Geog 461 Learning Objective Outline

LOO 04 Basic Capabilities and Workflow for GIS

04.1 What are two types of projects used in this course?
04.2 What are some of the basic capabilities of GIS?
04.3 How might we describe a basic GIS-based workflow approach?

04.1 What are two types of projects used in this course?
RUGIS Chapter 3 section 3.1

To undertake a GIS project we make use of one or more *methods*.

- Method - sequence of steps in which data are processed to carry out *GIS workflow*
- Method step - contains one or more techniques for collecting, storing, preparing, analyzing, and displaying data.
- Technique - basis for performing an operation on data; a GIS capability, implemented as a software *tool*

Pull those ideas together into a "GIS decision support project". For this course, be aware of difference between a *GIS project* and a *community improvement project*.

The term *community project* has a special significance when it comes to improving communities, particularly to planners, public works directors, council people, and the stake holding public (a reference to those who care). For example, a wastewater treatment facility is a community improvement project, but the process of siting such a *community project* as presented in the case study provides a step by step method for undertaking a *GIS project*.

The GIS project is the data processing activity (i.e., analysis of information to identify facility location). "Project" will likely always require one or more adjectives in order to keep the idea straight. GIS *project method* is a workflow intentionally structured to carry out data processing activities. GIS projects make use of fundamental capabilities during a workflow.

04.2 What are some of the basic capabilities of GIS?
RUGIS Chapter 3 section 3.1.1 – 3.1.6

Types of GIS software capabilities perform decision support activities.
GIS software capabilities (also called functions) operate with data, transforming data into information. As such, GIS software capabilities perform GIS-based transformations.

GIS transformations - facilitate a transition "from data to information" by processing the elements of a database (as constituents of a map) and deriving their
a) spatial properties and/or relationships, e.g., distance, direction, pattern, and/or
b) non-spatial properties and/or relationships, e.g. set membership, greater or less than, and/or
c) temporal properties and relationships, interval of time, and/or
d) a combination of those depending on complexity of operations used.

In ArcGIS, a user has access to GIS capabilities through wizard-like *tools*, i.e., software implementations of specific functions. The tools are grouped into *toolsets*, which in turn comprise *toolboxes*. Below (and in RUGIS Table 3.1**)** we identify general categories of GIS

capabilities typical to most GIS. Some toolboxes contain tools that operate on various aspects of the decision problem, content, structure, and process.

Generally Data Management tools and the Map Visualization tools are the most numerous in terms of addressing information needs in general. Counting the number of entries (X) for each toolbox across the Table 3.1 columns indicates the number of tools.

Toolboxes (hence tools) are presented in an order in which a GIS analyst might encounter them.

Geocoding Tools : Geocoding (also called georeferencing) is the process of assigning a location, usually in the form of coordinate data values to a feature.
- assigns a coordinate to a feature, e.g, like assigning street addresses to coordinates.
- creation, maintenance, and deletion of address locators, including coordinates.

Linear referencing is a measuring system for linear features such as river mile and route milepost. These tools are found in their own ArcGIS toolbox, but they are of the same general class of functions as geocoding tools. A linear (spatial) reference is a geocode along a linear feature.

Data Management Tools : capabilities to perform tasks from managing basic structures, such as fields and workspaces, through projecting and reprojecting coordinates of features/raster cells comprising a geodataset, as well as more complex tasks related to topology and versioning.

Tools can be organized around toolsets, which are data management function-specific.
- Fields toolset contains tools that make changes to the attributes fields of a feature class
- Joins toolset contains tools that add and remove a table join
- Relationship Classes toolset contains tools that create associations between feature classes, and between feature classes and tables, and the
- Raster toolset contains tools that create and manipulate raster datasets.

Map Visualization Tools : capabilities we use to compose displays. Although some GIS like ArcGIS have a separate software module for performing map visualization, the packaging of tool capabilities is really a result of a “product offering”, i.e., how to make tools available within a product for supporting customer needs (aka marketing), rather than overall functional similarity.
- add, delete, and change data layers on a map.
- change the symbolization on a map.
- highlight features on a map, either by location or by attribute.
- pan, zoom, identify various features within a data layer, and measure distances between features.

Feature Analysis Tools : offer processing for feature (vector data model) spatial relationships. Commonly these contain sets such as Extract, Overlay, Proximity, and Statistics.
- Extract toolset contains tools employing attribute and/or spatial queries to extract features and their attributes;
    - attribute queries utilize relational (e.g. >, <, =) and/or Boolean (AND, OR, XOR) operators;
    - spatial queries utilize spatial relationships of distance, containment, overlap, and intersection to extract features.

- Overlay toolset contains tools to combine, erase, modify, or update spatial features. All of these tools involve transforming two or more existing sets of features into a new single set of features exposing spatial relationships between the input features.
- Proximity toolset contains tools to determine the proximity of features within a feature set. Tools can identify features that are closest to one another, calculate the distances around them, and calculate distances between them. A buffering tool to create an exclusionary or inclusionary zone around a feature is one of a distance-based tool.
- Statistics toolset contains tools for computing descriptive statistics on attribute data. The statistics include frequency count of each unique attribute value, mean, minimum, maximum, and standard deviation.

Grid Analysis Tools : contain capabilities for analyzing continuous surfaces represented by grid cell (raster data model) layers. Map algebra (ArcGIS Spatial Analyst extension) is the GIS language of spatial analysis for continuous surfaces offering a set of functions for individual raster cells, cell neighborhoods, cell regions, and an entire raster layer.

Network Analysis Tools : support GIS analysts for performing tracing along networks. There are many different kinds of networks, based on the feature behavior. Electric networks are not the same as natural gas networks, which are not the same as highway networks, or sewer networks, or for that matter storm sewer networks are very different than water supply networks.

When to apply certain of the tools from the toolsets is a matter of GIS *project workflow*, that is how we should sequence the GIS operations to perform work.

04.3 How might we describe a basic GIS-based workflow approach?
RUGIS Chapter 3. Section 3.2.1.

Let us explore a **simple and general workflow approach** for a GIS project. What kinds of tools might be used? Sec 3.2.1 about wastewater treatment plant siting, but can be characterizes as a simple and general workflow.

1) Identify project objectives (e.g. concerns about growth of development how to protect water)
    e.g., What is the problem to be solved, e.g., in terms of water flow and water quality
        Who is the intended audience? What is the study area? Will data be used again?
        What are the final products expected? Maps and Tables.

2) Create a project database (for examining the wastewater facility location problem)
    e.g., Designing the database based on Dept of Ecology watershed characterization.
        Acquiring the data, for example from KC Data Portal and Ecology web site.
        Assembling the data for analysis. Managing the data.

3) Analyze the data to determine the condition of water flow and water quality.
    e.g., spatial-temporal modeling already performed by Ecology
        extracting the data in step 2 supports the modeling effort for this project.

4) Present the results to those interested
    e.g., create tables and maps

The above is a general workflow that must be detailed for better understanding. This detailing is what we are doing in the lab assignment using a geodesign approach discussed next lecture.