GEOGRAPHIC INFORMATION SYSTEMS

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What is GIS and what does it do?

More and more people around the country and around the globe would like to plug into geographic, social, economic, political, and environmental information digital information to answer practical questions in their lives. To explore geo-referenced digital information, electronic tools designed for acquiring, presenting, and interacting with information that links location with measured values are needed. One such tool is called a geographic information system, better known as GIS. Desktop GIS is an immensely powerful computer mapping system. It is a tool for managing information of any kind according to where it is located. For example, businesses can track customer locations, optimize delivery routes, or decide where to site future businesses using GIS; scientists use GIS to manage sensitive wildlife habitats or track animal movements in an ecosystem; and health care specialists track the spread of infectious disease with GIS. GIS technology powers solutions for telecommunications, utilities, agriculture, defense, oil, health care, transportation, mining, environmental management, petroleum, water/wastewater, and many other industries as well as local, state, and federal government agencies.

How does GIS work?

Desktop GIS represents the real world on a computer similar to the way maps represent the world on paper. Both GIS and paper maps convey information about places. However, desktop GIS has power and flexibility that paper maps lack. The scale of the map influences the size of what appears on it. With GIS, however, you can store and link huge amounts of information about the objects represented on maps. These objects are called features. Each map feature has a location, a representative shape, and a symbol that represents one or more of its characteristics. Because features on maps are organized according to relative location or position, maps are good for showing the relationships among feature locations. These relationships, called spatial relationships, are important because understanding them helps us solve problems.

Maps use three basic shapes-- points, lines and areas to represent real-world objects. Points represent objects that have discrete locations and are too small to be depicted as areas. Lines represent objects that have length but are too narrow to be depicted as areas. Areas represent objects too large to be depicted as points or lines. Shapes alone do not give you enough information, so maps use graphic symbols to help identify features and provide information about them.

Most features can be represented as more than one shape. The scale of a map tells how the size of the map features compares with the size of the geographic objects they represent. Map scales vary from small-scale to large-scale. For example, on a small-scale map a city may be represented as a point (Figure 1). That same city would be represented as an area on a large-scale map (Figure 2).

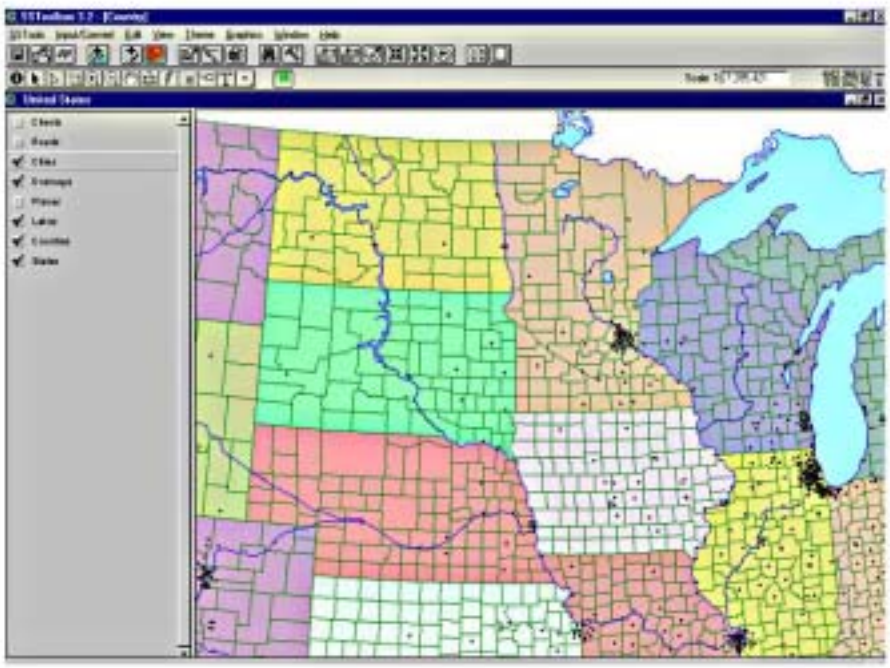

Figure 1. Picture of a small-scale map shown in a GIS. Black circles represent the cities.

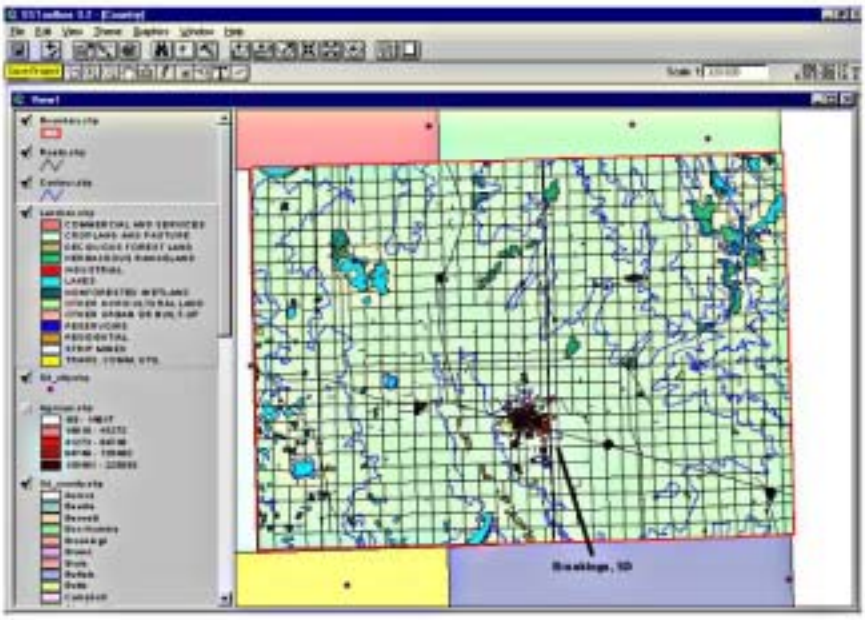

Figure 2. Large-scale map representing cities, roads, lakes and stream in Brookings County, SD.

With desktop GIS, you are not limited to the amount of information you can get about what you see on the map. Desktop GIS stores all the information about map features in a GIS database and links the features on the map to the information about them. This means that you can access all the information about a feature by simply clicking on it. For example, in Figure 3 (shown below) a table is shown on the left (highlighted in yellow) and a window titled a 'View' (highlighted in blue) is shown on the right. 'Views' are made of 'themes'. 'Themes' are used to create the map shown in Figure 3 and highlighted in red.

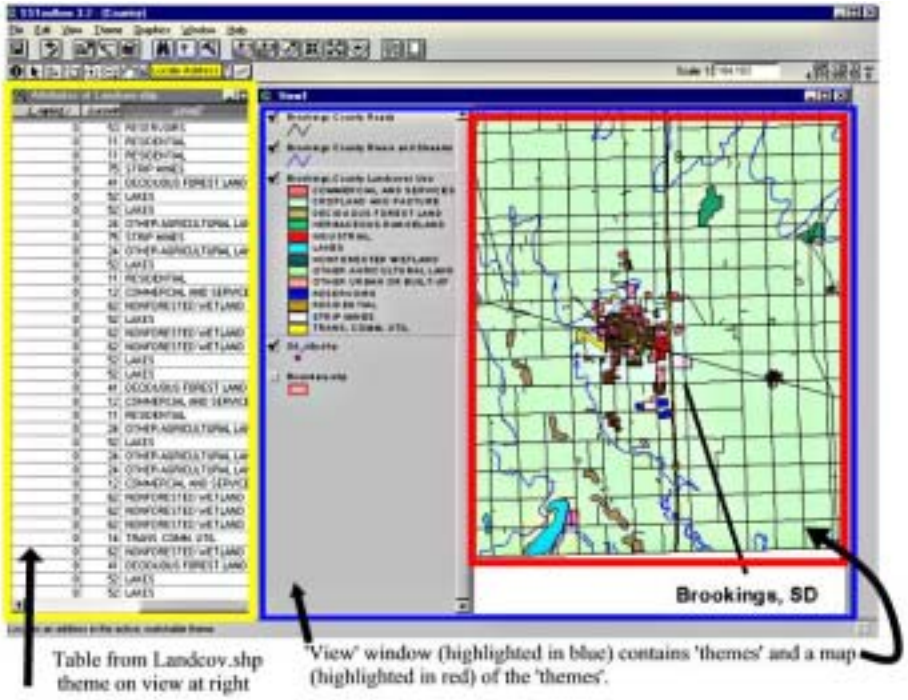

Figure 3. Window from a GIS that shows the 'View' area with 'Themes' shown on the right side of the picture. On the left side of the picture, a table is shown. This table contains data about the map.

The information that a desktop GIS stores about map features is referred to as attribute information, or attributes. The attributes of a river, for example, might include its name, length, average depth, rate of flow, water quality, how many dams are on it, and how many bridges cross it. Desktop GIS formats attributes in rows and columns, and stores them as tables. Each column stores a different attribute and each row relates to a single feature. The link between map features and their attributes is the basic principle behind how a desktop GIS works, and is the source of its power. Once the map features and attributes are linked, you can access the attributes for any map feature or locate any feature from its attributes in a table. GIS can also display features based on any attribute in the table. Because the link between features and attributes is a two-way relationship, changing an attribute in the table automatically results in a change on a map. Desktop GIS links sets of features and their attributes and manages them together in units called themes. A theme contains a set of related features, such as roads, streams, parcels, or wildlife habitat areas, along with the attributes for those features. For example, in Figure 3, the theme shown in the view include: (1) Brookings County Roads, (2) Brookings County Rivers and Streams and (3) Brookings County Landcover Use.

All the themes for a geographic area taken together make up a GIS database. The design of a GIS database is strong because it's flexible. You can add new themes to a GIS database or delete old ones; you can separate themes

to create more themes, or combine themes if they have common characteristics. What you want to do with a GIS database, and what information you need, will determine the best design for you.

The GIS database can be ‘queried’. This means a user can ask questions and get answers about the database. For example, in Figure 4, the user queries the database about location of the residential area in and around Brookings, SD. The results of the query are highlighted in yellow in both the table and the map.

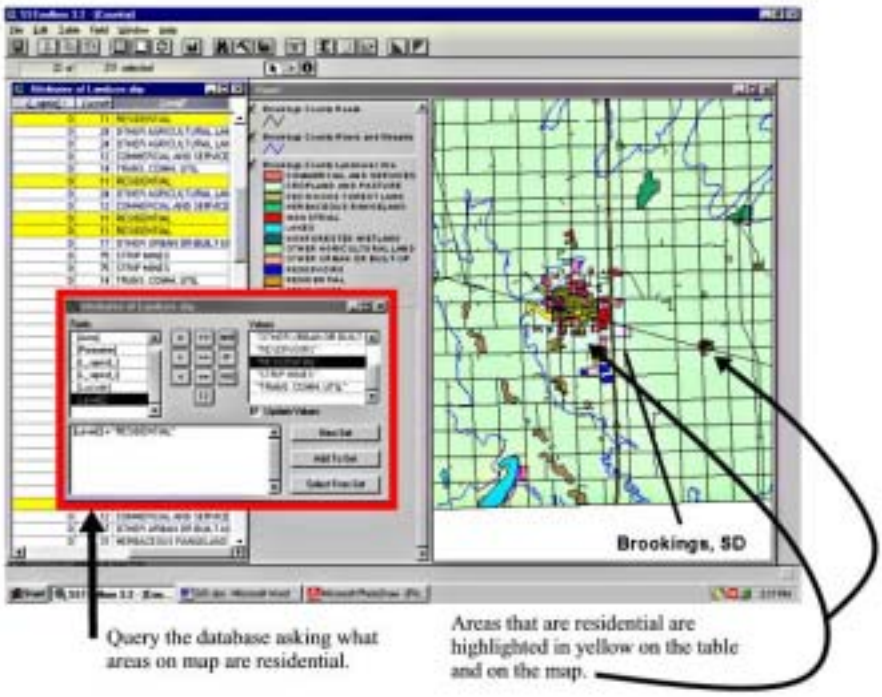

Figure 4. Example of a query of a GIS database.

Information can be presented as maps, charts, and tables, along with graphics you import from other programs or even graphics you draw yourself. The presentations you create can be output to a printer to produce hard copy, or displayed on your computer's screen. You decide what information to present and how much--how much detail, which colors and symbols, and how the final pieces will be arranged. And if you audience or your objective should change, it's easy to make your presentation reflect those changes, without having to start over.

What do you need to know about the data?

Geographic data refers to information about the earth's surface and the objects found on it. This information comes in three basic forms: spatial data, tabular data, and image data. Spatial data contains the locations and shapes of map features. Tabular data is collected and compiled for specific areas and is the

descriptive data that GIS links to map features. Image data includes such diverse elements as satellite images, aerial photographs, and scanned data--data that's been converted from printed to digital format. Data can be created or bought. For example, a GPS receiver can be used to identify sites in an agricultural field where weed data is collected. A table can be created in the GIS showing location as well as species and number of weeds present in the measured area. Alternatively, data can be purchased. In most cases, images are bought from satellite or aircraft companies that used cameras to collect images of the Earth's surface.

Contributions from **Environmental Systems Research Institute**
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