERZANOWSKI J., 1989. Logika a filozofia (Logic and philosophy). In: Perzanowski J. (ed.), *Jak filozofować? Studia z metodologii filozofii*. Polskie Wydawnictwo Naukowe PWN, Warszawa: 229–261.

PHILIP L.J., 1998. Combining quantitative and qualitative approaches to social research in human geography – an impossible mixture? *Environment and Planning* A 30: 261–276.

POPPER K.R., 1965. *The logic of scientific discovery*. Harper, New York.

RATAJCZAK W., 1998. *Metodologiczne aspekty fraktalnego modelowania rzeczywistości* (Methodological aspects of the fractal modelling of reality). Wydawnictwo Naukowe UAM, Poznań.

Rediscovering geography: New relevance for science and society, 1997. National Academy Press, Washington.

SAYER A., 1985. Realism and geography. In: Johnston R.J. (ed.), *The future of geography*. Methuen, London:159–173.

SCHAEFER F.K., 1953. Exceptionalism in geography: a methodological examination. *Annals of the Association of American Geographers* 43: 226–249.

SECHREST L. & SIDANI S., 1995. Quantitative and qualitative methods: Is there an alternative? *Evaluation and Program Planning* 18 (1): 77–87.

SIEMIANOWSKI A., 1976. *Poznawcze i praktyczne funkcje nauk empirycznych* (Cognitive and practical functions of empirical sciences). Polskie Wydawnictwo Naukowe PWN, Warszawa.

UNWIN T., 1992. *The place of geography*. Prentice Hall, Harlow.

WIDACKI W., 2004. Czy systemy informacji geograficznej zmieniły geografię? (Have geographic information systems changed geography?) In: Chojnicki Z. (ed.), *Geografia wobec problemów teraźniejszości i przyszłości*. Bogucki Wyd. Naukowe, Poznań: 157–168.

WILSON A.G., 1972. Theoretical geography: some speculations. *Transactions of the Institute of British Geographers* 57: 32–44.

WOLEŃSKI J., 1996. Wyjaśnianie a przewidywanie (Explanation and forecasting). In: Woleński J., *W stronę logiki*. Aureus, Kraków: 251–265.

WÓJCICKI R., 1991. *Teorie w nauce* (Theories in science). Part I. Instytut Filozofii i Socjologii PAN, Warszawa.

WÓJCICKI R., 1995. Filozofia czy teoria nauki? (A philosophy or a theory of science?) In: Zamiara K. (ed.), *O nauce i filozofii nauki*. Wyd. Fundacji Humaniora, Poznań: 159–164.

ZNAMIEROWSKI C., 1957. *Zasady i kierunki etyki* (Principles and directions of ethics). Polskie Wydawnictwo Naukowe PWN, Warszawa.