Essentials of Geography

Physical Geography Lecture - GEOG B1

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What is Geography?

Geography (Earth/Write) - More than just maps!
The science that studies the relationships between natural systems, geographic areas, human activities, and their INTERDEPENDENCE, *over space.*
Geographers use maps to reveal patterns in the data.

Five Spatial Themes (Fig. 1.2)

Location: exact position on land (address or absolute position)
Region: has uniform physical or human characteristics
Human-Earth Relationships: People interacting with the land - resources used / overused / sustainability
Movement: communications, migration patterns, diffusion
Place: characteristics (human & physical) of a location

Geographic Methods

Geography integrates all scientific fields, both physical and human.   (Fig. 1.3)
Geographers conduct **spatial analysis** - we measure and analyze phenomenon, and their distribution and movement in physical space
We look at the processes in the world and find how they interact (ie: water-atmosphere-weather system) through areas.

Physical Geography

The spatial analysis of all the physical elements, processes, and systems that make up Earth's environment:

-Energy -Air -Water
-Weather -Climate -Landforms
-Soils -Animals -Plants
-Microorganisms - and Human Impact

Scientific Process

Traditional **Scientific Method** of scientific investigation still fundamentally important.

Real process of science is more dynamic - leaves more room for questioning and “out of the box” thinking.

However, it must have a conclusion that can be repeatedly tested and shown as either true or false, and results must be reported (Fig. 1.4).

Being objective is key.

Human Impact

2011 - we hit 7,000,000,000 people.
Almost all new population growth occurs in less-developed countries (LDCs) = 81% of population
In most more-developed countries (MDCs), the population is no longer increasing.
However, people in MDCs have a greater impact on Earth's resources per person (energy use, food consumption, etc)

Sustainability Science

A recent discipline based on concepts of sustainable development involving Earth systems .
Emphasis on human well-being - more than just survival.
Looks at human impact and how our actions are or are not supportive of long-term ecological balance (“Footprint” p.7-8)
Key issues: feeding the world, energy supplies and demands, climate change, loss of biodiversity, and air and water pollution.

Earth Systems

A **system** is a distinct set of ordered, interrelated components and their attributes, linked by flows of energy and matter. *Matter is mass that takes a physical shape and occupies space. Energy is the capacity to change the motion of, or to do work on, matter.*

Systems in nature are not usually self-contained, or **closed**. In nature, inputs of energy and matter flow into the system, and outputs of energy and matter flow from the system - an **open system** (Fig. 1.6 and 1.7).

System Feedback

Feedback loops: when a system is operating, it generates outputs that influence, or feed back into, its own operations, and this feedback can produce changes in the system.
If the feedback discourages change in the system, it is a **negative feedback**, and can lead to stability in nature.
If the feedback encourages change, it is a **positive feedback**. Unchecked positive feedback can lead to a runaway condition that leads to instability, disruption, or death of organisms (Fig 1.8).

System Equilibrium

When an energy and material system maintains its balance over time (and any changes fluctuate around a stable average), it is in a **steady-state equilibrium** (Fig. 1.9). When a steady-state system had a changing trend over time, it is in a state of **dynamic equilibrium** (Fig. 1.9). The changes appear gradually and the system compensates. A system in equilibrium resists abrupt change, but sometimes it reaches a **threshold**, or tipping point, and it must find a new balance.

Models

Scientists create visual representations of systems to better people's understanding of how they work.

A **model** is a simplified and idealized representation of the real world (i.e.: hydrologic cycle, rock cycle).

Conceptual models are more generalized and shows how processes interact in a system.

Numerical models are more specific and based on collected data.

Geosystems

There are three interconnected **abiotic** (nonliving) systems:

- **Atmosphere** - Chapters 2-6
- **Hydrosphere** (and **cryosphere**) - Chapters 7-11
- **Lithosphere** - Chapters 12-17
- These abiotic systems form the realm of the biotic (living) system: **Biosphere** (or **ecosphere**) - Chapters 18-20
- See pages 12-15

Earth’s Dimensions

The Greek mathematician and philosopher, Pythagorus, figured it out over 2,000 years ago: Earth is round.
The Earth is spherical, or round, but not perfectly spherical.
Sir Isaac Newton postulated it was an oblate ellipsoid (flattened sphere) due to centrifugal forces while it rotates.
Due to the irregular shape of our planet, we now call it a **geoid** (Fig. 1.12).

Location - Latitude

Latitude is an angular distance north or south of the equator. The equator is at 0°, and the poles are 90° North or 90° South, respectively (Fig. 1.13)

A line connecting all points along the same latitudinal angle is a **parallel**. They ring around Earth.

Each degree of latitude is approximately 100km (69 miles).

To pinpoint locations, we divide each degree into 60 minutes, and each minute into 60 seconds (Fig. 1.14)

Latitudinal Zones

The zones are the same to the north or south of the equator. Each zone has a specific natural environment due to the amount of solar energy received.

- Arctic: 66.5° to pole
- Subarctic: 55° to 66.5°
- Midlatitude: 35° to 55°
- Subtropical: 23.5° to 35°
- Equatorial & Tropical: 0° to 23.5°
- See Fig. 1.15

Location - Longitude

Longitude is the angular distance east or west of a 0º point on Earth's surface.

A line connecting all the points along the same longitude is called a **meridian**.

These meridians run from north to south, converging at the poles, and they run at right angles to every latitudinal parallel.

The 0º meridian is called the **prime meridian**.

See Fig. 1.16 and Fig 1.18

Navigation: Great & Small Circles

A **great circle** is a circle of Earth's circumference whose center coincides with the center of Earth. Infinite

Every meridian is a half of a great circle, but only one parallel is a great circle…… which is it?

The shortest distance between two points is along a great circle. Airline and shipping routes tend to follow great circles.

A **small circle** is a circle through Earth th
at does not intersect with Earth's center. See Fig. 1.17

Global Time

Coordinating global activities means a global time system. Our planet rotates 360º every 24 hours, or 15º per hour. That combined with 24 standard meridians at equal intervals from the prime meridian, gives us our time zone system. In 1884, that system was called **Greenwich Mean Time (GMT)**, but the invention of the quartz clock in 1939, and atomic clocks in the early 1950s led to more accurate time measurment: **Coordinated Universal Time (UTC)**.
See Fig. 1.19

International Date Line

The prime meridian (0º) corrollates to the 180º meridian on the opposite side of the earth.
The 180º meridian marks the place where each day officially begins (at 12:01 AM), and it is called the **International Date Line (IDL)**.
From this line the new day sweeps westward as the planet rotates eastward on its axis. The west side of the IDL is always one day ahead of the east side.
Fig. 1.20

Daylight Savings Time

Practiced by 70 countries (mostly in temperate latitudes).
Time is set 1 hour ahead in spring, and 1 hour back in fall.
The idea is to extend daylight for evening activities at the expense of daylight in the morning.
First proposed by Benjamin Franklin, but only adopted in WWI, and later in WWII, when some government used the practice to save energy (1 less hour of artificial light needed).

Maps & Cartography

A **map** is a generalized, overhead view of an area which is greatly reduced in size. Usually represents a specific characteristic with place names and political boundaries.

Cartography is the science and art of map-making. It blends aspects of geography, engineering, mathematics, and computer science.

Maps are useful tools to help visualize one location in relation to another.

Scale

Maps are models - they need to apply measurements on the map to the real world. This is usually done with a ratio. The ratio of the image on a map to the real world is the map's **scale**. The scale relates the size of a unit on the map to the size of a similar unit on the ground (1:24,000 or 1/24,000).
Most maps have a *graphic scale*, or *bar scale*, with units to allow measurement of distances on a map (Fig. 1.21).
Small scale maps show larger areas with less detail, and large scale maps show smaller areas with more detail.

Map Projections

Taking a round object and making a flat map will always lead to distortion in the representation of the real world. The reduction of a sphere to a flat surface is called a **map projection** (Fig. 1.22).

Cartographers have to use their intended purpose of the map to choose the projection properties:

- **Equal area** (equivalence) - the scale of the map never changes
- **True shape** (conformity) - the scale will change betwee regions.

Projection Classes

The main projection classes are cylindrical, planar (or azimuthal), conic, and oval shape (Fig. 1.23).

The “contact” line, or “contact” point, is the only area where all globe properties are preserved. Areas away from the line or point become increasingly distorted.

The cartographer should center his projection on the area of interest to avoid as much distortion as possible.

Mercator Projection

Meridians are equally spaced vertical lines, and although parallels are also straight horizontal lines, they are spaced closer together near the equator (Fig. 1.22).
The distortion at the poles is so great that the projection is cut off at the 80th parallel in each hemisphere.
Presents a false notion of the size of mid-latitude and polar land masses.
Rhumb line, a line of constant direction, can be drawn as a straight line on a Mercator projection (Fig. 1.24).

Modern Tools & Techniques

Global Positioning System (GPS) - receiver senses radio signals from 4 satellites to accurately pinpoint latitude, longitude, and elevation (Fig. 1.25).

Remote sensing (RS) - getting information about distant objects without physical contact by using satellites, aircraft, and deep sea submersibles (Fig. 1.27).

Photogrammetry - getting accurate data from photos using a broad range of wavelengths, both visible and invisible.

Satellite Imaging

Requires satellites to collect huge amounts of data at varying wavelengths and processing it for different uses - simulated natural color, false color (to highlight a specific feature), enhanced contrast, signal filtering, and different levels of sampling and resolution.

Different orbital paths of the satellites affect the data collected (Fig. 1.28). Low orbits are faster and more useful for scientific monitoring of the surface.

Remote Sensing Systems

Passive RS - recording wavelengths of energy emitted from the surface. Using visible wavelengths for daytime hours, and infrared for nighttime views (Fig. 1.29).
Active RS - directing a beam of energy at a surface and analyzing the energy reflected back. Use *radar* (radio detection & ranging) or *LiDAR* (light detection & ranging). Both can penetrate clouds and darkness.

Geographic Information Systems

Remote sensing collects huge amounts of spatial data that needs to be stored, analyzed, and processed.
A **geographic information system (GIS)** is a computer-based data-processing tool for gathering, manipulating, and analyzing geographic information.
Spatial data can be layered over a basic locational map. The reference points on the map will serve to help accurately place the data from the various layers (Fig. 1.31).