SCIENTIFIC METHODS IN GEOGRAPHY

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INTRODUCTION:

After the World War II, many more developments took place in the geographical studies. Up to the end of 19th century, the geographical issues were descriptive basically analyzed by the sensual organs. The introduction of quantitative revolution changes the descriptive character of the subject and makes it a scientific discipline. There is a paradigm shift from 'ideographic' to 'nomothetic' in order to maintain the discipline to the level of logical and rational pursuit of understanding. The most of the Anglo-American realm, who was trained in mathematics and statistics and some them who shifted to geography, from the natural sciences, geography appeared to be a true science- a law-seeking discipline rather than an ideographic science. Much fundamental research in geography has not been concerned with a high level of generalization, and it has given meaning to other research efforts which succeeded. Accurate study depends on quantification and should furnish a theoretical framework with the capacity to illuminate actually observed distribution pattern and space relations.

The positivist-led geography then called for the development of theory, for the application of quantitative methods, and for a focus on laws and generalizations to form the building block for further nomothetic research. As 'science' geography with its positivist character, concerned itself with empirical questions and not with normative questions. Empirical questions are questions about how things are in reality. In this context, the reality is defined as the world which can be sensed. This means that science is concerned with objects in the world. Science can describe how a thing is, and discovers the association of causes which explain why things are as they are.

Contemporary positivist-led geography, therefore, sought to investigate two pertinent questions of geographic character: (i) theoretical questions that deal with the formulation of empirical generalizations, explanations or laws, perhaps even with basic theory and (ii) methodological questions that have to do with experiments in new methods of study, new techniques of observation and analysis, or new cartographic methods.

SCIENTIFIC METHOD:

Science is popularly defined as an accumulation of systematic knowledge. It is a method of approach to the entire empirical world and it does not aim at persuasion. It is nearly a mode of analysis that permits the scientists to state propositions in the form of 'if -, then -,'The sole purpose of science is to understand the world in which man lives.

The term 'scientific method' denotes the logical structure of the process by which the search for trustworthy knowledge advances. The primary task of the scientific method is to explain empirical phenomena. There is no need to argue that geography ought to be a science. Geography simply is a science by virtue of the fact that it is a truth-seeking discipline whose raw materials consist of empirical observations. There is no suggestion that geography should undergo any sort of epistemological restructuring (Marshall, 1985).

Hay (1985) identifies four groups of geographers with regard to the appropriateness or inappropriateness of scientific method in geography. The first group consists of physical geographers, who believed that their discipline is a field of natural science. In the second group are those human geographers, who see scientific methods as being appropriate to their discipline as a social science. The third group consists of those who believe that the geography makes scientific or quasi-scientific methodology inappropriate. Most recently, a fourth group has emerged which seeks to apply Marxist methods in geography and believes that methods are scientific in the mould of classical natural sciences.

In order to understand the above-mentioned views, it is necessary to identify the key elements of scientific thinking and practices. It is also important to outline some of the philosophical problems as well as to examine some additional issues which arise when the scientific method is applied to geography and also other similar disciplines.

KEY ELEMENTS OF SCIENTIFIC METHODS:

The scientific method is characterized by five key elements. These five elements are:

1. Theory and fact

2. Law
3. Logic
4. Reduction
5. Hypotheses

1. THEORY AND FACT:

Basic to modern science is an intricate relation between theory and fact. The theory is compared with speculation and thus a theory remains speculation until it is proved. When this proof is made, the theory becomes facts. The theory is supposed to be the realm of philosophers. Therefore, a scientific theory is thought to be merely the summation of facts which have been accumulated upon a given discipline.

A fact is regarded as an empirically variable observation. It could never have produced modern science had it not been gathered. It can be said that facts of science are the product of observations that are not random but meaningful. Thus theory and facts are interrelated in many complex ways. The development of science can be considered as a constant interplay between theory and fact.

ROLE OF THEORY:

a. It defines the major orientation of a science.
b. It offers a conceptual scheme and classification of the relevant phenomena.
c. It predicts the facts.
d. It summarizes facts into empirical generalizations and systems of generalizations.
e. It points to gaps in our knowledge.

ROLE OF FACTS:

a. They help to initiate theories
b. They lead to the reformulation of the existing theory
c. They the rejection of theories which do not fit the facts.
d. They change the focus and orientation of theory
e. They classify and redefine theory.

LAW:

The second key element of scientific thinking is 'law'. Any fully developed scientific theory contains, embedded within it, certain statements about the unvarying relationship. These laws may be evident at the level of everyday experience or only at the level of scientific investigation. As with theories, there is a predisposition among scientists to seek laws. The credit to put the relevance of law in geography goes to Schaefer who said that geographer should seek to make law-like statements. To explain the phenomena, one has to describe the means to recognize them as instances of laws. Hence, geography has to be conceived as the science concerned with the formulation of the laws governing the spatial distribution of certain features on the surface of the earth (Schaefer, 1953).

A law should be unrestricted in its application over space and time. It is thus a 'universal statement of unrestricted range'. Law should not make specific reference to proper names. A major criterion in determining whether a statement is or is not a law is the relationship of the statement to the system of statements that constitutes a theory. If this criterion is accepted, then the ideas are required to be adjusted regarding the verification procedures necessary to transform a scientific hypothesis to a scientific law. The truth of an empirical law has to be established by the scientific method too, but in addition, it requires support from other empirical laws, theoretical laws and also from other lower level empirical laws that help it to predict.

Golledge and Amedeo (1968) indicated four types of laws which have relevance for human geographers:

i. **Cross-sectional Laws:** It describes the functional relationship, but shows no causal connection.
ii. **Equilibrium Laws:** It states what will be observed if certain criteria are met.
iii. **Dynamic Laws:** It incorporates notion of change, with the alteration in one variable being followed by an alteration in another.
iv. **Statistical Laws:** It is related to probability statements.

According to Sack, geography is concerned to explain events and it requires substantive laws: such laws may contain geometric terms. But these terms are insufficient to explain the man environmental relationship. He identified two types of laws relevant to geographical work: (i) Congruent Substance Laws and (ii) Overlapping Substance Laws.

The positivist-led geography has a wider application of laws for successful and fruitful analysis of geographical phenomena together with spatial pattern. The concept of law has a much wider significance in such geography which is being conceived of as a science with law-seeking episteme because it postulates three fold hierarchies of scientific statements.

LOGIC:

Logical validation is one of the most commonly used methods of validation and certainly one of the most difficult to apply. It refers to either theoretical or common-sense analysis which concludes that the item being what they are; the nature of the continuum cannot be other than stated to be. Logical validation or face validity as it is sometimes called is always used because it automatically springs from the careful definition of the continuum and the selection of the item. Scientists have tended to use mathematics (algebra and geometry) as the language for expressing and developing logic, but the mathematical language is not acceptable language for explanations of items.

REDUCTIONISM:

It is one the most important key of the scientific method. Reductionism is usually taken to apply to any doctrine that seeks to explain a higher order phenomenon in terms of a lower order phenomenon. Such doctrine can be held in different forms and applied in many different areas of intellectual endeavor. One form of reductionism is notion and another form is a thesis. Reductionism is defined as concepts or statements redefined in terms which are more elementary or basic.

A geographical explanation may say to be reductionist if it attempts to account for a range of phenomena in terms of a single determining factor. In human geography, the most common form of reductionism is probably expressed as descriptions of the behavior of individual actor. Some Marxist theories are said to be reductionist because they attempt to

explain the diversity of sound behavior by reference to the economy. Reductionism of a different variety may not be accepted that which views all human patterns in terms of a single-factor explanation such as class struggle that appears to be too simple explanation the great variety of society-environmental relationships which have been observed on the face of the Earth. It is rather difficult to comment on the success of reductionist methods in geography, given the fact that geography has yet to achieve a great success in terms of laws.

HYPOTHESIS:

Theory, law, logic, and reduction are the key elements of scientific thinking, but there is, however, a fifth element i.e. research hypothesis which provides a link to the area of scientific practice. A research hypothesis predicts the outcome of an experiment or observation if the theory is correct in well-developed natural science. Thus, a theory can be tested in contexts other than those for which it was originally devised. Hypotheses are a tentative statement that guides empirical work in several scientific epistemologies. In other words, we can say a hypothesis is a structured speculation that must be empirically tested.

TYPES OF HYPOTHESES:

There are different kinds of hypotheses used in the social or geographical analysis, studies and research. However, there are 4 types of hypotheses:

1. **Research Hypotheses:** Hypotheses derived from the researcher's theory about some geographical phenomena are called research hypotheses or working hypotheses.
2. **Null Hypotheses:** Null hypotheses are hypothetical models used to test research hypotheses. It is also considered as the reverse of research hypotheses.
3. **Scientific Hypotheses:** The Scientific hypothesis is a general proposition about all the things of a certain sort. It is an empirical proposition and is testable by experience.
4. **Statistical Hypotheses:** Statistical hypotheses that observations about people or things are reduced in some way to numerical quantities and decisions are made about these quantities.

FUNCTIONS OF HYPOTHESES:

A major function of hypotheses is to make it possible to test theories. In this regard, an alternative definition of a hypothesis is that it is a statement of theory in testable forms. Some hypotheses are not associated with any particular theory. It could become out as a result of some hypothesis, a theory will be constructed. Consequently, another function of hypotheses is to suggest theories that may account for some event.

Hypotheses also perform a descriptive function. Each time a hypothesis is tested empirically and its result tells something about the phenomena. If the hypothesis is supported, then the information about the phenomena increases. Even if the hypothesis is refuted, the test tells something about the phenomenon that is not known before.

TESTING HYPOTHESES:

Testing Hypotheses means subjecting them to some sort of empirical scrutiny to determine if they are supported or refuted by what the researchers observed. The accumulation of information as a result of hypothesis testing reduces the amount of ignorance we may have about why a social event occurs in a given way. There is two prerequisites for hypothesis testing:

1. A real social situation is needed that will suffice as a reasonable testing ground for the hypothesis.
2. The investigator should make sure that his or her hypotheses are testable.

GEOGRAPHICAL APPLICATION OF SCIENTIFIC METHODS: SOME PROBLEMS

After the 1950s there is continuing debate with regard to the application of scientific method in geography. There were two mutually exclusive arguments on this issue. One side argued that scientific method should be introduced into both physical and human geography. On the other hand, some geographers had claimed that the discipline was in some sense and exceptional discipline which might be excused from the constraints of the scientific method.

Despite counter arguments and dichotomies, after 1960s geographical research using the quasi-scientific method with emphasize on law seeking methods and model-based paradigms. The philosophical and methodological base for this was carried forward by many young Anglo-American geographers. A number of textbooks in both human and physical geography emphasized the need for theory, laws, hypotheses, measurement and statistical techniques. But

the protagonist of this approach was often unaware of the problems inherent in the scientific approach and could not identify the additional problem posed by its geographical use. Most of these problems stemmed from the twin fact that geography as whole deals with multi-variable open systems and human geography deals with knowing the subject.

RELEVANCE SCIENTIFIC METHOD IN GEOGRAPHY:

Scientific methods hold relevance in geographical research and training in both physical and human geography for three reasons:

1. The scientific method does have the ability to provide coherent and testable theories about the nature of geographical phenomena.
2. The scientific method remains appealing because it is logically corrected extension of thought structures developed in everyday life, including the willingness to correct theories or hypotheses in the light of experience.
3. Knowledge of a scientific type is required by society for its purpose of managing the social and natural system.

However, the scientific geography cannot remain untouched by critical evaluations and criticisms, the elements which are required to be retained had to be modified. As a result of these many geographical theories were derivative. The ability or inability of derivative theories to provide the basis for geographical explanation largely dependent on the test of their overall value as research programmes.

The advocates of the application of the scientific method of geography feel that at the level of practice, geography would need to retain most of its elements so as to prove the 'scientific status' of the discipline. There will be a continuing need for statistical analysis to carry on the application of scientific method to geographical study, research, and training. There is no doubt that the application of scientific method to geography has given a nomothetic basis to the discipline with a scientific status and saved it from the crisis of its identity that is suffered during the transition period.