Technical Details

- There is a history of collection and analysis of pesticides in the environment in East Africa.
- Harvesting information from past Masters and Ph.D. research is a good foundation to foster future analysis and understanding.
- Acquisition of new data continues this process, enhanced by meaningful collaboration.

Coming into this project with expertise on all fronts, we have the chance to build upon and enhance the research of everyone by combining our talents.

Research Problems

1. Science questions – Dr. Fitch
2. Social issues
   - Enabling access to new tools for research
   - Findings that impact peoples' lives and environmental management practices
   - Feedback to students as teaching and learning tools
   - Utilizing new tools and outside expertise to enhance current research
   - Meaningful collaboration using Internet tools: chat, conferencing, shared whiteboard, blogs, and wikis.
3. Technical tasks

Dr. Alanah Fitch detailed the science aspects of our research problems.

This collaboration has various possible social impacts, broader than the specific tasks at hand with collecting, analyzing and displaying data. To create a meaningful collaboration that will enhance the

Some of the technical aspects to getting this project to function smoothly, in a way most advantageous to all parties will be discussed.

Technical Expertise in Loyola CS and CUERP

- Geographic Information Systems
  - Internet Mapping
  - Spatial Analysis
- Parallel/Distributed Computing
  - Internet Computing
  - Grid Computing
- Data Mining and Statistics
- Pattern Recognition and Neural Networks
- Portals, Mashups and Web Technologies (Ajax and Java Enterprise Edition)
- Markup Languages (Google: markup languages syllabus)

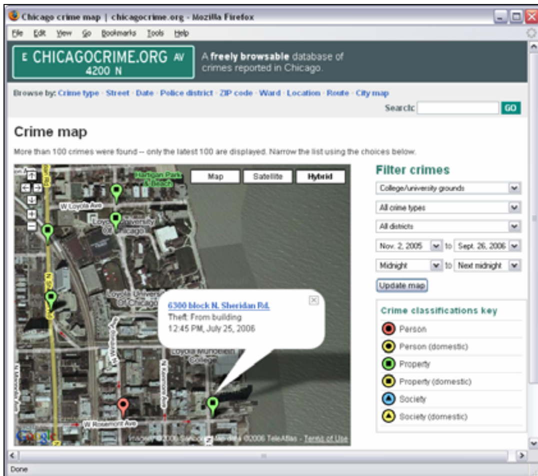
•**Internet mapping**, or Web mapping, provides access to the powerful display and analysis capabilities of an expensive desktop GIS package, without the infrastructure and data management costs. By running a server at Loyola that hosts data and the ArcIMS (Internet Mapping Server) software, researchers anywhere with secure internet access can view, query and analyze all available data.

•**Pattern Recognition**, through the use of neural networks and other types of knowledge-based techniques, will enable automated matching of the sample spectral response curves to a library of known compound spectral curves, enhancing the accuracy and efficiency of pesticide identification from samples.

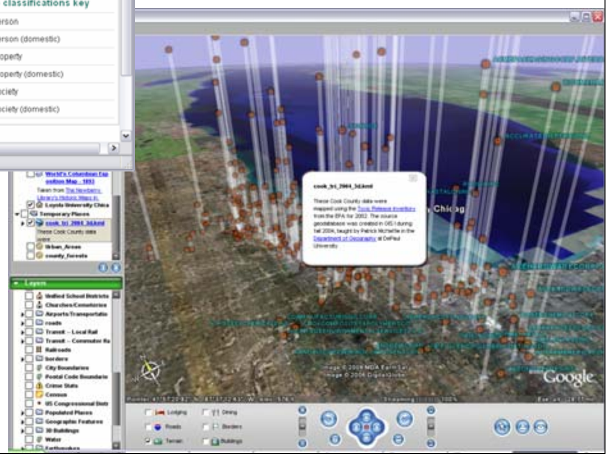
•A **mashup** is a website or application that uses content from more than one source to create a completely new service. A good example of this would be Google creating the Google Maps API and letting anyone utilize their Google Maps software and databases so that individuals can develop many new and creative uses for the mapping software. One of the more popular Google Maps mashups is the Chicago Crime map.

•**Ajax**, shorthand for *Asynchronous JavaScript and XML*, is a web development technique for creating interactive web applications. The intent is to make web pages feel more responsive by exchanging small amounts of data with the server behind the scenes, so that the entire web page does not have to be reloaded each time the user makes a change. This is meant to increase the web page's interactivity, speed, and usability.

Examples of Mashups

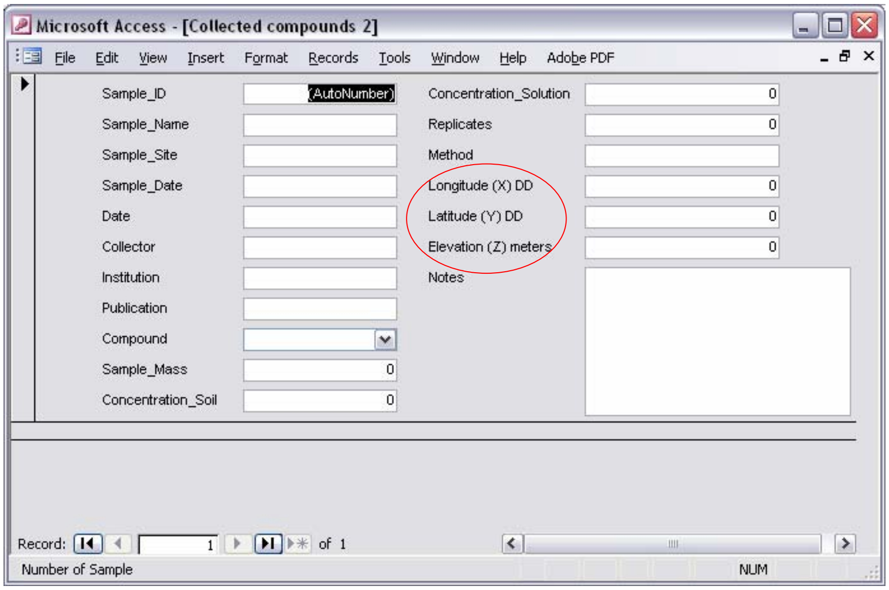


ChicagoCrime.org uses Google Maps API and Chicago Police Department crime data.



US EPA data on toxic chemical releases combined with Google Earth interface.

Example of Data entry form for Web Portal



Data entry

A form similar to this, with fields for all relevant data types can be created as part of the web portal you will use to upload your collected data. We may create a way to import entire spreadsheets of data, rather than only allowing the input of one feature at a time. Once imported, your data can be stored along with all previously collected records, and we can map your points so you can interact with them on the web mapping interface. As shown above, the GPS coordinate data you collect are attributes of your sample data that allow mapping of the points of collection.

What is GIS?

- Geographic Information Systems / Science
- GIS is built upon knowledge from geography, cartography, computer science and mathematics.
- Geographic Information Science is a new interdisciplinary field built out of the use and theory of GIS.

What is GIS?

Different definitions of a GIS have evolved in different areas and disciplines.

All GIS definitions recognize that spatial data are unique because they are linked to maps.

A GIS at least consists of a database, map information, and a computer-based link between them.

Much of GIS analysis and description consists of investigating the properties of geographic features and determining the relationships between them.

GIS enables us to make maps, as well as to answer complex questions through spatial analysis and modeling.

Definition 1: A GIS is a toolbox

“A powerful set of tools for storing and retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes" (Burrough, 1986, p. 6).

“Automated systems for the capture, storage, retrieval, analysis, and display of spatial data." (Clarke, 1995, p. 13).

Definition 2: A GIS is an information system

"An information system that is designed to work with data referenced by spatial or geographic coordinates. In other words, a GIS is both a database system with specific capabilities for spatially-referenced data, as well as a set of operations for working with the data" (Star and Estes, 1990, p. 2).

What can we do with GIS?

- ❑ Mapping where things are
- ❑ Mapping quantities
- ❑ Mapping densities
- ❑ Find what is inside or nearby a feature
- ❑ Mapping change

✓ GIS enables us to do feature attribute queries AND spatial relationship queries.

What can we do? What questions can we ask?

Map where things are: GIS can find places that have the specific features you're looking for. For example, sample locations plotted on a map.

Map quantities: GIS can map quantities of features to find places that meet desired criteria, or to see the relationships between places. This gives an additional level of information beyond simply mapping the locations of features. For example, selecting sampled locations where pesticide concentrations exceed a certain level.

Map densities: While you can see concentrations by simply mapping the locations of features, in areas with many features it may be difficult to see which have a higher concentrations than others. A density map lets you measure the number of features using a uniform unit of area, such as hectares or square kilometers, so you can clearly see the distribution.

Find what is inside: Use GIS to monitor what's happening and to take specific action by mapping what features exist inside a specific area. For example, find all sites within each district, zone or area, like school districts, neighborhoods or land use areas.

Find what's nearby: Find out what's occurring within a set distance of a feature by mapping what's nearby. For example, find sites within 2 kilometers of a major river system or villages further than 5 kilometers from a water body

Map change: Map the change in an area to anticipate future conditions, decide on a course of action or to evaluate the results of an action or policy. Measure differences in pesticide concentrations over time, and correlate with changes in land use and population densities.

GIS Data Queries

DBMS uses queries of ‘flat’ attribute files like a spreadsheet or database.

Spatial equivalents of the DBMS queries result in locating sets of features or building new GIS layers based on relative locations.

GIS enables us to do feature attribute queries AND spatial relationship queries.

Attributes of GIS data

Attributes of conservarea

FID	Shape*	OBJECTID	TYPE	NAME	SOURCE	REF__	ACT_REF__	STATUS	DATE_	SHAPE_AREA	SHAPE_LEN
0	Polygon	1	Conservation Area	Englewood	Map	C- 2	C- 1	Active	6/15/1962	135778080.969	47502.082726
1	Polygon	2	Conservation Area	Lawndale	Map	C-1	C- 3		6/1/1989	114889804.269	61943.304751
2	Polygon	3	Conservation Area	Lincoln Park	Map	C- 5	C- 4	Active	7/7/1965	43987692.59	28936.176763
3	Polygon	4	Conservation Area	Near West Side	Map	C- 6	C- 5	Active	3/1/1983	10685394.5682	19133.078571
4	Polygon	5	Conservation Area	North Kenwood/Oakland	Map	C- 7	C- 6	Active	10/14/1992	16201763.3892	22324.258604
5	Polygon	6	Conservation Area	Uptown	Map	C- 8	C- 7	Active	10/9/1968	20037964.6551	18370.697796
6	Polygon	7	Conservation Area	Hyde Park/Kenwood	Map	C- 3	C- 2	Active	11/7/1958	45422866.3202	32415.78477

Record: 1 Show: All Selected Records (0 out of 7 Selected.) Options

- Attribute data are stored logically in flat files.
- A flat file is a matrix of numbers and values stored in rows and columns, like a spreadsheet.
- Each object or feature corresponds to a row of the table.
  - Sample sites, Cities, Lakes, etc.
- Each characteristic or theme corresponds to a column of the table.
  - Sample number, Pesticide concentration, Date collected, etc.
- Entries in cells are called values.

Types of Attributes

Nominal: simple classification into categories, e.g. land cover class

Ordinal: order and ranking, e.g. top 10 most polluted river systems

Interval: e.g. Celsius temperature

Differences make sense

Ratio: e.g. concentration of dissolved oxygen

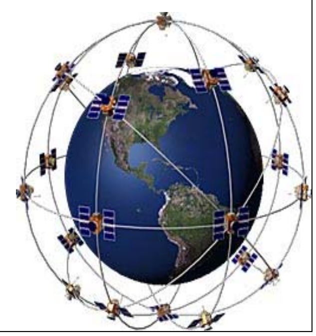
Ratios make sense, with a zero point

Cyclic: e.g. wind direction

What is GPS?

- **G**lobal **P**ositioning **S**ystem: A satellite-based radio navigation system. It was designed so that signals from at least four satellites would be above the horizon at all times, which is sufficient to compute the current latitude, longitude and elevation (X,Y,Z) of a GPS receiver anywhere on earth to within a few meters.

- Applications of GPS Technology
  - **Location**
  - **Mapping**
  - **Tracking**
  - **Navigation**



What is Global Positioning System (GPS)?

As part of the collection of data on pesticide concentrations, you can collect accurate coordinate data to register sample locations to a position on the Earth surface. These coordinates are Longitude (X), Latitude (Y), and Elevation or Altitude (Z).

GPS consists of 24 high orbit satellites sending out coded radio signals that are picked up by receivers that calculate position.

We know that Speed of light x time = distance

Radio waves are electromagnetic waves, like light, and travel at 186,000 miles per second

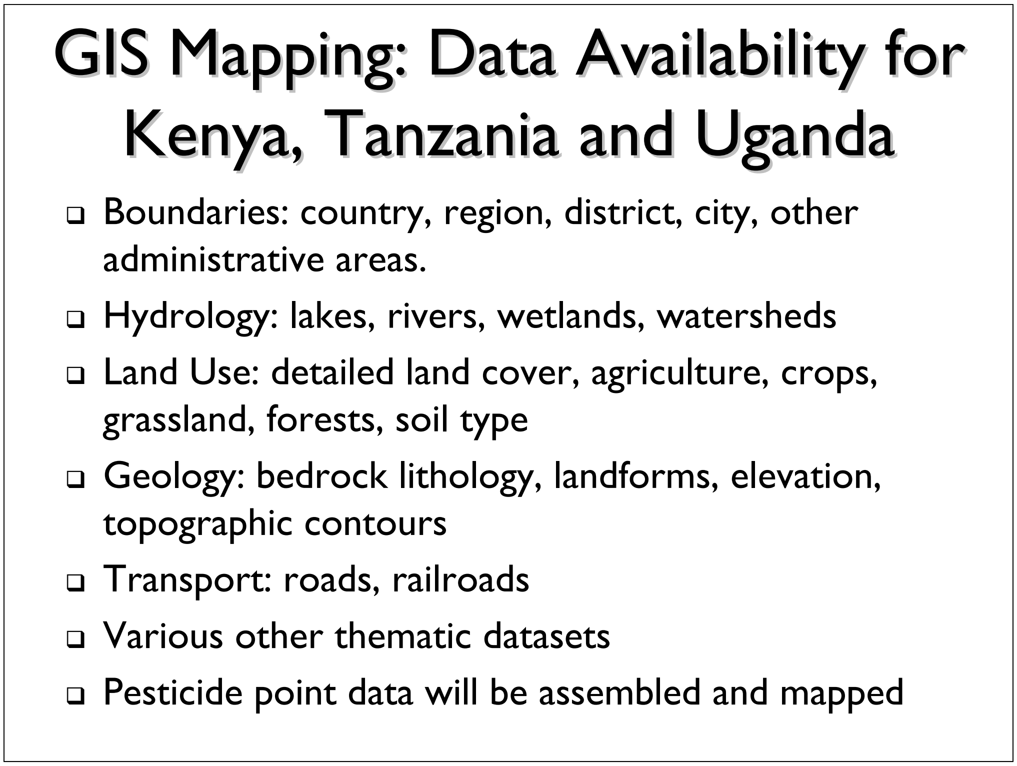
A satellite overhead will transmit its signal to us in 6/100ths of a second

Most receivers measure in nanoseconds (0.000000001 second)

Distance to each satellite can be calculated, and the receiver's position can be triangulated from the known positions of the satellites.

Wide Area Augmentation System satellites will provide enhanced spatial accuracy. WAAS is a satellite system that improves the location tracking accuracy of the GPS system from 20 meters to three meters. Deployed in 2003, WAAS comprises a group of earth stations and two satellites that will be near the horizon in East Africa. The earth stations track the GPS satellites and send correction signals to the WAAS satellites, which are picked up by WAAS-enabled GPS units.

For **Instructions for using a GPS handheld unit,** see the included document



GIS data availability and sources

Data collection began in September 2006. Various sources were revealed for high quality GIS datasets for the countries of Kenya, Tanzania and Uganda. All data collected to this point has been free and publicly available.

Sources should be cited for any maps utilizing this data. Formal citations can be provided by David Goldblatt, Loyola. dgoldb2@luc.edu.

Africover of the United Nations Food and Agriculture Organization http://www.africover.org/

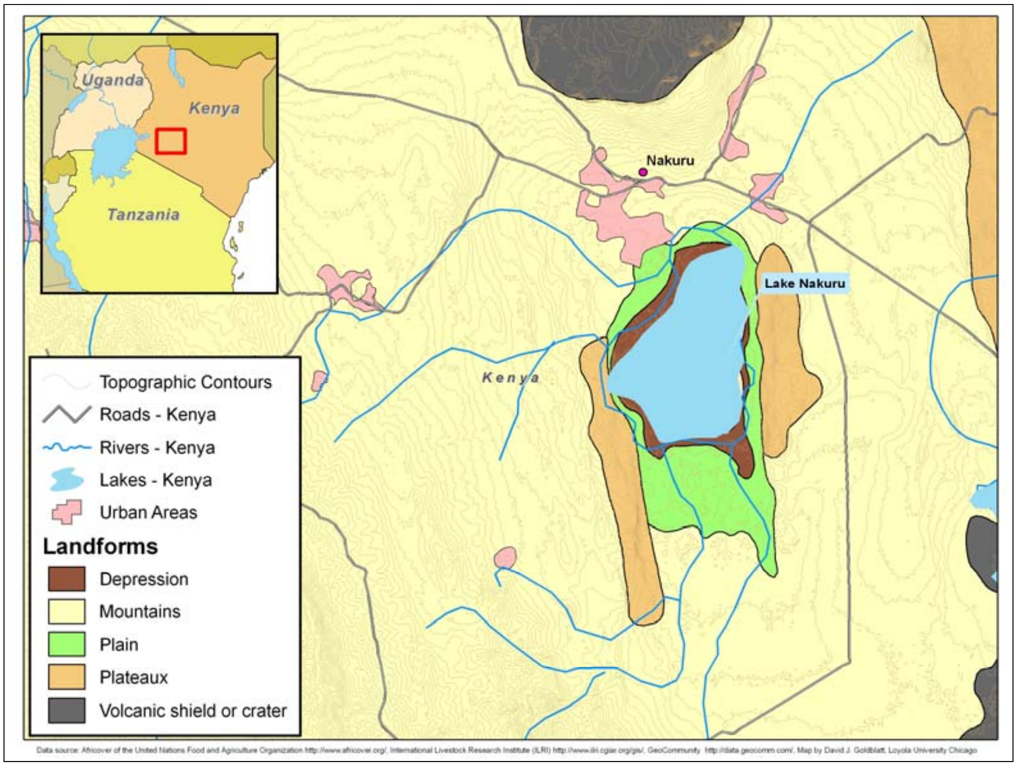
The International Livestock Research Institute (ILRI) http://www.ilri.cgiar.org/gis/

GeoCommunity http://data.geocomm.com/

SOTERSAF, Soil and Terrain Database for Southern Africa http://www.isric.org/

Mike Shand, Department of Geographical and Earth Sciences, University of Glasgow http://web.ges.gla.ac.uk/~mshand/

And others….



Using the geographic datasets available, and overlaying the distribution of point that represent pesticide sampling locations, many possible questions may be posed. GIS staff at Loyola is available to assist in the formulation of interesting, relevant questions, the answers to which will enhance ongoing research.

For instance, if an agricultural land use layer is shown with pesticide sample locations, correlations can be drawn between types of crops being grown on an area of land and the concentrations of different pesticides found within those areas. This assists an understanding of what chemicals are used for various agricultural applications. As another example, proximity to urban areas is a good indicator for vulnerability to ecosystem degradation. Developed urban areas, roads and other impervious surfaces alter the hydrology of a watershed. Rainfall and irrigation runoff from agricultural fields can be estimated from knowledge about the catchments, elevation slope, weather data, and hydrology, etc. Finally, population characteristics and demographics can be added to many spatial models to begin understanding disproportionate exposure by disadvantaged segments of the population. Relating health conditions and environmental factors that may be contributing causes is difficult, but is made easier using GIS.

Many other questions can be put to the data that can enrich our understanding of impacts of pesticides.

Stay tuned for the location of a new blog and other internet collaboration tools.