# Theoretical Geography

# Theoretical Geography:

## *Outlining the Unified Theory of Geography*

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This book is the final edition in the series of books “Modern Geography”, prepared by the author over the past 20 years.

This book, which marks a new stage in the evolution of Geography, will be essential for scientists and researchers in such disciplines as: Geography, Geology, Geophysics, Ecology, Sociology, Business, and Marketing.

It will also be a fascinating read for anyone interested in complex issues of geographical description of the surrounding world, based on the postulates of Theoretical Geography.

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# AUTHOR'S PREFACE

In search of an answer to the question of why, despite the enormous amount of information and research data on the modern geographical nature of the world, there is still no scientifically formulated concept of Theoretical Geography, the author of this publication comes to the following conclusion. Perhaps, to begin with, it should be assumed that geographical science should not be limited to just the question - why should it offer only a description of nature?

Much more important is how it should describe nature and with what tools. Since the main object of geography is the study of the outer geographic shell of the physical world of the Earth, consisting of an additional number of other shells or spheres, which are objects of study of related sciences, the presence of the Theoretical Geography is necessary for the scientific geographical explanation of such a combination and interaction of natural structures. In other words, the section of geography called Theoretical Geography is not a simple combination of various knowledge or statements, but constitutes the most important direction of modern geographical science. It would be correct to define theoretical geography as a systemic scientific direction that studies in a generalized, formalized form the geographic space, the evolution of geosystems and the development of natural and natural-social structures, the spatial organization and spatial relationships of natural and natural-social geographic structures of any hierarchical level.

Thus, Theoretical Geography is defined as a field of highly formalized studies of the organization of space and spatial relations, the evolution of geographical structures, phenomena and processes, aimed at identifying the fundamental patterns of their development.

At the same time, the main task of modern geographical science, including theoretical geography, remains, as before, the identification of the laws of nature of the external world, to which all phenomena and processes are subject, in their physical, chemical and biological environment, occurring on the Earth. Based on the above, one of the main tasks of geographical science remains the identification, understanding and use of the most general laws of nature that govern any area of natural structures, phenomena and processes. Secondly, based on the identified laws of nature, the description and explanation of the expected behavior of certain natural systems (geosystems) in dynamics.

At the same time, it is important to distinguish theoretical geography from theories of geography, which, unlike theoretical geography, do not have their own object, but are a set of private theories and methodologies of geographical sciences aimed at identifying conceptual approaches and principles of manifestation of natural patterns in geographic space. Therefore, based on the above, it is necessary to coordinate the efforts of researchers in the direction of the formation of the Theoretical Geography with the presentation of the Unified theory of Geography.

As is known, geography is a complex of natural and social sciences that study the structure, functioning and evolution of the geographic envelope, interaction and distribution in space of natural and natural-social systems and their components. The area of geography is huge and covers all natural and social structures existing on the Earth, in their physical, chemical and ecological surroundings. For this reason, the science of geography is usually divided into different levels of study, including general geography, physical geography, economic geography, human geography, cultural geography, systems geography, etc.

At the end of the series of publications under the general title “Modern Geography”, prepared by the author over a period of more than 20 years, the book “Theoretical Geography: Outlining the Unified Theory of Geography” will become an additional source of information for both advanced students and researchers. It will not only be a scientific and methodological continuation of the books published by the author: Territorial Geography [8, 2010], Agricultural Geography [9, 2013], Optimal Geography [10, 2015] and An Introduction to Systems Geography [11, 2025], but will also allow a new look at the object and tasks of research in geographical science at the current stage of its development.

The book's content begins with the definition of theoretical geography as an independent direction of geographical science for the study of spatial relationships of natural structures and how their location in space affects the dynamics of their development and characteristics. Particular importance within the framework of modern geography will be given to the theoretical framework of research and interpretation of relationships between people and the environment.

# INTRODUCTION

Theoretical Geography is defined as a scientific direction with the aim of forming systemic ideas about the history of geographical thought, intellectual traditions and structure of geographical science, modern laws and theories of geography, its language, tools and basic concepts.

The systematicity of ideas in theoretical geography determines the integrity and interconnection of the constituent components of the geographical shell of the Earth, one of the main subjects of geographical science, when changes in one component can lead to changes in another. This focus of geographical research is explained by the cyclical nature of natural processes and phenomena.

In general, theoretical geography is a field of highly formalized research into the spatial organization of geographic structures, phenomena and processes, with the aim of identifying the fundamental laws of environmental development.

Theoretical Geography can be divided into the study of natural structures, both as a whole and individual parts of the general geographic shell of the Earth, and the study of natural processes. In essence, theoretical geography studies the external, geographical manifestations of the development of the Earth. In theoretical geography, any relationship between natural and natural-social structures is reduced to their spatial location, knowledge about the qualitative and quantitative patterns of such relationships, which is an integral part of the subject of geographical science.

For the visual representation of the subject of study in Theoretical Geography, geographical maps of various scales and contents of ideal spaces are used. It should be noted that theoretical geography studies ideal objects, models of real processes and phenomena, endowed with given properties. Such models include, for example, population settlement systems, spatial distribution of the cultural landscape, etc.

The most important result of Theoretical Geography research is geographical laws and theories. Basic theories or central theories represent a set of knowledge of both factual and scientific views and, as a rule, have the scientific quality of texts of repeatability, consistency with existing established science and experiments. There are major theories that are generally accepted theories based solely on their claims to explain a wide range of data in the environment, although detection, explanation, and possible composition are quite often subjects of ongoing debate.

Since the main place in Theoretical Geography is occupied by theories of geography, and geographical theory can be a model of a natural event, the methodology of Theoretical Geography consists, among other things, in identifying key geographical concepts such as location, landscape, geosystem, scale, energy and matter, entropy and formulating the lows of nature that link these concepts. The content of the methodology of Theoretical Geography is aimed at explaining observed phenomena and processes of nature on the basis of formulated laws of nature, as well as predicting new natural phenomena that can be discovered in the course of fundamental theoretical and practical research.

Thus, Theoretical Geography is a section of Geography that uses various models and abstractions of physical structures and systems to substantiate, explain and predict natural phenomena and processes. The role of geographical theories within theoretical geography is important and is used not only to explain ongoing and interconnected natural processes, but also allows us to take a different look at the evolution of the nature of the physical world as a whole, as well as its individual components. Geographical theories appear to be significant for the advancement of knowledge in the field of modern geography, providing the results of research and discussion, and contributing to the further development of Theoretical Geography and geographical science in general.

Ultimately, Theoretical Geography does not consider questions like “why should geography describe nature?”. It takes as a postulate how, for certain reasons, the geographical description of natural phenomena should be carried out and studies the consequences of the stated postulate. Strictly speaking, Theoretical Geography should study not only the properties of nature itself, but also analyze these properties using various theoretical models.

Therefore, the main task of the Theoretical Geography remains the discovery and understanding of the most general laws of nature governing any area of the Earth’s geographic shell, and, secondly, based on these laws, the description and explanation of the expected behavior of certain geosystems in reality.

# CHAPTER 1

# GEOGRAPHY OF THE SPACE OF NATURAL STRUCTURES AND SYSTEMS

Spatial perspective in geography is defined as a special way of thinking about how and why natural, physical structures are located in geographic space. This is important because it allows us to explain and predict the patterns of development of natural and natural-social systems on the Earth's surface. Systems interact with the external environment as a whole, although geographic structures may not always meet the requirements of systems [48, 2023].

At the same time, spatial relations may arise between structures and natural systems in physical space, defining the locations and connections between them. They can characterize metric relations such as distance and direction, as well as topological relations such as connectedness and inclusion. Since a spatial object refers to a type of structure used in computer science and is represented as a system or model that allows you to work in space without the need to use a pre-established map, this promotes the use of a systems approach when formalizing the properties and functions of the structure itself. It may involve collecting latitude and longitude information and applying various spatial techniques such as buffering and kernel density.

Spatial relationships between structures can be described in terms of position relationships, distance relationships, directional relationships, and topological relationships between structures. Ultimately, spatial relationships examine the concept of where structures are in relation to something else and what makes them special. It should also be noted that natural geographic features are physical characteristics of the Earth's surface that occur naturally, such as mountains, rivers, valleys, and plains. These features form landscapes or geosystems [80, 1978] and significantly influence human activity, cultural customs, and internal boundaries within regions.

## Distribution of structures and systems in geographical space

The spatial distribution or location of natural structures denotes a geographic situation, which can be a part of space or a point or position in space where structures, organisms, fields or events can be found [12, 2021]. Since the terms location and situation are usually used as synonyms, the concept of location is a key element of spatial relations and plays an important role in both the physical and social spheres.

In fact, the concept of location is widely used not only in physical geography but also in economic, social, cultural and political geography. It is considered as the basis of geography, with which the manifestations of physical processes and phenomena such as climate, as well as the distribution of both flora and fauna, on the one hand, and socio-economic structures, their civilizational and political significance and development, on the other, are closely related [43, 2006].

So, the process of forming spatial representations of geographical structures developed in close connection with the development of measurement relations of positions and with the formation of the category of space in the philosophical sense.

At present, space is considered as a form of being of moving matter in its inseparable connection with time in its dialectical understanding, which means that space does not exist in itself. It, like time, is a form of being of moving matter.

Therefore, the properties of space are determined by the movement of the spatial position of the natural structure. In the evolutionary understanding, space and time, as the main categories of the development of the physical world, are presented as a fundamental condition under which each self-developing system, the mode of existence of which is a specific form of matter movement, has its own time, as well as its own space. Hence, the space and time of finite material systems are also finite, and the infinity of time can mean the qualitative infinity of specific forms of time of an infinite number of self-developing systems.

Thus, the categories of space and time act as extremely general abstractions, in which the structural organization and variability of our existence are expressed. The study of space in geography appears to be the most important, one of the main goals in geographical science.

Moreover, according to the theory of relativity, which unifies space and time, it adds time to space as a new, fourth dimension of its development. Based on the use of methods of the system approach and modeling, it became possible to study spatial and temporal relations in geography [11, 2025].

Thanks to the use of new scientific approaches in the study of natural structures and phenomena, the science of geography has now been transformed into a spatio-temporal science. Geographic space and time, as the main forms of existence of geosystems, allow us to study the order of distribution of simultaneously existing geographic phenomena and the extent of geosystems through spatial relations, and the order of duration of successive events constitutes the goals of studying temporal relations.

It should be noted that there are several types of geographical space that are represented independently of each other. If Isaac Newton [67,1687] considered space as absolute, existing constantly and regardless of whether there was any matter in it, then, on the contrary, other natural philosophers, in particular Gottfried Leibniz, believed that space is in fact a set of relationships between structures, determined by their distance and direction from each other. In this case, Leibniz's proposal sounds closer to the nature of our reasoning and, to a certain extent, he can be considered a scientist who proposed a typology of space.

According to Leibnizian relationism, extension or space, surfaces, lines and points are nothing other than rational entities, innate ideas and relations of orders, namely orders of coexistence [2, 1994a]. Spaces are distinguished: real, phase, and order space. While real space is the general geographic space that can be depicted in maps or remote sensing imagery, phase space can be described by the time series of a geographic system. The concept of phase space is taken from physics, but it is very useful for reflecting the regularity in the time series of geographic evolution. Unlike the previous two, the order space is defined by reference to the phase space definition and is characterized by hierarchical data, including geographical data based on rank order.

Along with the category of space, the category of time is also of decisive importance when it comes to, for example, the functioning of natural and socio-economic systems. The dynamics of the natural environment in evolutionary development is determined by time, since each element of the natural environment, as well as human behavior, changes over time [36, 1985]. In order to illustrate the geographical visualization of time, the concept of time geography was developed [37,1970], which is important, in particular, for understanding the processes and phenomena on the Earth's surface.

The formation of the everyday understanding of time is also associated with human economic activity, with various aspects of society. Here is the duration of the existence of individual objects and phenomena, and the duration of the transition from one point of the territory to another, and much more. All of the above motivated researchers to develop the concept of uniformly flowing time, since it was precisely this, independent of any conditions, that allowed for the implementation of coordination in people's actions in both economic and cultural life.

Interest in the concept of time geography continues to attract the attention of a wide range of specialists in practical terms, especially in the field of public health and social justice, social networks and transport logistics, location-based services and marketing.

## Spatial Interactions

Spatial interactions, in accordance with the concept of spatial interaction in geography, refer to the movement of matter, energy, people and information in space, determined by the processes of evolutionary development and decision-making in the field of social relationships. They cover various types of processes, phenomena and activities such as erosion, destruction, migration, flow of energy and matter, and information, with applications to predicting various flows and understanding the determinants of spatial systems.

In the process of spatial interactions, various spatial relationships arise, which are based on the study of forms and structures, as well as their relationships and transformations in formal mathematical systems.

The study of spatial relationships is conducted within the framework of spatial science, the aim of which is to study and analyze spatial patterns and relationships between humans and the environment. They include quantitative methods and data analysis techniques to identify significant features of spatial data. Ultimately, studies of spatial relationships of forms, structures and geosystems within the environment allow us to study the structure of their organization in relation to other objects or their spatial awareness. This is an important part of spatial awareness in describing and characterizing many other types of processes, phenomena and activities based on movement, including laterality and directionality.

Thus, space is such a form of existence of a self-developing system, the essence of which lies in the mutual arrangement of the interacting components of this system. The patterns of their changing mutual arrangement constitute the properties of space, determined by the very process of their interaction, i.e. the form of movement. At the same time, space is considered as a form of existence of moving matter in its inextricable connection with time in dialectical materialism. Space does not exist in itself. It, like time, is a form of being of moving matter.

The properties of space are determined by movement. And the dialectical-materialistic understanding of the infinity of space is based on the fact that there really exists an infinite number of concrete forms of space, related to concrete forms of movement of self-developing material systems. In contrast to space, time as a form of existence of a self-developing system is a sequential alternation of its states. The patterns of the alternation process that characterize the properties of time are determined by the process of interaction between the components of such a system or the form of movement.

As an example, illustrating the connections between matter, motion, space and time, the Solar system can be used. Since gravitational interaction was the cause of its origin, it is also the basis of its existence and development. At the same time, gravitational interaction determines the mutual arrangement of planets in orbits around the Sun, i.e. gravitational interaction is the movement or mode of existence of the solar system.

This movement occurs in space, i.e. it is the source of the mutual arrangement of the Sun and the planets. But this movement also occurs in time, i.e. one follows another, within the framework of which a consistent change in the mutual arrangement of the components of the solar system occurs. If we compare the solar system with a biological self-developing system, for example, a pasture ecosystem, the basis of whose existence is another, biological form of matter movement, then we can see the differences in space and time of these systems, which will be determined by the difference in their forms of existence - gravitational and biological forms of matter movement.

In addition, the space of the Solar System has a characteristic property such as orbitality. On the contrary, in a pasture ecosystem, the spatial relationships of organisms and the conditions of their existence do not have such a characteristic as orbitality. The biological form of matter motion determines other properties of biological space. If in the solar system the spatial relationship of planets and the Sun is determined by the gravitational interaction of masses, then in biological systems the dimensionality of space changes. In this case, the spatial properties of ecosystems determine biological metabolism.

The food chains that form the structure of biological metabolism act as biological space. And the alternation of states of food chains (ecosystem succession) constitute biological time. Therefore, biological time is fundamentally different from the time of the solar system, which represents a change of states [58, 1989].

Thus, space as a form of existence of a self-developing system is an object, the content of which consists in the mutual arrangement of interacting components of such a system. The patterns of their changing mutual arrangement or the properties of space are determined by the process of their interaction itself, i.e. the form of movement. Time, in this case, as a form of existence of a self-developing system, represents a sequential alternation of its states. The patterns of such alternation or the properties of time are determined by the very process of interaction of the components of such a system, i.e. also by the form of movement.

Ultimately, space and time as forms of being of moving matter, possessing different properties, represent different forms of being of matter. But since any changes in space are necessarily accompanied by changes in time, they act as interconnected, although different forms of being. Spaces cannot always pass into each other, nor can they pass into matter itself, since they are the basic forms of its existence, its inalienable properties.

The variety of specific forms of space and time determine the variety of forms of movement of matter, which is associated with the existence of specific self-developing systems.

In conclusion, I would like to note that the physical world is moving matter, which can move and develop only in space and time. In this case, spatial interaction as a basic concept is based on and considers how locations interact with each other in terms of movement of people, goods, services, energy or information. Complementarity, intermediary capabilities and portability are the main features of spatial interactions.

Another feature of spatial interactions is the structure of spatial data. The basic types of data found on maps are points, lines, and areas. These data can be stored in many forms, common examples being grid cells, point lists, line segment lists, and polygons, and can be used to construct not only graphs but also dependency matrices.

Naturally, one cannot fail to mention spatial interaction in human development, which depends on factors such as geographical location, cultural practices, economic conditions and technological progress. It should also be noted that other spatial characteristics include distance, direction, shape. In contrast to spatial characteristics, it is worth noting temporal characteristics, which include the time of occurrence, duration, occurrence before or after other events [94, 2021].

## Spatial relationships among structures and systems

Spatial relationships refer to the connections and arrangements between structures and systems in physical space. A spatial relationship is defined as some structure being located in space relative to some supporting structure. When the reference structure is much larger than the structure to be found, the latter is often represented by a point.

The concept of spatial relationships also includes spatial (or geometric) form, which suggests that structures and systems can have the expression of a point, a line, or an area, and if the quantities noted are related, then the structures and systems can be considered as a table between structures, a band, or a volume. It has been proposed to distinguish two classes of spatial relations: fine-grained, metric, coordinate spatial relations and global, abstract, categorical spatial relations [49, 1987].

Among the easily recognizable and understandable forms of spatial relations are geographical maps. Geographic maps can be used to calculate metric ratios of distance and area of structures. By the way, depending on the type of geographic maps used and how they are used, the corresponding spatial relationships can be determined. The convenience and popularity of using geographic maps lies not so much in the visualization of the spatial relationships themselves, but in what they mean on the maps.

The use of geographical maps implies not only the need for further study of the spread of any phenomenon or process, but also the possible effects of the spatial manifestation of any phenomenon or process, for example, the spread of disease, animal migrations, etc.

Thus, despite the impressive results of research on the psychological mechanisms underlying spatial relationships and behavior, there is currently no comprehensive theory that would help provide a basis for integrating our understanding of the various aspects of environmental knowledge. In this regard, the results of studies based on four dimensions that an ecosystem should have may be of particular interest: function, structure, form and content of the organism’s knowledge [96, 2014].

Taken together, formalizing the understanding of these dimensions in the question form of what (content), how (structure), and why (function) can contribute to an integrated view of our knowledge of the environment. The use of spatial environmental data will vary depending on the types of data and their structure. Therefore, as a rule, such data should be in accordance with the name of the structure and its position on the Earth's surface, which determines its relationship to the spatial reporting system.

When using a multilayer vector data model, structure names can be conceptually tied to elements such as polygons, such as lakes, rather than the hilltops and line segments needed to delimit them. Therefore, an additional spatial data type may be required if the software does not allow the primitive spatial units to be combined to the level where feature names correspond.

The requirements for the nature of the space can be met by identifying positions or tiles and then providing descriptive information about the identified position of a given structure. That said, some software systems may not be able to handle all points in space well enough to recognize only structures as encoded; that is, they do not have the ability to perform proximity tests or point-in-polygon or point-on-line tests quickly or at all. In this regard, it is important to consider the dual requirement for access to spatial structures, specifying both coordinate shapes and tiling systems [54, 1992].

By the way, physical or geographical structures, or information, lend themselves well to analysis in terms of spatial relationships. For non-physical information, one should take into account the fact how spatial relationships between elements of the geosystem are considered and remembered. For example, the levels of an organizational hierarchy are strictly hierarchical because the physical distance between elements does not matter. However, researchers tend to associate the vertical position of a system with power, believing that the relative position of two equally "ranked" individuals should be the same and not necessarily shifted upwards, since one person reports to a more senior manager [101, 2011].

To conclude the discussion of spatial relationship recognition between environmental structures, we can define their subject, object, and predicate, including the detection and localization of the subject and object in the image, as well as the classification of the predicate of the spatial relationship between them. For example, a floodplain in a river valley corresponds to the subject and object, respectively, and is not a predicate of the spatial relationship. At the same time, the floodplain and the river valley are located and detected in space, respectively. This example illustrates that recognizing spatial relationships differs from spatial description and reasoning about spatial relationships above. Spatial description focuses on extracting information about the spatial relationships of structures as different kinds of representation, in a quantitative way and in a concrete way or in an abstract way.

Spatial relationship reasoning focuses on the logical reasoning and computation of spatial relationship formulas between structures, while spatial relationship recognition focuses on the differences of whether a spatial relationship predicate fulfills its localization function between subject and object pairs [97, 2023]. Although visual relations may contain spatial relations as a superset, it should be noted that some part of visual relations may be mapped to spatial relations. For example, in the system: subject, person, predicate, riding, object. In the spatial concept it may be implied that a person is riding a horse. In this case, visual detection of relationships can be based on recognition of spatial relationships (ibid.).

## Spatial analysis of natural structures and systems

Spatial analysis is defined as the process of exploring structures and systems by examining, evaluating, analyzing, and modeling the spatial characteristics of data, such as location, attributes, and their relationships that reveal the geometric or geographic properties of the data. Location, region, human-environment relations, place and movement constitute the fundamental themes or areas of study in geography. Within these themes, geography is governed by a method rather than a specific body of knowledge, and this method is called the spatial analysis.

For example, Physical Geography focuses on the spatial analysis of all physical structures and processes that make up the environment: air, water, climate, landforms, soils, animals, plants, and the Earth itself. Thanks to the use of spatial models, geography studies the processes of the Earth's natural systems and their interactions, including with human society. The use of spatial analysis occurs in a certain order, involving a set of actions or mechanisms that are central to geographic analysis. The manifestations of numerous natural processes are considered within the framework of the Earth's vast water-atmosphere-climate system or crustal movements and earthquakes.

In general, the use of geographic research data is carried out using various models within the target system, for which analytical methods based on algorithmic methodologies are also used. The essence of this methodology is the use of location and movement direction algorithms. As an example, we can name the following modeling processes, with the help of which disaster warning and recovery of agriculture are provided, supply and logistics chains are assessed, and a number of other phenomena and processes that depend on spatial analysis.

In other words, spatial data, which is considered as a numerical representation of any physical structure in a geographic coordinate system, is the source of information for spatial analysis. Such spatial data can be divided into geographic and geometric categories. Whereas geometric data projects spatial information onto 2D surfaces, geographic information indicates the location or coordinates (latitude and longitude) of a structure that is superimposed on the surface of a sphere within the Earth. While GPS devices provide precise geographic information, applications such as Google Maps, which use 2D data, provide navigational directions to users.

As is known, such applications in navigation are used not only for scientific purposes, but are also widely represented in our everyday life.

An aspect of spatial analysis is mapping physical structures. Geographic information through maps of varying content and scale can be used as a consolidated version of spatial data collected from multiple sources to take appropriate action in solving both short-term and long-term problems. For example, the spatial analysis can help with traffic control in urban environments or to ensure the sustainability of flows of people and materials.

Among the most well-known and widely used methods of spatial analysis are GIS methods. The success of these methods is due to the fact that the use of spatial analysis in this methodology is determined by the presence of clearly defined steps. First of all, it is worth noting that this method uses a method called geocoding, which converts data points such as latitude, longitude and zip codes into precise geographic coordinates and projections. Subsequently, isochronous maps are used to show routes and travel times between locations, as well as encoding spatial structures such as polygons and lines to create 2D and 3D models of real-world structures.

To obtain new spatial information as a result of spatial analysis using GIS, various spatial forms are combined. This operation facilitates the calculation of overlapping areas or boundaries, which leads to the creation of calculated points, lines or polygons. Ultimately, based on the information obtained, researchers can create interactive maps with predictive data to identify trends and develop spatial analytics, which can be useful in predicting spatial changes in structures, phenomena and processes.

At the end of this paragraph, we will summarize everything that has been said and highlight the main stages of the spatial analysis. First of all, let us note that the process of spatial analysis begins with the analysis of spatial data, which can be in the form of attributes, properties or relationships, on the basis of which the location and distance data used are collected, processed, improved and the value is determined.

Based on the obtained data, spatial autocorrelation is carried out to determine the location of data points with similar characteristics. Since in practice, heterogeneity of the data set is possible due to the uneven distribution of features in the space of the region, the approach of spatial stratified heterogeneity is used to assess the coverage within geographic polygonal zones. If location data with known properties is available, a spatial interpolation method is used, for example, estimating air temperature from the location of a weather station. In the analysis of large areas, within which regional boundaries may touch or overlap, the use of a spatial interaction approach can be useful for understanding the interactions of points, lines and polygons of different structures. To describe geographic structures, models of underground reservoirs and probability distributions are used. In this case, the use of a statistical model of multipoint geoinformation allows us to analyze groups of algorithms, on the basis of which the distribution patterns of spatial structures are simulated.

Thus, the spatial analysis represents an important tool in the arsenal of modern data analysis. Its ability to visualize, analyze, and interpret spatial data makes it indispensable in many areas of geographic research. As technology advances and spatial data becomes more accessible, the importance and application of spatial analysis will continue to grow, enabling more informed decisions and a deeper understanding of the world around us.

The spatial distribution analysis and the use of spatiotemporal data are important because they allow experts in sociology, psychology, epidemiology, biology, business, and marketing (among others) to better understand human behavior, environmental factors, and the relationships between people and locations.

It must be said that spatial analysis is used in many fields, including urban planning, healthcare and environmental management. It involves collecting and analyzing location-based data such as geographic coordinates, demographics, and land use. For example, spatial analysis can help manage traffic in urban environments, thereby enabling authorities to take steps to create sustainable cities.

The technology can also allow users to check the geographical development of the disease and thus invest in efforts to control its spread. Spatial data that is used in numerous real-world situations can be useful in flow direction studies and the management of infrastructure projects. Some other spatial data applications enable you to solve complex location-based problems, explore and understand data from a geographic perspective, identify relationships, discover and quantify patterns, assess trends, and make predictions and decisions.

Spatial interaction is thus an important topic in the field of the spatial analysis. It is assumed that flows between units (zones, cities, nodes, counties) are related to the sizes of the points of origin (sources) and destination (sinks) and are inversely proportional to the distance between them [68, 2009]. The use of spatial analysis, in addition to investigating the location of spatial structures, is very important in studying spatial interactions, especially the flows of people, materials and information between places.

The level and nature of such interactions are a reflection of the need for movement (complementarity) and the difficulty or ease of overcoming the intermediate distance, which serves as an impeding factor.

In short, people and places matter (push and pull factors), and distance matters too, manifesting itself in spatial effects such as competing opportunities, clustering, and agglomeration.

# CHAPTER 2

# METHODOLOGY OF GEOGRAPHY

Methodology is defined as a set of the most essential elements of theory, constructive for the development of science itself. In other words, methodology is a concept of theory development. If theory is associated with the organization of knowledge about the object of research, then methodology is aimed at the process of obtaining this knowledge.

The main types of research methodologies, including those in geographical research, are quantitative, qualitative and mixed methods. Quantitative methods focus on numerical data of spatial organization and spatial relationships between structures and phenomena and statistical analysis, qualitative methods are aimed at detailed descriptions and interpretations, and mixed methods combine both approaches.

## Methodology of Geography

The methodology of geography is the study of the principles, methods and methods of studying geographical structures, phenomena and processes. Geography methodology involves the process of collecting data, analyzing, and systematically interpreting data to obtain new knowledge and answer specific questions or solve problems [24, 2006]. With this in mind, geographical research is the logical and systematic study of something new in a given space or in the spatial relationships between structures, phenomena and processes.

In terms of geography, data collection methods such as observation, surveys and interviews tend to be more qualitative in nature, whereas sampling, mapping and remote sensing tend to be more quantitative in nature. Simply put, the methodology of geography consists of systematically observing, formulating, testing, and revising hypotheses or concepts. If a hypothesis withstands the test of repeated experiments and reviews, it can be elevated to a theory.

Thus, the methodology of geography refers to the overall strategy and rationale for the approaches of the research to be undertaken. It involves studying the methods used in a chosen field of geography, as well as the theories or principles underlying them, in order to develop an approach that is appropriate to the aims of the geographical research.

In other words, the geographic approach is a problem-solving approach that uses data analysis to identify and predict spatial relationships given a range of real-world factors in geographic space. The space is the fundamental concept used in geography. Briefly defined, space is "the area on the Earth's surface in and around which all people exist and their activities take place" [26, 2013].

Naturally, given the existing knowledge about space, the proposed definition is very simplified and does not reveal all possible variants of geographic space, the characteristics of which will be proposed in the following discussions. If we systematize the concept of the geographical approach using its inherent characteristics, we can put together the following elements of the geographical approach. First of all, we should note the importance of geographical studies of spatial relationships between structures, phenomena and processes. Such relationships are concentrated within the concepts of position, scale, direction, distance, distribution and correlation. Naturally, the analysis of spatial relationships is based on obtaining and analyzing the relevant basic data.

Therefore, the peculiarity of the geographical approach is that it is essentially holistic, since the concept of location is a common denominator among various data, which can subsequently allow us to identify the relationships between phenomena and structures, thanks to the geographical approach and its spatial methodology.

Thus, understanding the spatial organization, extent and variations in different conditions and the degree of their correlation allows us to use a geographical approach, which is characterized by the analysis of the obtained data to identify and predict spatial relationships within a number of real objects and phenomena.

The special significance or uniqueness of the methodology of geography is the possibility of its use in finding solutions to many problems. Among such very urgent problems are the following: the study of climate change, the study of natural resources, the analysis of urbanization processes and the assessment of human impact on the environment. Conducting a characterization of the development features of the named processes and phenomena will allow us to identify general patterns in the development of manifestations of the functional features of these processes and phenomena.

The study of climate change is rightfully included in the most important problems of our time, since climate change itself, as well as its impact on the state and functioning of various geosystems and ecosystems, is not only a theoretical but also a practical task. I will note that climate change is not only a change in general trends in climate change, but also in the weather.

Overall, climate change impacts the environment in many ways, including changes in temperature and precipitation, rising sea levels, droughts, floods, etc. These natural phenomena and events affect the status, quality and use of water, energy production and distribution, transportation, biodiversity, agriculture, ecosystems and human health.

The noted consequences of climate change are characterized by spatial relationships between structures, phenomena and processes. Climate change is essentially a long-term change in a region’s average weather conditions, such as typical temperature, precipitation, and windiness, which can alter the range of conditions expected in many regions over a period of time. This means that there will also be changes in the manifestation of extreme conditions in various regions and territories, with subsequent impacts on natural and economic structures and development trends of natural processes and phenomena.

A key feature of natural resources is their geographic distribution. Typically, there is a concentration of them in certain regions of the world, which do not necessarily coincide with the regions where they are actively used in production, which leads to the formation and development of