Lecture 1

Introduction to Geographic Information Systems
Outline

- What is GIS?
- GIScience, Geography and Cartography
- GIS Maps
- Why is it important?
- What is Driving GIS?
- Applications of GIS
- Case Studies
- Components of a GIS
  - GIS Software
  - GIS Hardware
  - GIS Functions
What is a Geographic Information System?

“A computer based system to aid in the collection, maintenance, storage, retrieval analysis, output and distribution of spatial data and information.” – Bolstad

Other Definitions:
- A Toolbox
- An Information System
- A Series of Subsystems
- An Approach to Science
What is GIScience?

- Broader than GIS
- Forms the theoretical foundations on which GIS is based.
- Primary Goal: To redefine geography and geographic information in relation to the current digital age.
- Critical to the effective and *correct* application of GIS!
Geography and Cartography
How do they fit in?

• Geography
  • Defined: Geography is the study or science of place and space. How and why are features distributed over the earth’s surface?
  • Maintains a complex relationship with GIS.

GIS may be viewed as:
1. A branch or sub-discipline of geography
2. A completely separate discipline known as Geographic Information Science.

• Cartography
  • Defined: The art and science of mapmaking.
  • Provides a means of digital representation and display of geospatial data resulting from GIS analysis.
GIS Maps

- GIS maps are dynamic.
- Can contain collections of thematic layers. Layers, in turn, contain a collection of features that represent real-world objects.
- On a GIS map, features have a location, shape, and a symbol. Features grouped into a layer have the same shape and characteristics and are located within the same geographic extent.

- Example: These 4 layers all contain features that may be located within a city's boundaries. The layers represent distinct "themes" and may be drawn on top of each other to create an informative City GIS map.
GIS data layers are unique because information can be associated with geographic features.
Why is GIS important?

- Offers the means to solve large or complex geospatial problems.
- Helps to resolve issues related to dichotomies in scale.
- Integrates spatial and tabular information in a single system within a consistent framework.
- Offers insights and explanations that might otherwise be unavailable.
What is Driving GIS?

- Increasing population density
- Increasing social and environmental awareness
- Growth and price drops in technology
- Increasing availability of digital information
- Growing commercial applications
- Demonstrated cost savings (less duplication, data sharing, etc.)
GIS in Action

GIS can aid in disaster management and recovery. Satellite images of Banda Aceh, Indonesia illustrating tsunami damage.

GIS can aid in county government maintenance and evaluation. Images of the ocean shoreline and combined with digital maps.
Applications of GIS

Utility companies
- Ex. gas, phone, electric, water, cable TV companies
- a single company may have
  - hundreds of thousands of customers each with a connection to the network
  - thousands of miles of wires, underground pipes
  - transformers, switches, manholes, poles...
  - thousands of maintenance calls per day
- a company needs to keep track of all their customers and infrastructure by
  - maintaining accurate information about what is where
  - keeping records up to date
  - making daily work assignments to crews

Transportation
- a state department of transportation needs to
  - store information on the state of pavement
  - maintain an inventory of all highway signs
  - analyze data on accidents, look for 'black spots'
- a delivery company, e.g. Federal Express, UPS, needs to
  - keep track of shipments, know where they are
  - plan efficient delivery routes
- a transit authority needs to
  - know where transit vehicles are at all times

Forestry
- need to keep track of what timber is growing where
- need to be able to plan timber harvest
  - to provide for timber needs now, but maintain a healthy forest resource for the future
  - to determine locations of roads, methods of cutting and removing logs, to comply with environmental regulations
- need to manage forests for many purposes, including recreation
Case Study of GIS: Helping Levi Strauss Find the Best Retailers

- **Project Goal:** To increase distribution to more specialty stores such as general merchandise/work wear and western apparel outfitters.

- **Study Area:** North America

- **Desired Product:** A tool that would geographically display its existing authorized retailers, potential retailers, and the customers the distributors serve. This application would ensure that new stores would not adversely impact the sales opportunities of existing stores.
Case Study of GIS: Helping Levi Strauss Find the Best Retailers

- **The Solution**: ESRI Business Analyst Online... an on-demand reporting and mapping service that combines GIS technology with extensive business, demographic, and consumer household data and delivers it via the Web.

- **Results**: LS&CO. streamlined its review process of new retailer applications into a cost-sensitive solution that allows it to see prospects geographically in relation to existing stores.
Case Study of GIS: 
Wildlife Movement Corridors in the Northern Rockies

*Walker and Craighead (1997)*

- **Project Goal:**
  - To delineate landscape routes offering the best chance of success for wildlife moving among the three large core protected areas in the Northern Rockies.

- **Study Area:**
  - Northern Rockies (regions of Idaho, Wyoming, and Montana)

- **Target Species:**
  - Grizzly bear, elk, mountain lion
Case Study of GIS: Wildlife Movement Corridors in the Northern Rockies

Walker and Craighead (1997)

Forest Carnivore Habitat  Ungulate Species Habitat

Vegetation  Land Management

The Greater Yellowstone - Northern Continental Divide connection
Case Study of GIS: Wetland and Riparian Habitat Mapping in Southern California

- Project Goal: Produce a full set of wetland and riparian habitat maps for Southern California Coastal Watersheds.
Case Study of GIS: Wetland and Riparian Habitat Mapping in Southern California

- Use collateral data and GIS technology to output high quality maps.
  - Hydric soils (NRCS)
  - County hydrology layers
  - County infrastructure layers
  - Aerial Imagery
  - Vegetation
  - Topographic Maps
Components of a GIS Hardware

- Coordinate and text input devices
- Rapid access mass storage
- Archival storage
- Large, high resolution display
- High-quality hard-copy graphic and text output devices
- Digital media output
- Network and web data communication
- High-speed computer
Components of a GIS Software

- ArcGIS (http://www.esri.com/)
- GeoMedia (http://www.intergraph.com/gdca/default.asp)
- MapInfo (http://www.mapinfo.com/)
- Idrisi (http://www.clarklabs.org/)
- ERDAS (http://gi.leica-geosystems.com/default.aspx)
- AUTOCAD MAP (http://usa.autodesk.com)
- Microstation (http://www.bentley.com/en-us/)
- Microimages (http://www.microimages.com/)
Components of a GIS Functions

Data entry
- manual coordinate capture
- attribute capture
- digital coordinate capture
- data import

Editing
- manual point, line and area feature editing
- manual attribute editing
- automated error detection and editing

Data management
- copy, subset, merge data
- versioning
- data registration and projection
- summarization, data reduction
- documentation

Analysis
- spatial query
- attribute query
- interpolation
- connectivity
- proximity and adjacency
- buffering
- terrain analyses
- boundary dissolve
- spatial data overlay
- moving window analyses
- map algebra

Output
- map design and layout
- hardcopy map printing
- digital graphic production
- export format generation
- metadata output
- digital map serving
Required Computer Skills

- Keyboarding skills
- Basic operation of a standalone PC
- Identification, understanding and use of common hardware components (external hard drives, CD-ROM drives, printers etc.)
- Use of application software such as word processors, text editors, and spreadsheets.
- Navigation of hierarchical directory structures
- Basic Management of files and directories (copy, move, delete, rename etc.)
- Internet navigation skills