

## Basics of GIS

Geographic Information Systems (GIS) have been developed for storage, retrieval, analysis and display of georeferenced information of and about the Earth.

---

### Explorer's Guide

#### Before You Start

In small teams, discuss what type of data would be beneficial to investigate the effect of changing climate on agricultural land. What type of map (what data layers) would be appropriate to tell the story?

#### Learning by Doing

1. Start ArcGIS software. Select the open an existing map option and browse for World project in 4H-GIS folder to open it. From the list of data layers on the left, classify them as:
  - a) Point data layers: \_\_\_\_\_
  - b) Lines data layers: \_\_\_\_\_
  - c) Areas/polygon data layers: \_\_\_\_\_
  - d) Raster data: \_\_\_\_\_

Turn different data layers on and off by clicking corresponding checkboxes.

2. Turn on layers *Country92* and *Country04* and turn off all the other layers. Explore the use of the toolbar shown below to Zoom in, Zoom out, Pan, Full Extent, Select features, Identify and Measure distance on the map.



Identify at least five countries that were formed in 1990's and appear in *Country04* but not in *Country92* layer.

3. Turn off all the layers except *Utmzone* and *Continent*. Zoom to full extent. To explore different map projections, right click *Layers* in the display panel and click *properties*. Activate *coordinate system* pane and select predefined > projected coordinate system > world. Select *Cylindrical Equal Area projection*. Click Apply to see the effect of the projection. What do you observe? Try different projections (e.g., *Equidistant Conic*, *Polyconic*, *Equidistant Cylindrical*, *Robinson*, *Sinusoidal* projections).

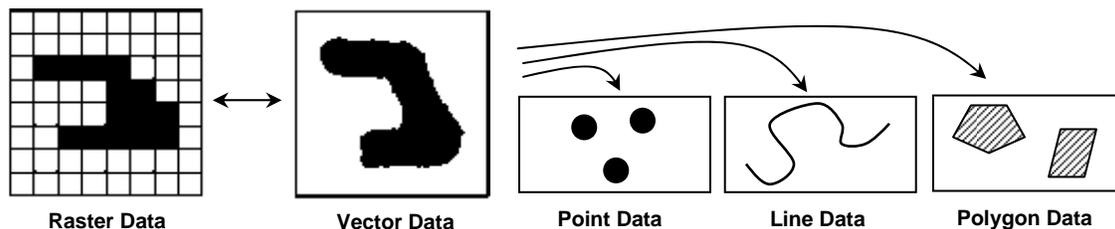


## How Does It Work

Geographic Information Systems (GIS) is a set of computer programs used to input, store, analyze and display geographically referenced data:

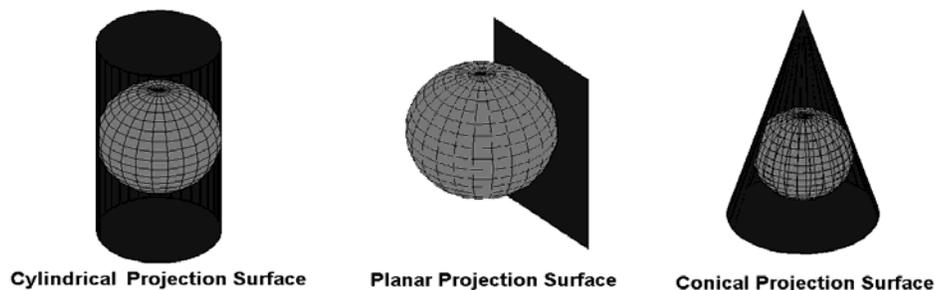
- **Input** – geographic data can be entered into a computer through a scanner, digitizer, GPS receiver, photo camera, downloaded from the Internet, entered using a keyboard, etc
- **Storage** – GIS includes a data base to store information that contains geographic coordinates (spatial data) as well as description of geographic objects (attribute data).
- **Analysis** – some of the most frequently used GIS tools include: querying, buffering, overlaying, measuring, matching address, etc.
- **Display** – geographic data can be represented as colorful maps, statistical charts, tables, video clips, 3D models, etc.

Vector and raster data are two major data types used by GIS. **Vector** data includes all discrete geographic objects (also called features). Three types of features are: **points** (wells, sample locations, city centers, bus stops), **lines** (streams, roads, power lines), and **polygons** (countries, land parcels, soil types, wetlands). **Raster** data represents all continuous surfaces, images or grids (photographs, interpolated weather maps, elevation models).



All GIS data that is related to specific locations should be **georeferenced**, which means assigned to a known coordinate system called **datum**. When scanning photographs or paper maps, we know relative distance between geographic objects in linear units (cm or inches), and georeferencing allows finding proper longitude and latitude coordinates. This allows overlaying (combining) many different types of data in a single map.

To convert three-dimensional representation of the Earth's surface to a two-dimensional mapping plane, a mathematical transformation called **projection** is needed. There are three major types of map projections: cylindrical, planar, and conical.



Only spherical representation of the Earth (globe) preserves direction, distance, shape and area of geographic objects. It is necessary to keep in mind that every projection distorts several of these characteristics:

Characteristic	Globe (Sphere)	Map Projection		
		Cylindrical	Planar	Conical
Directions	Preserved	Distorted	Preserved	Distorted
Distances	Preserved	Distorted	Distorted	Preserved
Shapes	Preserved	Preserved	Distorted	Distorted
Areas	Preserved	Distorted	Distorted	Distorted

### **Additional Challenge**

Using World project, zoom to the map of the 48 States of the USA and apply different projections. Which one looks the most familiar?

### **Vocabulary**

**Shapefile** is a vector file format for storing the location, shape and attributes of geographic features. It is stored in a set of several files with the same name and different extensions (e.g., .shp, .shx, .dbf).

**Attribute** represents information about a given geographical feature, which is generally stored in a table and linked to the features using a unique identifier (for example, attributes of a lake may include name, size and maximum depth).

**Digitizing** means converting shapes of geographic features from paper maps or raster imagery into vector data.

**Datum** is a mathematical model of the Earth used as a reference for the coordinate system applied.

### **Interesting to Know**

ESRI (Environmental Systems Research Institute, Inc.) is a worldwide company with headquarters in California, which produce ArcGIS (formerly ArcView) and is one of the world leading GIS software companies.

---

Viacheslav Adamchuk and Shana Thomas  
Phone: 402-472-8431  
E-mail: vadamchuk2@unl.edu  
Last updated: May 12, 2008