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CHANGING NATURE OF PHYSICAL GEOGRAPHY

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ABSTRACT: Physical geography (also known as physiography) is one of the three main branches of geography.[1][2][3][4][5] Physical geography is the branch of natural science which deals with the processes and patterns in the natural environment such as the atmosphere, hydrosphere, biosphere, and geosphere. This focus is in contrast with the branch of human geography, which focuses on the built environment, and technical geography, which focuses on using, studying, and creating tools to obtain,analyze, interpret, and understand spatial information.[4][5][6] The three branches have significant overlap, however.

KEYWORDS-physical,geography,environment,human,technical,spatial

I. INTRODUCTION


A natural arch.

Physical geography can be divided into several branches or related fields, as follows:

- Geomorphology[7][8] is concerned with understanding the surface of the Earth and the processes by which it is shaped, both at the present as well as in the past. Geomorphology as a field has several sub-fields that deal with the specific landforms of various environments e.g. desert geomorphology and fluvial geomorphology; however, these sub-fields are united by the core processes which cause them, mainly tectonic or climatic processes. Geomorphology seeks to understand landform history and dynamics, and predict future changes through a combination of field observation, physical experiment, and numerical modeling (Geomorphometry). Early studies in geomorphology are the foundation for pedology, one of two main branches of soil science.


Meander formation.

- Hydrology[7][8] is predominantly concerned with the amounts and quality of water moving and accumulating on the land surface and in the soils and rocks near the surface and is typified by the hydrological cycle. Thus the field encompasses water in rivers, lakes, aquifers and to an extent glaciers, in which the field examines the process and dynamics involved in these bodies of water. Hydrology has historically had an important connection with engineering and has thus developed a largely quantitative method in its research; however, it does have an earth science side that embraces the systems approach. Similar to most fields of physical geography it has sub-fields that examine the specific bodies of water or their interaction with other spheres e.g. limnology and ecohydrology.[1,2,3]
- Glaciology is the study of glaciers and ice sheets, or more commonly the cryosphere or ice and phenomena that involve ice. Glaciology groups the latter (ice sheets) as continental glaciers and the former (glaciers) as alpine glaciers. Although research in the areas is similar to research undertaken into both the dynamics of ice sheets and glaciers, the former tends to be concerned with the interaction of ice sheets with the present climate and the latter with the impact of glaciers on the landscape. Glaciology also has a vast array of sub-fields examining the factors and processes involved in ice sheets and glaciers e.g. snow hydrology and glacial geology.
- Biogeography[7][8] is the science which deals with geographic patterns of species distribution and the processes that result in these patterns. Biogeography emerged as a field of study as a result of the work of Alfred Russel Wallace, although the field prior to the late twentieth century had largely been viewed as historic in its outlook and descriptive in its approach. The main stimulus for the field since its founding has been that of evolution, plate

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tectonics and the theory of island biogeography. The field can largely be divided into five sub-fields: island biogeography, paleobiogeography, phylogeography, zoogeography and phytogeography.

- Climatology[7][8] is the study of the climate, scientifically defined as weather conditions averaged over a long period of time. Climatology examines both the nature of micro (local) and macro (global) climates and the natural and anthropogenic influences on them. The field is also sub-divided largely into the climates of various regions and the study of specific phenomena or time periods e.g. tropical cyclone rainfall climatology and paleoclimatology.
- Soil geography deals with the distribution of soils across the terrain. This discipline, between geography and soil science, is fundamental to both physical geography and pedology.[9][10][11] Pedology is the study of soils in their natural environment. It deals with pedogenesis, soil morphology, soil classification. Soil geography studies the spatial distribution of soils as it relates to topography, climate (water, air, temperature), soil life (micro-organisms, plants, animals) and mineral materials within soils (biogeochemical cycles).
- Palaeogeography[7] is a cross-disciplinary study that examines the preserved material in the stratigraphic record to determine the distribution of the continents through geologic time. Almost all the evidence for the positions of the continents comes from geology in the form of fossils or paleomagnetism. The use of these data has resulted in evidence for continental drift, plate tectonics, and supercontinents. This, in turn, has supported palaeogeographic theories such as the Wilson cycle.
- Coastal geography is the study of the dynamic interface between the ocean and the land, incorporating both the physical geography (i.e. coastal geomorphology, geology, and oceanography) and the human geography of the coast. It involves an understanding of coastal weathering processes, particularly wave action, sediment movement and weathering, and also the ways in which humans interact with the coast. Coastal geography, although predominantly geomorphological in its research, is not just concerned with coastal landforms, but also the causes and influences of sea level change.
- Oceanography[7] is the branch of physical geography that studies the Earth's oceans and seas. It covers a wide range of topics, including marine organisms and ecosystem dynamics (biological oceanography); ocean currents, waves, and geophysical fluid dynamics (physical oceanography); plate tectonics and the geology of the sea floor (geological oceanography); and fluxes of various chemical substances and physical properties within the ocean and across its boundaries (chemical oceanography). These diverse topics reflect multiple disciplines that oceanographers blend to further knowledge of the world ocean and understanding of processes within it.
- Quaternary science[8] is an interdisciplinary field of study focusing on the Quaternary period, which encompasses the last 2.6 million years. The field studies the last ice age and the recent interstadial the Holocene and uses proxy evidence to reconstruct the past environments during this period to infer the climatic and environmental changes that have occurred.
- Landscape ecology is a sub-discipline of ecology and geography that address how spatial variation in the landscape affects ecological processes such as the distribution and flow of energy, materials, and individuals in the environment (which, in turn, may influence the distribution of landscape "elements" themselves such as hedgerows). The field was largely funded by the German geographer Carl Troll. Landscape ecology typically deals with problems in an applied and holistic context. The main difference between biogeography and landscape ecology is that the latter is concerned with how flows or energy and material are changed and their impacts on the landscape whereas the former is concerned with the spatial patterns of species and chemical cycles.
- Geomatics is the field of gathering, storing, processing, and delivering geographic information, or spatially referenced information. Geomatics includes geodesy (scientific discipline that deals with the measurement and representation of the earth, its gravitational field, and other geodynamic phenomena, such as crustal motion, oceanic tides, and polar motion), cartography, geographical information science (GIS) and remote sensing (the short or large-scale acquisition of information of an object or phenomenon, by the use of either recording or real-time sensing devices that are not in physical or intimate contact with the object).
- Environmental geography is a branch of geography that analyzes the spatial aspects of interactions between humans and the natural world. The branch bridges the divide between human and physical geography and thus requires an understanding of the dynamics of geology, meteorology, hydrology, biogeography, and geomorphology, as well as the ways in which human societies conceptualize the environment. Although the branch was previously more visible in research than at present with theories such as environmental determinism linking society with the environment. It has largely become the domain of the study of environmental management or anthropogenic influences.[5,7,8]

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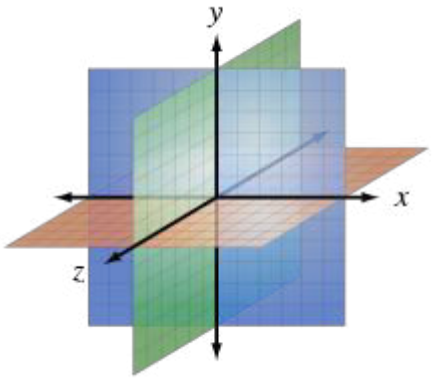
II. DISCUSSION

Core concepts

Space



A right-handed three-dimensional Cartesian coordinate system used to indicate positions in space.

Just as all phenomena exist in time and thus have a history, they also exist in space and have a geography.[25]

—United States National Research Council, 1997

For something to exist in the realm of geography, it must be able to be described spatially.[25][26] Thus, space is the most fundamental concept at the foundation of geography.[5][6] The concept is so basic, that geographers often have difficulty defining exactly what it is. Absolute space is the exact site, or spatial coordinates, of objects, persons, places, or phenomena under investigation.[5] We exist in space.[7] Absolute space leads to the view of the world as a photograph, with everything frozen in place when the coordinates were recorded. Today, geographers are trained to remember that the world is not the static image that appears on a map; and instead, the dynamic space where all processes interact and take place.[5][27]

Place

Place is one of the most complex and important terms in geography.[7][8][9][10] In human geography, place is the synthesis of the coordinates on the Earth's surface, the activity and use that occurs, has occurred, and will occur at the coordinates, and the meaning ascribed to the space by human individuals and groups.[26][9] This can be extraordinarily complex, as different spaces may have different uses at different times and mean different things to different people. In physical geography, a place includes all of the physical phenomena that occur in space, including the lithosphere, atmosphere, hydrosphere, and biosphere.[10] Places do not exist in a vacuum and instead have complex spatial relationships with each other, and place is concerned how a location is situated in relation to all other locations.[28][29] As a discipline then, the term place in geography includes all spatial phenomena occurring at a location, the diverse uses and meanings humans ascribe to that location, and how that location impacts and is impacted by all other locations on Earth.[9][10] In one of Yi-Fu Tuan's papers, he explains that in his view, geography is the study of Earth as a home for humanity, and thus place and the complex meaning behind the term is central to the discipline of geography.[8]

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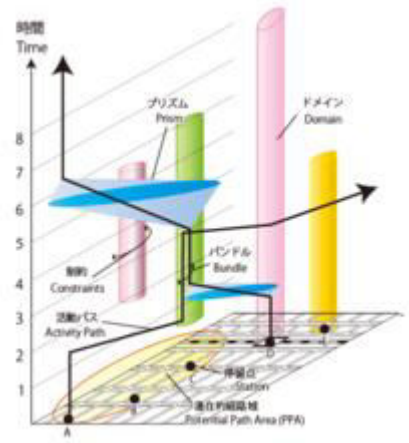
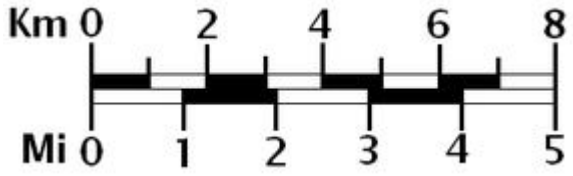
Time



Examples of the visual language of time geography: space-time cube, path, prism, bundle, and other concepts.

Time is usually thought to be within the domain of history, however, it is of significant concern in the discipline of geography.[30][31][32] In physics, space and time are not separated, and are combined into the concept of spacetime.[33] Geography is subject to the laws of physics, and in studying things that occur in space, time must be considered. Time in geography is more than just the historical record of events that occurred at various discrete coordinates; but also includes modeling the dynamic movement of people, organisms, and things through space.[7] Time facilitates movement through space, ultimately allowing things to flow through a system.[30] The amount of time an individual, or group of people, spends in a place will often shape their attachment and perspective to that place.[7] Time constrains the possible paths that can be taken through space, given a starting point, possible routes, and rate of travel.[34] Visualizing time over space is challenging in terms of cartography, and includes Space-Prism, advanced 3D geovisualizations, and animated maps.[28][34][35][27]

Scale



A graphical or bar scale. A map would also usually give its scale numerically ("1:50,000", for instance, means that one cm on the map represents 50,000cm of real space, which is 500 meters)[9,10,11]

Scale in the context of a map is the ratio between a distance measured on the map and the corresponding distance as measured on the ground.[2][36] This concept is fundamental to the discipline of geography, not just cartography, in that phenomena being investigated appear different depending on the scale used.[37][38] Scale is the frame that geographers use to measure space, and ultimately to try and understand a place.[36]

Laws of geography

Waldo Tobler in front of the Newberry Library. Chicago, November 2007

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During the quantitative revolution, geography shifted to an empirical law-making (nomothetic) approach.[39][40] Several laws of geography have been proposed since then, most notably by Waldo Tobler and can be viewed as a product of the quantitative revolution.[41] In general, some dispute the entire concept of laws in geography and the social sciences.[28][42][43] These criticisms have been addressed by Tobler and others, such as Michael Frank Goodchild.[42][43] However, this is an ongoing source of debate in geography and is unlikely to be resolved anytime soon. Several laws have been proposed, and Tobler's first law of geography is the most generally accepted in geography. Some have argued that geographic laws do not need to be numbered. The existence of a first invites a second, and many have proposed themselves as that. It has also been proposed that Tobler's first law of geography should be moved to the second and replaced with another.[43] A few of the proposed laws of geography are below:

- Tobler's first law of geography: "Everything is related to everything else, but near things are more related than distant"[28][42][43]
- Tobler's second law of geography: "The phenomenon external to a geographic area of interest affects what goes on inside."[42][44]
- Arbia's law of geography: "Everything is related to everything else, but things observed at a coarse spatial resolution are more related than things observed at a finer resolution."[37][42][38][45][46]
- The uncertainty principle: "That the geographic world is infinitely complex and that any representation must therefore contain elements of uncertainty, that many definitions used in acquiring geographic data contain elements of vagueness, and that it is impossible to measure location on the Earth's surface exactly."[43]

Additionally, several variations or amendments to these laws exist within the literature, although not as well supported. For example, one paper proposed an amendmended version of Tobler's first law of geography, referred to in the text as "The Tobler-von Thünen law."[41] This proposed variation of Tobler's first law states, "Everything is related to everything else, but near things are more related than distant things, as a consequence of accessibility."[41]

Sub-disciplines

Geography is a branch of inquiry that focuses on spatial information on Earth. It is an extremely broad topic and can be broken down multiple ways.[12] There have been several approaches to doing this spanning at least several centuries, including "four traditions of geography" and into distinct branches.[47][11] The Four traditions of geography are often used to divide the different historical approaches theories geographers have taken to the discipline.[11] In contrast, geography's branches describe contemporary applied geographical approaches.[3]

III. RESULTS

All geographic research and analysis start with asking the question "where," followed by "why there." Geographers start with the fundamental assumption set forth in Tobler's first law of geography, that "everything is related to everything else, but near things are more related than distant things."[28][29] As spatial interrelationships are key to this synoptic science, maps are a key tool. Classical cartography has been joined by a more modern approach to geographical analysis, computer-based geographic information systems (GIS).

In their study, geographers use four interrelated approaches:

- Analytical – Asks why we find features and populations in a specific geographic area.
- Descriptive – Simply specifies the locations of features and populations.
- Regional – Examines systematic relationships between categories for a specific region or location on the planet.
- Systematic – Groups geographical knowledge into categories that can be explored globally.[12,13,15]

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Quantitative methods

James Cook's 1770 chart of New Zealand

Quantitative methods in geography became particularly influential in the discipline during the quantitative revolution of the 1950s and 60s.[13] These methods revitalized the discipline in many ways, allowing scientific testing of hypotheses and proposing scientific geographic theories and laws.[64] The quantitative revolution heavily influenced and revitalized technical geography, and lead to the development of the subfield of quantitative geography.[24][13]

Geomatics

Geomatics is concerned with the application of computers to the traditional spatial techniques used in cartography and topography. Similar to the terms geographic information science and technical geography, geomatics emerged from the quantitative revolution in geography in the mid-1950s. Today, geomatics methods include spatial analysis, geographic information systems (GIS), remote sensing, and global positioning systems (GPS). Geomatics has revitalized some geography departments, especially in Northern America, where the subject had a declining status during the 1950s.

Quantitative cartography

Cartography is the art, science, and technology of making maps. Cartographers study the Earth's surface representation with abstract symbols (map making). Although other subdisciplines of geography rely on maps for presenting their analyses, the actual making of maps is abstract enough to be regarded separately. Cartography has grown from a collection of drafting techniques into an actual science.[17,18,19]

Cartographers must learn cognitive psychology and ergonomics to understand which symbols convey information about the Earth most effectively and behavioural psychology to induce the readers of their maps to act on the information. They must learn geodesy and fairly advanced mathematics to understand how the shape of the Earth affects the distortion of map symbols projected onto a flat surface for viewing. It can be said, without much controversy, that cartography is the seed from which the larger field of geography grew. Most geographers will cite a childhood fascination with maps as an early sign they would end up in the field.

Geographic information systems

Geographic information systems (GIS) deal with storing information about the Earth for automatic retrieval by a computer in an accurate manner appropriate to the information's purpose.[65] In addition to all of the other subdisciplines of geography, GIS specialists must understand computer science and database systems. GIS has revolutionized the field of cartography: nearly all mapmaking is now done with the assistance of some form of GIS software. The science of using GIS software and GIS techniques to represent, analyse, and predict the spatial relationships is called geographic information science (GISc).[66]

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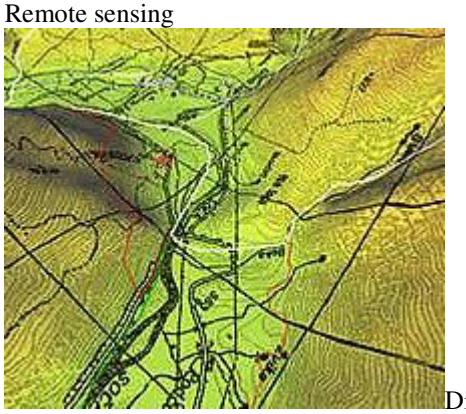
Remote sensing


Digital elevation model (DEM)

Remote sensing is the art, science, and technology of obtaining information about Earth's features from measurements made at a distance.[67] Remotely sensed data can be either passive, such as traditional photography, or active, such as LiDAR.[67] A variety of platforms can be used for remote sensing, including satellite imagery, aerial photography (including consumer drones), and data obtained from hand-held sensors.[67] Products from remote sensing include Digital elevation model and cartographic base maps. Geographers increasingly use remotely sensed data to obtain information about the Earth's land surface, ocean, and atmosphere, because it: (a) supplies objective information at a variety of spatial scales (local to global), (b) provides a synoptic view of the area of interest, (c) allows access to distant and inaccessible sites, (d) provides spectral information outside the visible portion of the electromagnetic spectrum, and (e) facilitates studies of how features/areas change over time. Remotely sensed data may be analyzed independently or in conjunction with other digital data layers (e.g., in a geographic information system). Remote sensing aids in land use, land cover (LULC) mapping, by helping to determine both what is naturally occurring on a piece of land and what human activities are taking place on it.[68]

Geostatistics

Geostatistics deal with quantitative data analysis, specifically the application of a statistical methodology to the exploration of geographic phenomena.[69] Geostatistics is used extensively in a variety of fields, including hydrology, geology, petroleum exploration, weather analysis, urban planning, logistics, and epidemiology. The mathematical basis for geostatistics derives from cluster analysis, linear discriminant analysis and non-parametric statistical tests, and a variety of other subjects. Applications of geostatistics rely heavily on geographic information systems, particularly for the interpolation (estimate) of unmeasured points. Geographers are making notable contributions to the method of quantitative techniques.[20,21,22]

Qualitative methods

Qualitative methods geography in geography are descriptive rather than numerical or statistical in nature.[70][14][39] They add context to concepts, and explore human concepts like beliefs and perspective that are difficult or impossible to quantify.[14] Human geography is much more likely to employ qualitative methods than physical. Increasingly, technical geographers are attempting to employ GIS methods to qualitative datasets.[14][71]

Qualitative cartography

Qualitative cartography employs many of the same software and techniques as quantitative.[71] It may be employed to inform on map practices, or to visualize perspectives and ideas that are not strictly quantitative in nature.[71][14]

Ethnography

Ethnographical research techniques are used by human geographers.[72] In cultural geography, there is a tradition of employing qualitative research techniques, also used in anthropology and sociology. Participant observation and in-depth interviews provide human geographers with qualitative data.

Geopoetics

Geopoetics is an interdisciplinary approach that combines geography and poetry to explore the interconnectedness between humans, space, place, and the environment.[73][74] Geopoetics is employed as a mixed methods tool to explain the implications of geographic research.[75] It is often employed to address and communicate the implications of complex topics, such as the anthropocene.[76][77][78][79][80]

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Interviews

Geographers employ interviews to gather data and acquire valuable understandings from individuals or groups regarding their encounters, outlooks, and opinions concerning spatial phenomena.[81][82] Interviews can be carried out through various mediums, including face-to-face interactions, phone conversations, online platforms, or written exchanges.[39] Geographers typically adopt a structured or semi-structured approach during interviews involving specific questions or discussion points when utilized for research purposes.[81] These questions are designed to extract focused information about the research topic while being flexible enough to allow participants to express their experiences and viewpoints, such as through open-ended questions.[81]

IV. CONCLUSIONS

The discipline of geography, especially physical geography, and geology have significant overlap. In the past, the two have often shared academic departments at universities, a point that has led to conflict over resources.[108] Both disciplines do seek to understand the rocks on the Earth's surface and the processes that change them over time. Geology employs many of the tools and techniques of technical geographers, such as GIS and remote sensing to aid in geological mapping.[109] However, geology includes research that goes beyond the spatial component, such as the chemical analysis of rocks and biogeochemistry.[110]

History

The discipline of History has significant overlap with geography, especially human geography.[111][112] Like geology, history and geography have shared university departments. Geography provides the spatial context within which historical events unfold.[111] The physical geographic features of a region, such as its landforms, climate, and resources, shape human settlements, trade routes, and economic activities, which in turn influence the course of historical events.[111] Thus, a historian must have a strong foundation in geography.[111][112] Historians employ the techniques of technical geographers to create historical atlases and maps.[23,25]

Planetary science

While the discipline of geography is normally concerned with the Earth, the term can also be informally used to describe the study of other worlds, such as the planets of the Solar System and even beyond. The study of systems larger than the Earth itself usually forms part of Astronomy or Cosmology. The study of other planets is usually called planetary science. Alternative terms such as areography (geography of Mars) have been employed to describe the study of other celestial objects. Ultimately, geography may be considered a subdiscipline within planetary science.[25]

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