Name: ______________________________ Date: ____________________ Period: ________

FRQ 1.2: Tools & Maps

Contemporary Geographic Tools

LEARNING OUTCOME 1.1.3

Identify geography's contemporary analytic mapping tools.

Maps are not just paper documents in textbooks. They have become an essential tool for contemporary delivery of online services through smart phones, tablets, and computers.

PINPOINTING LOCATIONS: GPS

Our smart phones, tablets, and computers are equipped with **Global Positioning System (GPS),** which is a system that determines the precise position of something on Earth. The GPS in use in the United States includes three elements:

- Satellites placed in predetermined orbits by the U.S. military (24 in operation and 3 in reserve).
- Tracking stations to monitor and control the satellites.
- A receiver that can locate at least 4 satellites, figure out the distance to each, and use this information to pinpoint its own location.

GPS is most commonly used for navigation. Pilots of aircraft and ships stay on course with GPS. On land, GPS detects a vehicle's current position, the motorist programs the desired destination into a GPS device, and the device provides instructions on how to reach the destination. GPS can also be used to find the precise location of a vehicle, enabling a motorist to summon help in an emergency or a customer to monitor the progress of a delivery truck or position of a bus or train.

Thanks to GPS, our electronic devices provide us with a wealth of information about the specific place on Earth we currently occupy. Cell phones equipped with GPS allow individuals to share their whereabouts with others. Geographers find GPS to be particularly useful in coding the precise location of objects collected in fieldwork.

The locations of all the information we gather and photos we take with our electronic devices are recorded through **geotagging,** which is identification and storage of a piece of information by its precise latitude and longitude coordinates. Geotagging has led to concerns about privacy.

ANALYZING DATA: GI-SCIENCE

Geographic Information Science (GIScience) is analysis of data about Earth acquired through satellite and other electronic information technologies. A **geographic information system (GIS)** captures, stores, queries, and displays the geographic data. GIS produces maps (including those in this book) that are more accurate and attractive than those drawn by hand. A map is created by retrieving a number of stored objects and combining them to form an image. Each type of information is stored in a layer (Figure 1-11). For example, separate layers could be created for boundaries of countries, bodies of water, roads, and names of places. A simple map might display only a single layer by itself, but most maps combine several layers, and GIS permits construction of much more complex maps than can be drawn by hand.

The acquisition of data about Earth's surface from a satellite orbiting Earth or from other long-distance methods is **remote sensing.** Remote-sensing satellites scan Earth's surface and transmit images in digital form to a receiving station on Earth's surface. At any moment, a satellite sensor records the image of a tiny area called a picture element, or pixel. Scanners detect the radiation being reflected from that tiny area. A map created by remote sensing is essentially a grid containing many rows of pixels. The smallest feature on Earth's surface that can be detected by a sensor depends on the resolution of the scanner. Geographers use remote sensing to map the changing distribution of a wide variety of features, such as agriculture, drought, and sprawl.

GIScience helps geographers create more accurate and complex maps and measure changes over time in the characteristics of places. Layers of information acquired through remote sensing and produced through GIS can be described and analyzed. GIScience enables geographers to calculate whether relationships between objects on a map are significant or merely coincidental. For example, a map showing where life expectancy is low (such as in Figure 1-24) can be combined with layers showing the location of people with various incomes and the location of crimes.

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Interpreting Maps

LEARNING OUTCOME 1.1.4

Understand the role of map scale and projection in reading maps.

To make any map, a cartographer must make two decisions:

- How much of Earth's surface to depict on the map (map scale).
- How to transfer a spherical Earth to a flat map (projection).

For more details about cartography, see Appendix A.

MAP SCALE

The first decision a cartographer faces is how much of Earth's surface to depict on the map. Is it necessary to show the entire globe, or just one continent, or a country, or a city? To make a scale model of the entire world, many details must be omitted because there simply is not enough space. Conversely, if a map shows only a small portion of Earth's surface, such as a street map of a city, it can provide a wealth of detail about a particular place.

The level of detail and the amount of area covered on a map depend on its map scale. When specifically applied to a map, **map scale** refers to the relationship of a feature's size on a map to its actual size on Earth. Map scale is presented in three ways (Figure 1-12):

- **Ratio.** A ratio or fraction shows the numerical ratio between distances on the map and Earth's surface. A scale of 1:1,000,000 means that 1 unit (for example, inch, centimeter, foot, finger length) on the map represents 1 million of the same unit on the ground. The 1 on the left side of the ratio always refers to a unit of distance on the map, and the number on the right always refers to the same unit of distance on Earth's surface.
- **Written.** A written scale describes the relationship between map and Earth distances in words. For example, in the statement "1 centimeter equals 10 kilometers," the first number refers to map distance and the second to distance on Earth's surface.
- **Graphic.** A graphic scale usually consists of a bar line marked to show distance on Earth's surface. To use a bar line, first determine with a ruler the distance on the map in inches or centimeters. Then hold the ruler against the bar line and read the number on the bar line opposite the map distance on the ruler. The number on the bar line is the equivalent distance on Earth's surface.

Maps often display scale in more than one of these three ways.

The appropriate scale for a map depends on the information being portrayed. A map of a neighborhood, such as Figure 1-12c, may have a scale of 1:10,000, whereas a map of a city (Figure 1-12a) may have a scale of 1:1,000,000. One inch represents about 1/6 mile on Figure 1-12c and 16 miles on Figure 1-12a.

At the scale of a small portion of Earth's surface, such as a downtown area, a map provides a wealth of details about the place. At the scale of the entire globe, a map must omit many details because of lack of space, but it can effectively communicate processes and trends that affect everyone.

PROJECTION

Earth is very nearly a sphere and is therefore accurately represented with a globe. However, a globe is an extremely limited tool with which to communicate information about Earth's surface. A small globe does not have enough space to display detailed information, whereas a large globe is too bulky and cumbersome to use. And a globe is difficult to write on, photocopy, display on a computer screen, or carry in the glove box of a car. Consequently, most maps—including those in this book—are flat. Three-dimensional maps can be made but are expensive and difficult to reproduce.

1 centimeter on the map equals 10 kilometers on Earth, 1:1,000,000 | 1 centimeter on the map equals 1 kilometer on Earth, 1:100,000 | 1 centimeter on the map equals 100 meters on Earth, 1:10,000

(a) (b) (c)

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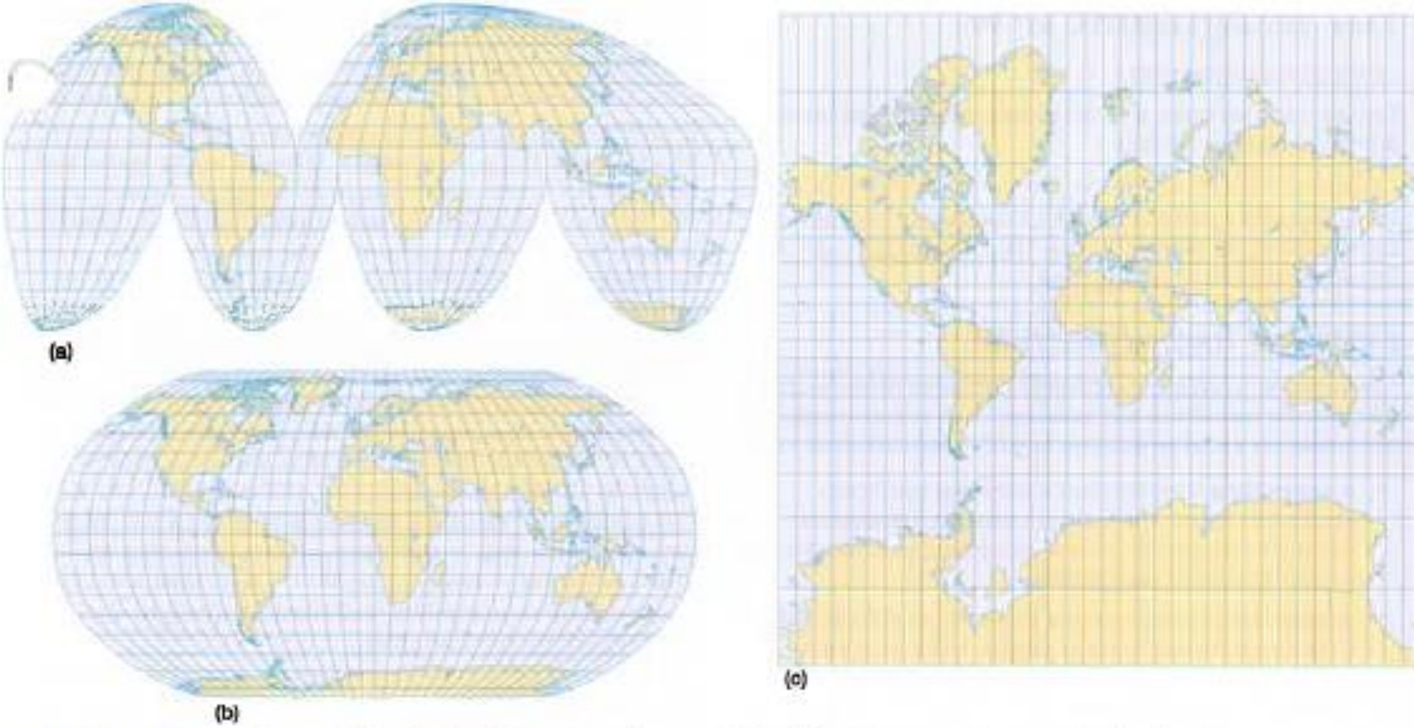

▲ **FIGURE 1-13 PROJECTIONS (a)** Goode Homolosine, an equal area projection; **(b)** Robinson, an uninterrupted projection; **(c)** Mercator, featuring accurate shapes and directions.

Earth's spherical shape poses a challenge for cartographers because drawing Earth on a flat piece of paper unavoidably produces some distortion. Cartographers have invented hundreds of clever methods of producing flat maps, but none has produced perfect results. The scientific method of transferring locations on Earth's surface to a flat map is called **projection** (Figure 1-13).

The problem of distortion is especially severe for maps depicting the entire world. Four types of distortion can result:

1. The *shape* of an area can be distorted, so that it appears more elongated or squat than it is in reality.
2. The *distance* between two points may become increased or decreased.
3. The *relative size* of different areas may be altered, so that one area may appear larger than another on a map while it is in reality smaller.
4. The *direction* from one place to another can be distorted.

Most of the world maps in this book, such as Figure 1-13a, are equal area projections. The primary benefit of this type of projection is that the relative sizes of the landmasses on the map are the same as in reality. The projection minimizes distortion in the shapes of most landmasses. Areas toward the North and South poles—such as Greenland and Australia—become more distorted, but they are sparsely inhabited, so distorting their shapes usually is not important.

To largely preserve the size and shape of landmasses, however, the projection in Figure 1-13a forces other distortions:

- The Eastern and Western hemispheres are separated into two pieces, a characteristic known as interruption.
- The meridians (the vertical lines), which in reality converge at the North and South poles, do not converge at all on the map. Also, they do not form right angles with the parallels (the horizontal lines).

The Robinson projection (Figure 1-13b) is useful for displaying information across the oceans. Its major disadvantage is that by allocating space to the oceans, the land areas are much smaller than on interrupted maps of the same size.

The Mercator projection (Figure 1-13c) has several advantages: Shape is distorted very little, direction is consistent, and the map is rectangular. Its greatest disadvantage is that relative size is grossly distorted toward the poles, making high-latitude places look much larger than they actually are.

PAUSE & REFLECT 1.1.4

Compare the sizes of Greenland and South America on the three maps in Figure 1-13. Which of the two landmasses is actually larger? How do you know?

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AP© HUMAN GEOGRAPHY -- SECTION II -- Time—25 minutes --- Percent of total score—100

Directions: You have 25 minutes to answer the free response portion. It is suggested that you take 5 minutes of this time to plan and outline each answer. While a formal essay is not required, it is not enough to answer a question by merely listing facts. Illustrate your answers with substantive geographic examples where appropriate. Be sure to number each of your answers, including individual parts, in this booklet as the questions are numbered below

1. Geography is considered a science in large part because of the use of tools in order to prepare and interpret maps.

   A. **Discuss** the contemporary tools that geographers use to analyze and interpret maps.
   B. **Identify** the three basic ways map scale can be presented.
   C. **Explain** the purpose of using map scale.
   D. **Discuss** why distortions occur when projecting the earth's surface to a flat map.
   E. **Identify** <u>ONE</u> advantage and <u>ONE</u> disadvantage of the Robinson projection and the Mercator projections.

HINT (A)– YOU SHOULD MENTION GPS, GIS, GEOTAGGING, AND REMOTE SENSING
HINT (B) – EASY, JUST LIST THE THREE TYPES
HINT (C) – NOT JUST A DEFINTION.
HINT (D) – NOT JUST A DEFINTION, PROVIDE EXAMPLES OF DISTORTIONS
HINT (E) – NOTE WHAT IS BEING ASKED:

ROBINSON		MERCATOR	
ADVANTAGE	DISADVANTAGE	ADVANTAGE	DISADVANTAGE