Text 1
USES OF THEMATIC MAPS IN GEOGRAPHY

A thematic map emphasizes a theme or topic, such as the average distribution of rainfall in an area. They're different from general reference maps because they don't just show natural and manmade features such as rivers, cities, political subdivisions, and highways. If these items appear on a thematic map, they're reference points to enhance one's understanding of the map's theme and purpose.

Normally, thematic maps use coastlines, city locations, and political boundaries as their basis. The map's theme is then layered onto this base map via different mapping programs and technologies such as geographic information systems (GIS).

Audiences and Sources

The most significant factor to consider when designing thematic maps is the map's audience, which helps determine what items should be included on the map as reference points in addition to the theme. A map being made for a political scientist, for example, would need to show political boundaries, whereas one for a biologist might need contours showing elevation.

The sources of thematic maps' data are also important. Cartographers must find accurate, recent, reliable sources of information on a wide range of subjects, from environmental features to demographic data, to make the best possible maps.

Once accurate data is found, there are various ways to use that data that must be considered with the map's theme. Univariate mapping deals with only one type of data and looks at the occurrence of one type of event. This process would be good for mapping a location's rainfall. Bivariate data mapping shows the distribution of two data sets and models their correlations, such as rainfall amounts relative to elevation. Multivariate data mapping, which uses two or more data sets, could look at rainfall, elevation, and the amount of vegetation relative to both, for example.

Types of Thematic Maps

Although cartographers can use data sets in different ways to create thematic maps, five thematic mapping techniques are used most often:

The most common is the choropleth map, which portrays quantitative data as a color and can show density, percent, average value, or quantity of an event within a geographic area. Sequential colors represent increasing or decreasing positive or negative data values. Normally, each color also represents a range of values.

Proportional or graduated symbols are used in another type of map to represent data associated with locations, such as cities. Data is displayed on these maps with proportionally sized symbols to show differences in occurrences. Circles are most often used, but squares and other geometric shapes are also suitable. The most common way to size these symbols is to make their areas proportional to the values to be depicted using mapping or drawing software.

Another thematic map, the isarithmic or contour map, uses isolines to depict continuous values such as precipitation levels. These maps also can display three-dimensional values, such as elevation, on topographic maps. Generally, data for isarithmic maps is gathered via measurable points (e.g. weather stations) or is collected by area (e.g. tons of corn per acre by county). Isarithmic maps also follow the basic rule that there are high and low sides in relation to the isoline. For example, in elevation, if the isoline is 500 feet, then one side must be higher than 500 feet and one side must be lower.

A dot map, another type of thematic map, uses dots to show the presence of a theme and display a spatial pattern. A dot can represent one unit or several, depending on what is being depicted.

Finally, dasymetric mapping is a complex variation on the choropleth map that uses statistics and additional information to combine areas with similar values instead of using the administrative boundaries common in a simple choropleth map.

Text 2
MAP SCALE: MEASURING DISTANCE ON A MAP

A map represents a portion of Earth's surface. Because an accurate map represents a real area, each map has a "scale" that indicates the relationship between a certain distance on the map and the distance on the ground. The map scale is usually located in the legend box of a map, which explains the symbols and provides other important information about the map. A map scale can be printed in a variety of ways.

Words & Numbers Map Scale

A *ratio* or *representative fraction (RF)* indicates how many units on Earth's surface are equal to one unit on the map. It can be expressed as 1/100,000 or 1:100,000. In this example, 1 centimeter on the map could equal 100,000 centimeters (1 kilometer) on Earth. It could also mean that 1 inch on the map is equal to 100,000 inches on the real location (8,333 feet, 4 inches, or about 1.6 miles). Other common RFs include 1:63,360 (1 inch to 1 mile) and 1:1,000,000 (1 cm to 10 km).

A *word statement* gives a written description of map distance, such as "1 centimeter equals 1 kilometer" or "1 centimeter equals 10 kilometers." Obviously, the first map would show much more detail than the second, because 1 centimeter on the first map covers a much smaller area than on the second map.

To find a real-life distance, measure the distance between two points on the map, whether inches or centimeters – whichever scale is listed – and then do the math. If 1 inch on the map equals 1 mile and the points you're measuring are 6 inches apart, they're 6 miles apart in reality.

Caution

The first two methods of indicating map distance would be ineffective if the map is reproduced by a method such as photocopying with the size of the map modified (zoomed in or reduced). If this occurs and one attempts to measure 1 inch on the modified map, it's not the same as 1 inch on the original map.

Graphic Scale

A *graphic scale* solves the shrink/zoom problem because it is simply a line marked with the distance on the ground that the map reader can use along with a ruler to determine scale on the map. In the United States, a graphic scale often includes both metric and U.S. common units. As long as the size of the graphic scale is changed along with the map, it will be accurate.

To find a distance using a graphic legend, measure the legend with a ruler to find its ratio; maybe 1 inch equals 50 miles, for instance. Then measure the distance between the points on the map and use that measurement to determine the real distance between those two places.

Large or Small Scale

Maps are often known as *large scale* or *small scale*. A large-scale map refers to one that shows greater detail because the representative fraction (e.g., 1/25,000) is a larger fraction than a small-scale map, which would have an RF of 1/250,000 to 1/7,500,000. Large-scale maps will have an RF of 1:50,000 or greater (i.e., 1:10,000). Those between 1:50,000 to 1:250,000 are maps with an intermediate scale. Maps of the world that fit on two 8 1/2-by-11-inch pages are very small scale, about 1 to 100 million.

Text 3
WHAT IS A MAP PROJECTION?

It is impossible to accurately represent the spherical surface of the earth on a flat piece of paper. While a globe can represent the planet accurately, a globe large enough to display most features of the earth at a usable scale would be too large to be useful, so we use maps. Also, imagine peeling an orange and pressing the orange peel flat on a table – the peel would crack and break as it was flattened because it can't easily transform from a sphere to a plane. The same is true for the surface of the earth and that's why we use map projections.

The term map projection can be thought of literally as a projection. If we were to place a light bulb inside a translucent globe and project the image onto a wall – we'd have a map projection. However, instead of projecting a light, cartographers use mathematical formulas to create projections.

Map Projection and Distortion

Depending on the purpose of a map, the cartographer will attempt to eliminate distortion in one or several aspects of the map. Remember that not all aspects can be accurate so the map maker must choose which distortions are less important than the others. The mapmaker may also choose to allow a little distortion in all four of these aspects to produce the right type of map.

Conformality: The shapes of places are accurate

Distance: Measured distances are accurate

Area/Equivalence: The areas represented on the map are proportional to their area on the earth

Direction: Angles of direction are portrayed accurately

Popular Cartographic Projections

Gerardus Mercator invented his famous projection in 1569 as an aid to navigators. On his map, lines of latitude and longitude intersect at right angles and thus the direction of travel – the rhumb line – is consistent. The distortion of the Mercator Map increases as you move north and south from the equator. On Mercator's map, Antarctica appears to be a huge continent that wraps around the earth and Greenland appears to be just as large as South America although Greenland is merely one-eighth the size of South America. Mercator never intended his map to be used for purposes other than navigation although it became one of the most popular world map projections.

During the 20th century, the National Geographic Society, various atlases, and classroom wall cartographers switched to the rounded Robinson Projection. The Robinson Projection is a projection that purposely makes various aspects of the map slightly distorted to produce an attractive world map. Indeed, in 1989, seven North American professional geographic organizations (including the American

Cartographic Association, National Council for Geographic Education, Association of American Geographers, and the National Geographic Society) adopted a resolution that called for a ban on all rectangular coordinate maps due to their distortion of the planet.

Text 4
WHAT IS THE CORIOLIS EFFECT?

The Coriolis effect (also known as the Coriolis force) refers to the apparent deflection of objects (such as airplanes, wind, missiles, and ocean currents) moving in a straight path relative to the Earth's surface. Its strength is proportional to the speed of the Earth's rotation at different latitudes. For example, a plane flying in a straight line north will appear to take a curved path when viewed from the ground below.

This effect was first explained by Gaspard-Gustave de Coriolis, a French scientist and mathematician, in 1835. Coriolis had been studying kinetic energy in waterwheels when he realized that the forces he was observing also played a role in larger systems.

Coriolis Effect: Definition

The Coriolis effect is an "apparent" effect, an illusion produced by a rotating frame of reference. This type of effect is also known as a fictitious force or an inertial force. The Coriolis effect occurs when an object moving along a straight path is viewed from a non-fixed frame of reference. Typically, this moving frame of reference is the Earth, which rotates at a fixed speed. When you view an object in the air that is following a straight path, the object will appear to lose its course because of the rotation of the Earth. The object is not actually moving off its course. It only appears to be doing so because the Earth is turning beneath it.

Causes of the Coriolis Effect

The main cause of the Coriolis effect is the Earth's rotation. As the Earth spins in a counter-clockwise direction on its axis, anything flying or flowing over a long distance above its surface is deflected. This occurs because as something moves freely above the Earth's surface, the Earth moves east under the object at a faster speed.

As latitude increases and the speed of the Earth's rotation decreases, the Coriolis effect increases. A pilot flying along the equator itself would be able to continue flying along the equator without any apparent deflection. A little to the north or south of the equator, however, and the pilot would be deflected. As the pilot's plane nears the poles, it would experience the most deflection possible.

Another example of latitudinal variations in deflection is the formation of hurricanes. These storms don't form within five degrees of the equator because there is not enough Coriolis rotation. Move further north and tropical storms can begin to rotate and strengthen to form hurricanes.

In addition to the speed of the Earth’s rotation and latitude, the faster the object itself is moving, the more deflection there will be.

The direction of deflection from the Coriolis effect depends on the object’s position on Earth. In the Northern Hemisphere, objects deflect to the right, while in the Southern Hemisphere they deflect to the left.

Impacts of the Coriolis Effect

Some of the most important impacts of the Coriolis effect in terms of geography are the deflection of winds and currents in the ocean. There is also a significant effect on man-made items such as planes and missiles.

In terms of affecting the wind, as air rises off of the Earth's surface, its speed over the surface increases because there's less drag as the air no longer has to move across the Earth's many types of landforms. Because the Coriolis effect increases with an object's increasing speed, it significantly deflects air flows.

In the Northern Hemisphere these winds spiral to the right and in the Southern Hemisphere they spiral to the left. This usually creates the westerly winds moving from the subtropical areas to the poles.

Because currents are driven by the movement of wind across the waters of the ocean, the Coriolis effect also affects the movement of the ocean's currents. Many of the ocean's largest currents circulate around warm, high-pressure areas called gyres. The Coriolis effect creates the spiraling pattern in these gyres.

Finally, the Coriolis effect is important to man-made objects as well, especially when they travel long distances over the Earth. Take, for example, a flight leaving from San Francisco, California, that is heading to New York City. If the Earth did not rotate, there would be no Coriolis effect and thus the pilot could fly in a straight path to the east. However, due to the Coriolis effect, the pilot has to constantly correct for the Earth's movement beneath the plane. Without this correction, the plane would land somewhere in the southern portion of the United States.

Text 5
RING OF FIRE

The Ring of Fire is a 25,000 mile (40,000 km) horseshoe-shaped area of intense volcanic and seismic (earthquake) activity that follows the edges of the Pacific Ocean. Receiving its fiery name from the 452 dormant and active volcanoes that lie within it, the Ring of Fire includes 75% of the world's active volcanoes and is also responsible for 90% of the world's earthquakes.

Where Is the Ring of Fire?

The Ring of Fire is an arc of mountains, volcanoes, and oceanic trenches that stretch from New Zealand northward along the eastern edge of Asia, then east across the Aleutian Islands of Alaska, and then south along the western coasts of North and South America.

What Created the Ring of Fire?

The Ring of Fire was created by plate tectonics. Tectonic plates are like giant rafts on the Earth's surface that often slide next to, collide with, and are forced underneath each other. The Pacific Plate is quite large and thus it borders (and interacts) with a number of large and small plates.

The interactions between the Pacific Plate and its surrounding tectonic plates creates a tremendous amount of energy, which, in turn, easily melts rocks into magma. This magma then rises to the surface as lava and forms volcanoes.

Major Volcanoes in the Ring of Fire

With 452 volcanoes, the Ring of Fire has some that are more famous that others. The following is a listing of major volcanoes in the Ring of Fire.

The Andes – Running 5,500 miles (8,900 km) north and south along the western edge of South America, the Andes Mountains are the longest, continental mountain range in the world. The Andean Volcanic Belt is within the mountain range and is broken up into four volcanic zones that include such active volcanoes as Cotopaxi and Cerro Azul. It is also home to the highest, active volcano – Ojos del Salado.

Popocatepetl – Popocatepetl is an active volcano in the Trans-Mexican Volcanic Belt. Located near Mexico City, this volcano is considered by many to be the most dangerous in the world since a large eruption could potentially kill millions of people.

Mt. Saint Helens – The Cascade Mountains in the United States' Pacific Northwest hosts the 800 mile (1,300 km) Cascade Volcanic Arc. The Cascades contain 13 major volcanoes and nearly 3,000 other volcanic features. The most recent eruption in the Cascades occurred at Mt. Saint Helens in 1980.

Aleutian Islands – Alaska's Aleutian Islands, which consist of 14 large and 55 small islands, were made from volcanic activity. The Aleutians contain 52 volcanoes, with a few of the most active being Cleveland, Okmok, and Akutan. The deep Aleutian Trench, which also sits next to the islands, has been created at the subduction zone with a maximum depth of 25,194 feet (7679 meters).

Mt. Fuji – Located on the Japanese island of Honshu, Mt. Fuji, at 12,380 feet (3,776 m), is the tallest mountain in Japan and the world's most visited mountain. However, Mt. Fuji is more than a mountain, it is an active volcano that last erupted in 1707.

Krakatoa – In the Indonesia Island Arc sits Krakatoa, remembered for its massive eruption on August 27, 1883 that killed 36,000 people and was heard 2,800 miles away (it is considered the loudest sound in modern history). The Indonesian Island Arc is also home to Mt. Tambora, whose eruption on April 10, 1815 was the largest in major history, being calculated as a 7 on the Volcanic Explosion Index (VEI).

Mt. Ruapehu – Rising to 9,177 feet (2797 m), Mt. Ruapehu is the tallest mountain on the North Island of New Zealand. Located in the southern section of the Taupo Volcanic Zone, Mt. Ruapehu is New Zealand's most active volcano.

As a place that produces most of the world's volcanic activity and earthquakes, the Ring of Fire is a fascinating place. Understanding more about the Ring of Fire and being able to accurately predict volcanic eruptions and earthquakes may help eventually save millions of lives.

Text 6
GEODESY AND THE SIZE AND SHAPE OF THE PLANET EARTH

Earth, with an average distance of 92,955,820 miles (149,597,890 km) from the sun, is the third planet and one of the most unique planets in the solar system. It formed around 4.5 to 4.6 billion years ago and is the only planet known to sustain life. This is because of factors like its atmospheric composition and physical properties such as the presence of water over 70.8% of the planet allow life to thrive.

Earth is also unique however because it is the largest of the terrestrial planets (one that have a thin layer of rocks on the surface as opposed to those that are mostly made up of gases like Jupiter or Saturn) based on its mass, density, and diameter. Earth is also the fifth largest planet in the entire solar system.

Earth's Size

As the largest of the terrestrial planets, Earth has an estimated mass of 5.9736 × 1024 kg. Its volume is also the largest of these planets at $108.321 \times 10^{10} km^3$.

In addition, Earth is the densest of the terrestrial planets as it is made up of a crust, mantle, and core. The Earth's crust is the thinnest of these layers while the mantle comprises 84% of Earth's volume and extends 1,800 miles (2,900 km) below the surface. What makes Earth the densest of these planets, however, is its core. It is the only terrestrial planet with a liquid outer core that surrounds a solid, dense inner core. Earth's average density is 5515×10 kg/m^3. Mars, the smallest of the terrestrial planets by density, is only around 70% as dense as Earth.

Earth is classified as the largest of the terrestrial planets based on its circumference and diameter as well. At the equator, Earth's circumference is 24,901.55 miles (40,075.16 km). It is slightly smaller between the North and South poles at 24,859.82 miles (40,008 km). Earth's diameter at the poles is 7,899.80 miles (12,713.5 km) while it is 7,926.28 miles (12,756.1 km) at the equator. For comparison, the largest planet in Earth's solar system, Jupiter, has a diameter of 88,846 miles (142,984 km).

Earth's Shape

Earth's circumference and diameter differ because its shape is classified as an oblate spheroid or ellipsoid, instead of a true sphere. This means that instead of being of equal circumference in all areas, the poles are squished, resulting in a bulge at the equator, and thus a larger circumference and diameter there.

The equatorial bulge at Earth's equator is measured at 26.5 miles (42.72 km) and is caused by the planet's rotation and gravity. Gravity itself causes planets and other celestial bodies to contract and form a sphere. This is because it pulls all the mass of an object as close to the center of gravity (the Earth's core in this case) as possible.

Because Earth rotates, this sphere is distorted by the centrifugal force. This is the force that causes objects to move outward away from the center of gravity. Therefore, as the Earth rotates, centrifugal force is greatest at the equator so it causes a slight outward bulge there, giving that region a larger circumference and diameter.

Local topography also plays a role in the Earth's shape, but on a global scale, its role is very small. The largest differences in local topography across the globe are Mount Everest, the highest point above sea level at 29,035 ft (8,850 m), and the Mariana Trench, the lowest point below sea level at 35,840 ft (10,924 m). This difference is only a matter of about 12 miles (19 km), which is quite minor overall. If the equatorial bulge is considered, the world's highest point and the place that is farthest from the Earth's center is the peak of the volcano Chimborazo in Ecuador as it is the highest peak that is nearest the equator. Its elevation is 20,561 ft (6,267 m).

Geodesy

To ensure that the Earth's size and shape are studied accurately, geodesy, a branch of science responsible for measuring the Earth's size and shape with surveys and mathematical calculations is used.

Throughout history, geodesy was a significant branch of science as early scientists and philosophers attempted to determine the Earth's shape. Aristotle is the first person credited with trying to calculate Earth's size and was, therefore, an early geodesist. The Greek philosopher Eratosthenes followed and was able to estimate the Earth's circumference at 25,000 miles, only slightly higher than today's accepted measurement.

In order to study the Earth and use geodesy today, researchers often refer to the ellipsoid, geoid, and datums. An ellipsoid in this field is a theoretical mathematical model that shows a smooth, simplistic representation of the Earth's surface. It is used to measure distances on the surface without having to account for things like elevation changes and landforms. To account for the reality of the Earth's surface, geodesists use the geoid which is a shape that is constructed using the global mean sea level and as a result takes elevation changes into account.

The basis of all geodetic work today though is the datum. These are sets of data that act as reference points for global surveying work. In geodesy, there are two main datums used for transportation and navigation in the U.S. and they make up a portion of the National Spatial Reference System.

Today, technology like satellites and global positioning systems (GPS) allow geodesists and other scientists to make extremely accurate measurements of the Earth's surface. In fact, it is so accurate, geodesy can allow for worldwide navigation but it also allows researchers to measure small changes in the Earth's surface down to the centimeter level to obtain the most accurate measurements of the Earth's size and shape.

Text 7
WHAT IS PHYSICAL GEOGRAPHY?

The vast discipline of geography is divided into two major branches: 1) physical geography and 2) cultural or human geography.

Physical geography encompasses the geographic tradition known as the Earth sciences tradition. Physical geographers look at the landscapes, surface processes, and climate of the earth – all of the activity found in the four spheres (the atmosphere, hydrosphere, biosphere, and lithosphere) of our planet.

Sub-Branches of Physical Geography

Since the Earth and its systems are so complex, there are many sub-branches and even sub-sub-branches of physical geography as a research area, depending on how granularly the categories are divided. They also have overlap between them or with other disciplines, such as geology.

Geographical researchers will never be at a loss of something to study, as they often need to understand multiple areas to inform their own targeted research.

Geomorphology: the study of Earth's landforms and its surface's processes—and how these processes change and have changed Earth's surface—such as erosion, landslides, volcanic activity, earthquakes, and floods.

Quaternary science: the study of the previous 2.6 million years on Earth, such as the most recent ice age and Holocene period, including what it can tell us about the change in Earth's environment and climate.

Meteorology: the study of Earth's weather, such as fronts, precipitation, wind, storms, and the like, as well as forecasting short-term weather based on available data.

Climatology: the study of Earth's atmosphere and climate, how it has changed over time, and how humans have affected it.

Hydrology: the study of the water cycle, including water distribution across the planet in lakes, rivers, aquifers, and groundwater; water quality; drought effects; and the probability of flooding in a region. Potamology is the study of rivers.

Coastal geography: the study of the coasts, specifically concerning what happens where land and water meet.

Oceanography: the study of the world's oceans and seas, including aspects such as floor depths, tides, coral reefs, underwater eruptions, and currents. Exploration and mapping is a part of oceanography, as is research into the effects of water pollution.

Pedology: the study of soil, including types, formation, and regional distribution over Earth.

Biogeography: the study of the distribution of life forms across the planet, relating to their environments; this field of study is related to ecology, but it also looks into the past distribution of life forms as well, as found in the fossil record.

Paleogeography: the study of historical geographies, such as the location of the continents over time, through looking at geological evidence, such as the fossil record.

Landscape ecology: the study of how ecosystems interact with and affect each other in an area, especially looking at the effects of the uneven distribution of landforms and species in these ecosystems (spatial heterogeneity.

Environmental geography: the study of the interactions between people and their environment and the resulting effects, both on the environment and on the people; this field bridges physical geography and human geography.

Geomatics: the field that gathers and analyzes geographic data, including the gravitational force of Earth, the motion of the poles and Earth's crust, and ocean tides (geodesy). In geomatics, researchers use the Geographic Information System (GIS), which is a computerized system for working with map-based data.

Astronomical geography or astronography: the study of how the sun and moon affect the Earth as well as our planet's relationship to other celestial bodies.

Text 8
HISTORY AND PRINCIPLES OF PLATE TECTONICS

Plate tectonics is the scientific theory that attempts to explain the movements of the Earth's lithosphere that have formed the landscape features we see across the globe today. By definition, the word "plate" in geologic terms means a large slab of solid rock. "Tectonics" is a part of the Greek root for "to build" and together the terms define how the Earth's surface is built up of moving plates.

Theory of Continental Drift

Plate tectonics grew out of a theory that was first developed in the early 20th century by the meteorologist Alfred Wegener. In 1912, Wegener noticed that the coastlines of the east coast of South America and the west coast of Africa seemed to fit together like a jigsaw puzzle.

Further examination of the globe revealed that all of the Earth's continents fit together somehow and Wegener proposed an idea that all of the continents had at one time been connected in a single supercontinent called Pangaea. He believed that the continents gradually began to drift apart around 300 million years ago - this was his theory that became known as continental drift.

The main problem with Wegener's initial theory was that he was unsure of how the continents moved apart from one another. Throughout his research to find a mechanism for continental drift, Wegener came across fossil evidence that gave support to his initial theory of Pangaea. In addition, he came up with ideas as to how continental drift worked in the building of the world's mountain ranges. Wegener claimed that the leading edges of the Earth's continents collided with each other as they moved, causing the land to bunch up and form mountain ranges. He used India moving into the Asian continent to form the Himalayas as an example.

Eventually, Wegener came up with an idea that cited the Earth's rotation and its centrifugal force toward the equator as the mechanism for continental drift. He said that Pangaea started at the South Pole and the Earth's rotation eventually caused it to break up, sending the continents toward the equator. This idea was rejected by the scientific community and his theory of continental drift was dismissed as well.

Theory of Thermal Convection

In 1929, Arthur Holmes, a British geologist, introduced a theory of thermal convection to explain the movement of the Earth's continents. He said that as a substance is heated its density decreases and it rises until it cools sufficiently to sink again. According to Holmes it was this heating and cooling cycle of the Earth's mantle that caused the continents to move. This idea gained very little attention at the time.

By the 1960s, Holmes' idea began to gain more credibility as scientists increased their understanding of the ocean floor via mapping, discovered its mid-ocean ridges, and learned more about its age. In 1961 and 1962, scientists proposed the process of seafloor spreading caused by mantle convection to explain the movement of the Earth's continents and plate tectonics.

Principles of Plate Tectonics Today

Scientists today have a better understanding of the make-up of the tectonic plates, the driving forces of their movement, and the ways in which they interact with one another. A tectonic plate itself is defined as a rigid segment of the Earth's lithosphere that moves separately from those surrounding it.

There are three main driving forces for the movement of the Earth's tectonic plates. They are mantle convection, gravity, and the Earth's rotation.

Mantle Convection

Mantle convection is the most widely studied method of tectonic plate movement and it is very similar to the theory developed by Holmes in 1929. There are large convection currents of molten material in the Earth's upper mantle. As these currents transmit energy to the Earth's asthenosphere (the fluid portion of the Earth's lower mantle below the lithosphere), new lithospheric material is pushed up toward the Earth's crust. Evidence of this is shown at mid-ocean ridges where younger land is pushed up through the ridge, causing the older land to move out and away from the ridge, thus moving the tectonic plates.

Gravity and Earth's Rotation

Gravity is a secondary driving force for the movement of the Earth's tectonic plates. At mid-ocean ridges, the elevation is higher than the surrounding ocean floor. As the convection currents within the Earth cause new lithospheric material to rise and spread away from the ridge, gravity causes the older material to sink toward the ocean floor and aid in the movement of the plates. The Earth's rotation is the final mechanism for the movement of the Earth's plates but it is minor in comparison to mantle convection and gravity.

Formation of Plate Boundaries

As the Earth's tectonic plates move, they interact in a number of different ways and form different types of plate boundaries. Divergent boundaries are where the plates move away from each other and new crust is created. Mid-ocean ridges are an example of divergent boundaries. Convergent boundaries are where the plates collide with one another and cause the subduction of one plate beneath the other. Transform boundaries are the final type of plate boundary and at these locations, no new crust is created and none is destroyed. Instead, the plates slide horizontally past one another. No matter the type of boundary, the movement of the Earth's tectonic plates is essential in the formation of the various landscape features we see across the globe today.

There are seven major tectonic plates (North America, South America, Eurasia, Africa, Indo-Australian, Pacific, and Antarctica) as well as many smaller microplates such as the Juan de Fuca plate near the United States' state of Washington.

Text 9
POPULATION GEOGRAPHY

Population geography is a branch of human geography that is focused on the scientific study of people, their spatial distributions and density. To study these factors, population geographers examine the increase and decrease in population, peoples' movements over time, general settlement patterns and other subjects such as occupation and how people form the geographic character of a place. Population geography is closely related to demography (the study of population statistics and trends).

Topics in Population Geography

Closely related to population distribution is population density – another topic in population geography. Population density studies the average number of people in an area by dividing the number of people present by total area. Usually these numbers are given as persons per square kilometer or mile.

There are several factors which affect population density and these are often subjects of population geographers' study as well. Such factors can relate to the physical environment like climate and topography or be related to the social, economic and political environments of an area. For example, areas with harsh climates like California's Death Valley region are sparsely populated. By contrast, Tokyo and Singapore are densely populated because of their mild climates and their economic, social and political development.

Overall population growth and change is another area of importance for population geographers. This is because the world's population has grown dramatically over the last two centuries. To study this overall subject, population growth is looked at via natural increase. This studies an area's birth rates and death rates. The birth rate is the number of babies born per 1000 individuals in the population every year. The death rate is the number of deaths per 1000 people every year.

The historic natural increase rate of population used to be near zero, meaning that births roughly equaled deaths. Today, however, an increase in life expectancy due to better healthcare and standards of living has lowered the overall death rate. In developed nations, the birth rate has declined, but it is still high in developing nations. As a result, the world's population has grown exponentially.

In addition to natural increase, population change also considers net migration for an area. This is the difference between in-migration and out-migration. An area's overall growth rate or change in population is the sum of natural increase and net migration.

An essential component to studying world growth rates and population change is the demographic transition model — a significant tool in population geography. This model looks at how population changes as a country develops in four stages. The first stage is when birth rates and death rates are high so there are little natural increase and a relatively small population. The second stage features high birth rates and low death rates so there is high growth in the population (this is normally where least developed countries fall). The third stage has a decreasing birth rate and a decreasing death rate, again resulting in slowed population growth. Finally, the fourth stage has low birth and death rates with low natural increase.

Graphing Population

Developed nations usually have an equal distribution of people throughout the different age groups, indicating slowed population growth. Some, however, show negative population growth when the number of children are equal or slightly lower than older adults. Japan's population pyramid, for example, shows slowed population growth.

Technologies and Data Sources

In addition to census data, population data is also available through government documents like birth and death certificates. Governments, universities and private organizations also work to conduct different surveys and studies to gather data about population specifics and behavior that could be related to topics in population geography.

Text 10
POPULATION DENSITY

Population density is an often reported and commonly compared statistic for places around the world. Population density is the measure of the number of people per unit area, commonly represented as people per square mile (or square kilometer).

The population density of the planet (including all land area) is about 38 people per square mile (57 per sq km). The population density of the United States is approximately 87.4 people per square mile, according to the 2010 U.S. Census.

Computing Population Density

To determine an area's population density, divide an area's total population by the land area in square miles (or square kilometers).

For example, Canada's population of 35.6 million (July 2017 estimated by the CIA World Factbook), divided by the land area of 3,855,103 square miles (9,984,670 sq km) yields a density of 9.24 people per square mile.

Although this number would seem to indicate that 9.24 people live on each square mile of Canadian land area, the density within the country varies dramatically; a vast majority lives in the southern part of the country. Density is only a raw gauge to measure a population's disbursement across the land.

Density can be computed for any area, as long as one knows the size of the land area and the population within that area. The population density of cities, states, entire continents, and even the world can be computed.

What Country Has the Highest Density?

The tiny country of Monaco has the world's highest population density. With an area of three-fourths of a square mile (2 sq km) and a total population of 30,645, Monaco has a density of almost 39,798 people per square mile.

However, because Monaco and other microstates have very high densities due to their extremely small size, Bangladesh (population 157,826,578) is often considered the most densely populated country, with more than 2,753 people per square mile.

What Country Is the Most Sparse?

Mongolia is the world's least densely populated country, with only five people per square mile (2 per sq km). Australia and Namibia tie for a close second with 7.8 people per square mile (3 per sq km). These two countries are further examples of density being a limited statistic, as Australia may be huge, but the population resides mainly on its coasts. Namibia has the same density figure but a much smaller total land area.

Most Tightly Packed Continent

Perhaps not surprisingly, the most densely populated continent is Asia. Here are the population densities of the continents:

North America - 60.7 people per square mile

South America - 61.3 people per square mile

Europe - 187.7 people per square mile

Asia - 257.8 people per square mile

Africa - 103.7 people per square mile

Australia - 7.8 people per square mile

Most Densely Populated Hemisphere

About 90 percent of the Earth's people live on 10 percent of the land. Additionally, about 90 percent of the people live north of the equator in the Northern Hemisphere.

Text 11
WHY DOES BRAIN DRAIN OCCUR?

Brain drain refers to the emigration (out-migration) of knowledgeable, well-educated, and skilled professionals from their home country to another country. This can take place because of several factors. The most obvious is the availability of better job opportunities in the new country. Other factors that can cause brain drain include: war or conflict, health risks, and political instability.

Brain drain occurs most commonly when individuals leave less developed countries (LDCs) with fewer opportunities for career advancement, research, and academic employment and migrate to more developed countries (MDCs) with more opportunities. However, it also occurs in the movement of individuals from one more developed country to another more developed country.

The Brain Drain Loss

The country that experiences brain drain suffers a loss. In LDCs, this phenomenon is much more common and the loss is much more substantial. LDCs generally do not have the ability to support growing industry and the need for better research facilities, career advancement, and salary increases. There is an economic loss in the possible capital that the professionals may have been able to bring in, a loss in advancement and development when all of the educated individuals use their knowledge to benefit a country other than their own, and a loss of education when educated individuals leave without assisting in the education of the next generation.

There is also a loss that occurs in MDCs, but this loss is less substantial because MDCs generally see an emigration of these educated professionals as well as an immigration of other educated professionals.

Possible Brain Drain Gain

There is an obvious gain for the country experiencing "brain gain" (the influx of skilled workers), but there is also a possible gain for the country that loses the skilled individual. This is only the case if professionals decide to return to their home country after a period of working abroad. When this happens, the country regains the worker as well as gains a new abundance of experience and knowledge received from the time abroad. However, this is very uncommon, particularly for LDCs that would see the most gain with the return of their professionals. This is due to the clear discrepancy in higher job opportunities between LDCs and MDCs. It is generally seen in the movement between MDCs.

There is also a possible gain in the expansion of international networking that can come as a result of brain drain. In this respect, this involves networking between nationals of a country who are abroad with their colleagues who remain in that home country. An example of this is Swiss-List.com, which was established to encourage networking between Swiss scientists abroad and those in Switzerland.

Examples of Brain Drain in Russia

In Russia, brain drain has been an issue since Soviet times. During the Soviet-era and after the collapse of the Soviet Union in the early 1990s, brain drain occurred when top professionals moved to the West or to socialist states to work in economics or science. The Russian government is still working to counter this with the allocation of funds to new programs that encourage the return of scientists that left Russia and encourages future professionals to remain in Russia to work.

Examples of Brain Drain in India

The education system in India is one of the top in the world, boasting very few drop-outs, but historically, once Indians graduate, they tend to leave India to move to countries, such as the United States, with better job opportunities. However, in the last few years, this trend has started to reverse itself. Increasingly, Indians in America feel that they are missing the cultural experiences of India and that there are currently better economic opportunities in India.

Combating Brain Drain

There are many things governments can do to combat brain drain. According to the OECD Observer, "Science and technology policies are key in this regard." The most beneficial tactic would be to increase job advancement opportunities and research opportunities in order to reduce the initial loss of brain drain as well as encourage highly-skilled workers both inside and outside the country to work in that country. The process is difficult and it takes time to establish these sorts of facilities and opportunities, but it is possible, and becoming increasingly necessary.

These tactics, however, do not address the issue of reducing brain drain from countries with issues such as conflict, political instability or health risks, meaning that brain drain is likely to continue as long as these problems exist.

Text 12
URBAN GEOGRAPHY

Urban geography is a branch of human geography concerned with various aspects of cities. An urban geographer's main role is to emphasize location and space and study the spatial processes that create patterns observed in urban areas. To do this, they study the site, evolution and growth, and classification of villages, towns, and cities as well as their location and importance in relation to different regions and cities. Economic, political and social aspects within cities are also important in urban geography.

In order to fully understand each of these aspects of a city, urban geography represents a combination of many other fields within geography. Physical geography, for example, is important in understanding why a city is located in a specific area as site and environmental conditions play a large role in whether or not a city develops. Cultural geography can aid in understanding various conditions related to an area's people, while economic geography aids in understanding the types of economic activities and jobs available in an area. Fields outside of geography such as resource management, anthropology, and urban sociology are also important.

Definition of a City

An essential component within urban geography is defining what a city or urban area actually is. Although a difficult task, urban geographers generally define the city as a concentration of people with a similar way of life-based on job type, cultural preferences, political views, and lifestyle. Specialized land uses, a variety of different institutions, and use of resources also help in distinguishing one city from another.

In addition, urban geographers also work to differentiate areas of different sizes. Because it is hard to find sharp distinctions between areas of different sizes, urban geographers often use the rural-urban continuum to guide their understanding and help classify areas. It takes into account hamlets and villages which are generally considered rural and consist of small, dispersed populations, as well as cities and metropolitan areas considered urban with concentrated, dense populations.

History of Urban Geography

The earliest studies of urban geography in the United States focused on site and situation. This developed out of the man-land tradition of geography which focused on the impact of nature on humans and vice versa. In the 1920s, Carl Sauer became influential in urban geography as he motivated geographers to study a city's population and economic aspects with regard to its physical location. In addition, central place theory and regional studies focused on the hinterland (the rural outlying are supporting a city with agricultural products and raw materials) and trade areas were also important to early urban geography.

Throughout the 1950s and 1970s, geography itself became focused on spatial analysis, quantitative measurements and the use of the scientific method. At the same time, urban geographers began quantitative information like census data to compare different urban areas. Using this data allowed them to do comparative studies of different cities and develop computer-based analysis out of those studies. By the 1970s, urban studies were the leading form of geographic research.

Shortly thereafter, behavioral studies began to grow within geography and in urban geography. Proponents of behavioral studies believed that location and spatial characteristics could not be held solely responsible for changes in a city. Instead, changes in a city arise from decisions made by individuals and organizations within the city.

By the 1980s, urban geographers became largely concerned with structural aspects of the city related to underlying social, political and economic structures. For example, urban geographers at this time studied how capital investment could foster urban change in various cities.

Throughout the late 1980s until today, urban geographers have begun to differentiate themselves from one another, therefore allowing the field to be filled with a number of different viewpoints and focuses. For example, a city's site and situation is still regarded as important to its growth, as is its history and relationship with its physical environment and natural resources. People's interactions with each other and political and economic factors are still studied as agents of urban change as well.

Themes of Urban Geography

Although urban geography has several different focuses and viewpoints, there are two major themes that dominate its study today. The first of these is the study of problems relating to the spatial distribution of cities and the patterns of movement and links that connect them across space. This approach focuses on the city system. The second theme in urban geography today is the study of patterns of distribution and interaction of people and businesses within cities. This theme mainly looks at a city's inner structure and therefore focuses on the city as a system.

In order to follow these themes and study cities, urban geographers often break down their research into different levels of analysis. In focusing on the city system, urban geographers must look at the city on the neighborhood and citywide level, as well as how it relates to other cities on a regional, national and global level. To study the city as a system and its inner structure as in the second approach, urban geographers are mainly concerned with the neighborhood and city level.

Text 13
TRANSPORTATION GEOGRAPHY

Transportation geography is a branch of economic geography that studies transportation and all aspects related to it and the geography of an area. This means that it examines the transportation or movement of people, goods, and information in or across different regions. It can have a local focus in a city (New York City for example), as well as a regional (the United States' Pacific Northwest), national or global focus. Transportation geography also studies the different modes of transportation such as road, rail, aviation and boat and their relationships to people, the environment and urban areas.

Transportation has been important in geographic study for hundreds of years. In the early days of geography explorers used known sailing routes to explore new areas and set up trading outposts. As the world's economy began to modernize and develop railway and maritime shipping became increasingly important and knowledge of foreign markets was essential. Today transportation capacity and efficiency is important so knowing the quickest way to move people and products is important and in turn, understanding the geography of the regions in which these people and products are moving is vital.

Transportation geography is a very broad subject that looks at many different topics. For example, transportation geography could possibly look at the link between the presence of a railroad in an area and the percentage of commuters using rail to get to work in a developed area. Social and environmental impacts of the creation of transportation modes are other topics within the discipline. Transportation geography also studies the constraints of movement across space. An example of this might be looking at how the shipment of goods varies at different times of the year due to weather conditions.

To gain a better understanding of transportation and its relationship to geography transportation geographers today study three important fields that relate to transportation: nodes, networks, and demand. The following is a list of the three major branches of transportation geography:

1) Nodes are the beginning and end points for transportation between geographic areas. The Port of Los Angeles is an example of a node because it is the start and end for the shipment of goods to and from the United States. The presence of a node is important economically because it can aid in the development of a city due to jobs for example.

2) Transportation networks are the second major field in transportation geography and they represent the structure and organization of transportation infrastructures like roads or train lines through an area. Transportation networks connect the nodes and are significant because they can directly affect the capacity and efficiency of the movement of people and goods. For example, a well-developed train line would be an efficient transportation network to move people and goods from two nodes, say, from San

Francisco to Los Angeles. It is up to transportation geographers to study the differences between two networks to most efficiently move items between nodes.

3) The third major field of transportation geography is demand. Demand is based on public demand for different types of transportation. For example, if commuters are in constant traffic congestion on a daily basis in a city, public demand might support the development of a transit system such as light rail to move them within the city or two and from the city and their home. Overall, transportation is a significant topic within geography because the world's economy depends on transportation. By studying how transportation relates to geography, researchers and geographers can gain a better understanding of why cities, transportation networks and the world's economy have developed the way they have.

Text 14
ECOTOURISM

Ecotourism is broadly defined as low impact travel to endangered and often undisturbed locations. It is different from traditional tourism because it allows the traveler to become educated about the areas – both in terms of the physical landscape and cultural characteristics, and often provides funds for conservation and benefits the economic development of places that are frequently impoverished.

When Did Ecotourism Start?

Ecotourism and other forms of sustainable travel have their origins with the environmental movement of the 1970s. Ecotourism itself did not become prevalent as a travel concept until the late 1980s. During that time, increasing environmental awareness and a desire to travel to natural locations as opposed to built up tourist locations made ecotourism desirable.

Since then, several different organizations specializing in ecotourism have developed and many different people have become experts on it. Martha D. Honey, PhD, a co-founder of the Center for Responsible Tourism, for example, is just one of many ecotourism experts.

Principles of Ecotourism

Due to the growing popularity of environmentally-related and adventure travel, various types of trips are now being classified as ecotourism. Most of these are not truly ecotourism, however, because they do not emphasize conservation, education, low impact travel, and social and cultural participation in the locations being visited.

Therefore, to be considered ecotourism, a trip must meet the following principles set forth by the International Ecotourism Society:

Minimize the impact of visiting the location (i.e.- the use of roads)

Build respect and awareness for the environment and cultural practices

Ensure that the tourism provides positive experiences for both the visitors and the hosts

Provide direct financial aid for conservation

Provide financial aid, empowerment and other benefits for local peoples

Raise the traveler's awareness of the host country's political, environmental and social climate

Examples of Ecotourism

Opportunities for ecotourism exist in many different locations worldwide and its activities can vary as widely.

Madagascar, for instance, is famous for its ecotourist activity as it is a biodiversity hotspot, but also has a high priority for environmental conservation and is committed to reducing poverty. Conservation International says that 80% of the country's animals and 90% of its plants are endemic only to the island. Madagascar's lemurs are just one of many species that people visit the island to see.

Because the island's government is committed to conservation, ecotourism is allowed in small numbers because education and funds from the travel will make it easier in the future. In addition, this tourist revenue also aids in reducing the country's poverty.

Another place where ecotourism is popular is in Indonesia at Komodo National Park. The park is made up of 233 square miles (603 sq km) of land that is spread out over several islands and 469 square miles (1,214 sq km) of water. The area was established as a national park in 1980 and is popular for ecotourism because of its unique and endangered biodiversity. Activities at Komodo National Park vary from whale watching to hiking and accommodations strive to have a low impact on the natural environment.

Finally, ecotourism is also popular in Central and South America. Destinations include Bolivia, Brazil, Ecuador, Venezuela, Guatemala, and Panama. These destinations are just a few where ecotourism is popular but opportunities exist in hundreds of more places worldwide.

Criticisms of Ecotourism

Despite the popularity of ecotourism in the above-mentioned examples, there are several criticisms of ecotourism as well. The first of these is that there is no one definition of the term so it is difficult to know which trips are truly considered ecotourism.

In addition, the terms "nature," "low impact," "bio," and "green" tourism are often interchanged with "ecotourism," and these do not usually meet the principles defined by organizations like the Nature Conservancy or the International Ecotourism Society.

Critics of ecotourism also cite that increased tourism to sensitive areas or ecosystems without proper planning and management can actually harm the ecosystem and its species because the infrastructure needed to sustain tourism such as roads can contribute to environmental degradation.

Ecotourism is also said by critics to have a negative impact on local communities because the arrival of foreign visitors and wealth can shift political and economic conditions and sometimes make the area dependent on tourism as opposed to the domestic economic practices.

Regardless of these criticisms though, ecotourism and tourism, in general, are increasing in popularity all over the globe and tourism plays a large role in many worldwide economies.

Text 15
THE NEW FIFTH OCEAN

In 2000, the International Hydrographic Organization created the fifth and newest world ocean — the Southern Ocean — from the southern portions of the Atlantic Ocean, Indian Ocean, and the Pacific Ocean. The new Southern Ocean completely surrounds Antarctica.

The Southern Ocean extends from the coast of Antarctica north to 60 degrees south latitude. The Southern Ocean is now the fourth largest of the world's five oceans.

Are There Really Five Oceans?

For some time, those in geographic circles have debated whether there are four or five oceans on Earth.

Some consider the Arctic, Atlantic, Indian, and Pacific to be the world's four oceans. Now, those that side with the number five can add the fifth new ocean and call it the Southern Ocean or the Antarctic Ocean, thanks to the International Hydrographic Organization (IHO).

The IHO Makes a Decision

The IHO, the International Hydrographic Organization, has attempted to settle the debate through a 2000 publication that declared, named, and demarcated the Southern Ocean.

The IHO published the third edition of Limits of Oceans and Seas (S-23), the global authority on the names and locations of seas and oceans, in 2000. The third edition in 2000 established the existence of the Southern Ocean as the fifth world ocean.

There are 68 member countries of the IHO. Membership is limited to non-landlocked countries. Twenty-eight countries responded to the IHO's request for recommendations on what to do about the Southern Ocean. All responding members, except Argentina, agreed that the ocean surrounding Antarctica should be created and given a single name.

Eighteen of the 28 responding countries preferred calling the ocean the Southern Ocean over the alternative name Antarctic Ocean, so the former is the name that was selected.

Where Is the Fifth Ocean?

The Southern Ocean consists of the ocean surrounding Antarctica across all degrees of longitude and up to a northern boundary at 60 degrees south latitude (which is also the limit of the United Nations' Antarctic Treaty).

Half of the responding countries supported 60 degrees south, while only seven preferred 50 degrees south as the ocean's northern limit. Even with a mere 50 percent support for 60 degrees, the IHO decided that since 60 degrees south does not run through land and 50 degrees south does pass through South America, 60 degrees south should be the northern limit of the newly demarcated ocean.

Why the Need for a New Southern Ocean?

A great deal of oceanographic research in recent years has been concerned with ocean circulations.

At approximately 20.3 million square kilometers (7.8 million square miles) and about twice the size of the U.S.A., the new ocean is the world's fourth-largest (following the Pacific, Atlantic, and Indian, but larger than the Arctic Ocean). The Southern Ocean's lowest point is 7,235 meters (23,737 feet) below sea level in the South Sandwich Trench.

The sea temperature of the Southern Ocean varies from negative two degrees C to 10 degrees C (28 degrees F to 50 degrees F). It is home to the world's largest ocean current, the Antarctic Circumpolar Current. This current moves east and transports 100 times the water flow of all the world's rivers.

Despite the demarcation of this new ocean, it's likely that the debate over the number of oceans will continue nonetheless. After all, there is but one "world ocean," as all five (or four) oceans on our planet are connected.