

# Putting the Geographic in GIS

Prepared for  
The Geography Graduate Student Association (GGSA)  
The University at Buffalo  
Geography Awareness Week  
November 18, 2016

# Geography and GIS at Harvard University

- The Geography Department (1878 – 1948)
- The Institute of Geographical Exploration (1930 – 1951)
- The Laboratory for Computer Graphics and Spatial Analysis (1965 - 1991)
- The Center for Geographic Analysis (2006 – present)

# The Geography Department

- Geography courses were offered at Harvard since 1878.
- Harvard was one of the major centers of geographic training by the late 1890s.
- Geography, in the Department of Geology and Geography, reached its peak of eight faculty members in 1928, and continued at this level for two decades.
- In 1948, the University terminated the geography program. The reason given was: "Harvard cannot hope to have strong departments in everything."
- There had been numerous attempts to reinstall a geography department since, none succeeded so far.

# The Geography Department



***Derwent Stainthorpe Whittlesey (1890-1956)***  
***Professor of Geography***



**James Bryant Conant (1893-1978)**  
**The 23rd President of Harvard University**

# The Institute of Geographical Exploration

- Alexander Hamilton Rice, explorer of tropical America and husband of Titanic survivor Eleanor Elkins Widener, donated specimens from his trips to Harvard, and funded the construction of the Institute of Geographical Exploration in 1929.
- He was named Professor and Director of Geographical Explorations in return, and funded the operation of the Institute which was mostly independent from the University.
- In 1951, Rice ended his financial support to the Institute and retired, handing the building to the University. Harvard closed the Institute immediately.

# The Institute of Geographical Exploration



Alexander Hamilton Rice (1875-1956)



# The Laboratory for Computer Graphics and Spatial Analysis

- Howard Fisher, Harvard College and Design School graduate, received a grant from the Ford Foundation and funded the Laboratory for Computer Graphics in 1965.
- In 1968, William Warntz, professor of theoretical geography, became director of the Lab and extended its work into spatial analysis.
- The Lab pioneered early cartographic and architectural computer applications that led to integrated geographic information systems. Some call it “the birth of GIS.”
- Jack Dangermond, then a graduate student at the Design School, worked in the Lab in 1967-69.
- Financial strain and the lack of commercial inspiration for projects led to the dispersal of many team members from 1981. Despite some further research during the late 1980s, the Laboratory closed in 1991.

# The Laboratory for Computer Graphics and Spatial Analysis



**Howard T. Fisher (1903-1979)**



**William W. Warntz (1922-1988)**



**Spatial Modeling in a Landscape Studio, supported by the Lab in the late 1960s. From left: Carl Steinitz, Peter Rogers and Jack Dangermond**

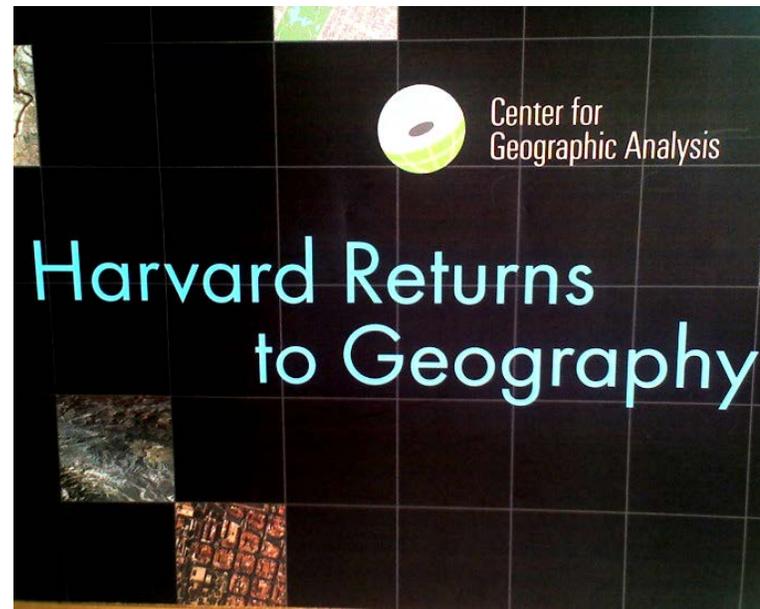
# The Center for Geographic Analysis



**Larry Summers, the  
27th President of  
Harvard University  
from 2001 to 2006**



**Peter K. Bol, the Vice  
Provost for Advances  
in Learning, founding  
director of the CGA  
from 2005 to 2014**



# The Center for Geographic Analysis

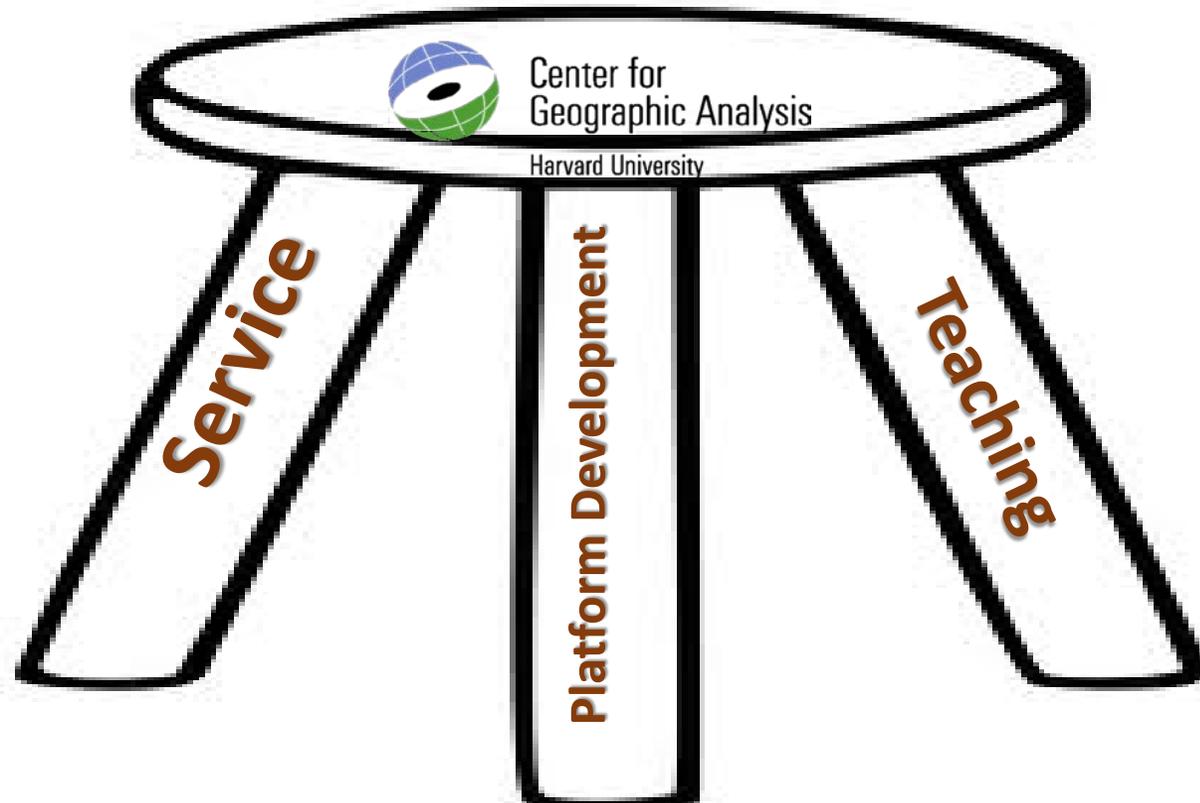


Inauguration Conference of the CGA  
May 2006

From left:  
Roger Tomlinson (1933-2014)  
Laura Dangermond, ESRI Co-founder  
Jack Dangermond, ESRI President  
Richard Marston, AAG President, 2005-  
06  
Douglas Richardson, AAG Executive  
Director

# The CGA's Mission

Support *research* and *education* that relies on *geographic information*.



# CGA Basic Services

- Maintaining **help desks** in both campuses;
- Consulting with students, faculty, and staff on research and teaching **projects**;
- Consulting on **grant proposals**;
- Providing non-credit **instruction** in geospatial software applications on a regular basis;
- Assessing, organizing, financing for, and maintaining university site licenses for **software**;
- Providing **hardware** and support for geospatial tools;
- Undertaking initiatives that improve the university **infrastructure** in relation to geographic analysis.



Home » Services » Project Consultation

### CGA Projects

See also our Project Resume Slideshow.

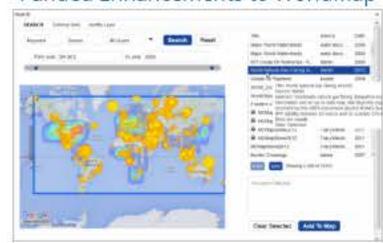
Contact CGA

- Help Desk
- Project Consultation**
- Project resume**
- Projects Map
- Course Support
- Course Resume
- CGA Products
- WorldMap
- CGA Tools & Code
- GIS Data Portals
- CGA Web Maps
- Technical blog
- Geocoding

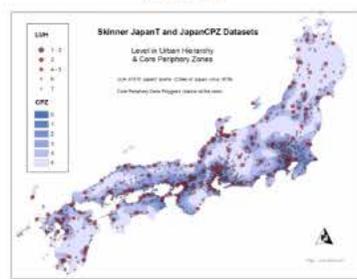
The Northern Sea Route Map



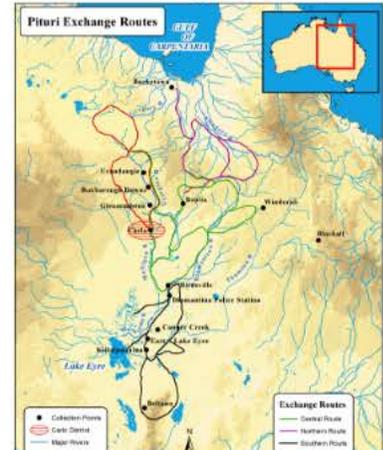
Global Spatio-Temporal Search: NEH Funded Enhancements to WorldMap



G. W. Skinner Regional Systems Analysis



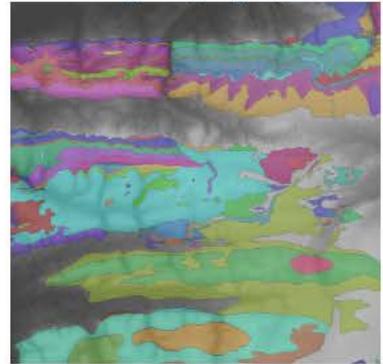
Pituri Exchange Routes Map



Map creation for the Encyclopedia of Holocaust Camps and Ghettos, 1933-1945



Geologic Mapping Support



# Questions the CGA Encountered

- What is the relationship between the CGA today and the other geographic entities Harvard had in the past?
- Why is the CGA called the Center for **Geographic** Analysis?
- What is the relationship between Geography and GIS?
- What should we call scientific inquiries in GIS?

**GIS** here loosely means the applied geographic information science (**GIScience**) and the related geospatial technologies (**GISystem**)

# What are the possible relationships between Geography and GIS?

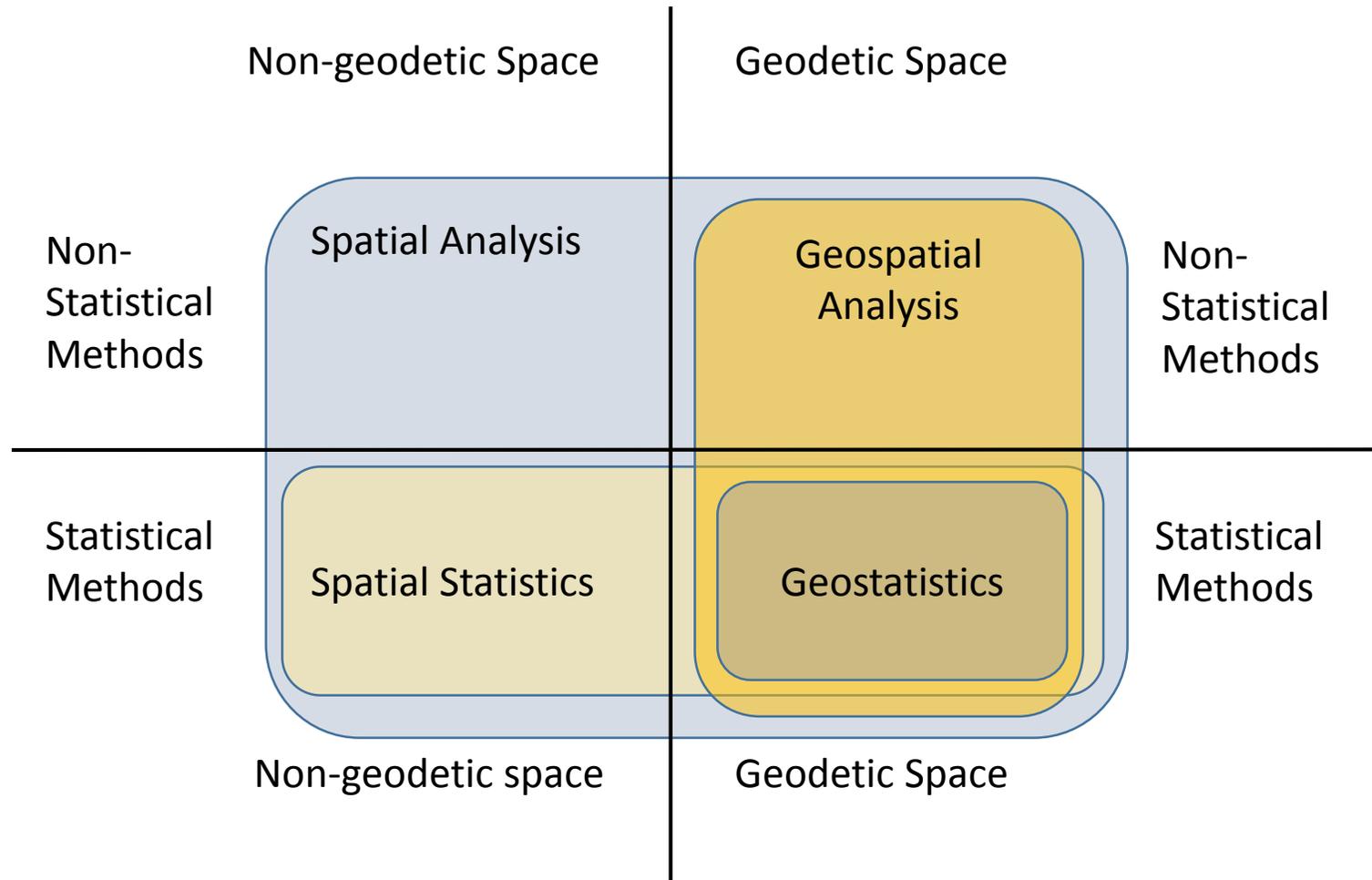
- Geography is the encompassing scientific field, and GIScience is a subfield in it.
  - Or is it?
- GIScience takes achievements from mainstream Information Science (database modeling, software engineering, etc.) and other fields (geodesy, remote sensing, statistics, etc.) and implements them in GISystem.
  - Then where is geography?
- Geography defines the scope of GIS.
  - If so, GIScience is a subfield of Information Science, the “G” becomes a limiting factor of the “IS”.
- Geography benefits from the boom of GIS.
  - Is it virtue by association?
- Geography provides content, GIScience provides methodology, IS provides technology, all three feed into GISystem.
  - Is that a reality or a dream?

# What do people call scientific inquiries in GIS?

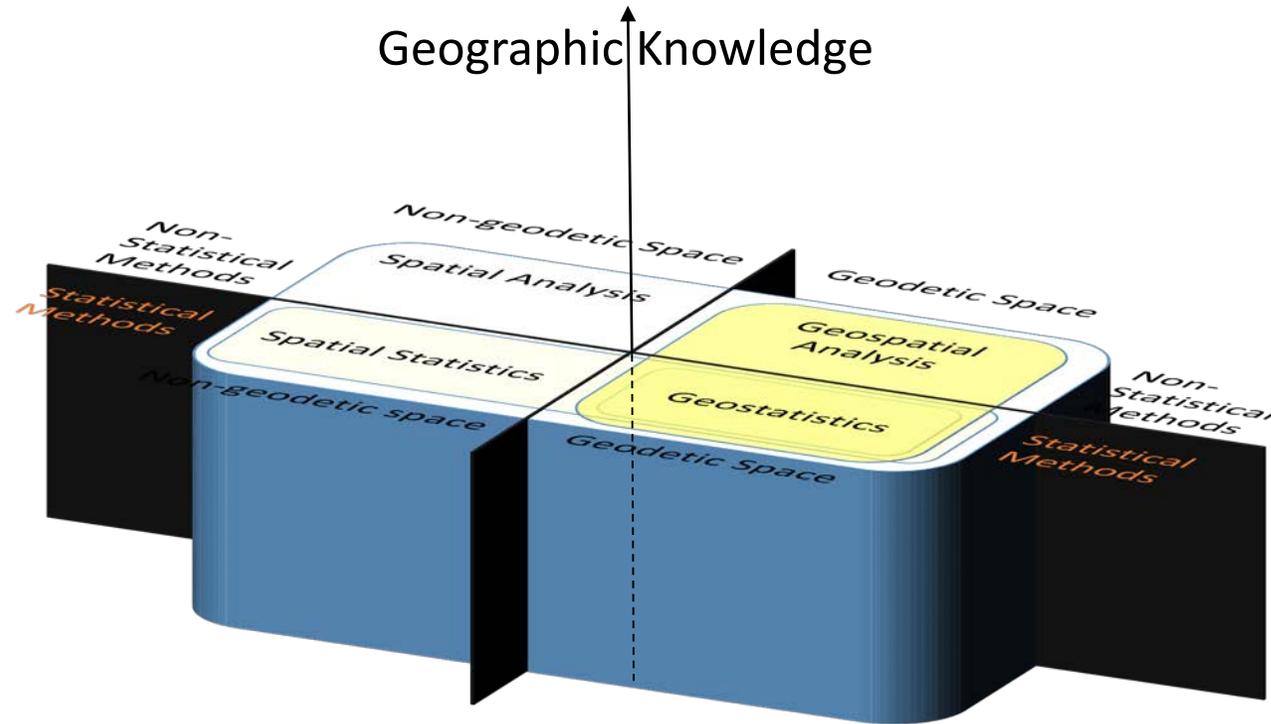
- Spatial analysis
- Geospatial analysis
- Spatial Statistics
- Geostatistics
- Geographic analysis
- ... ..

What are the relationships among them?

# What are the relationships among them?



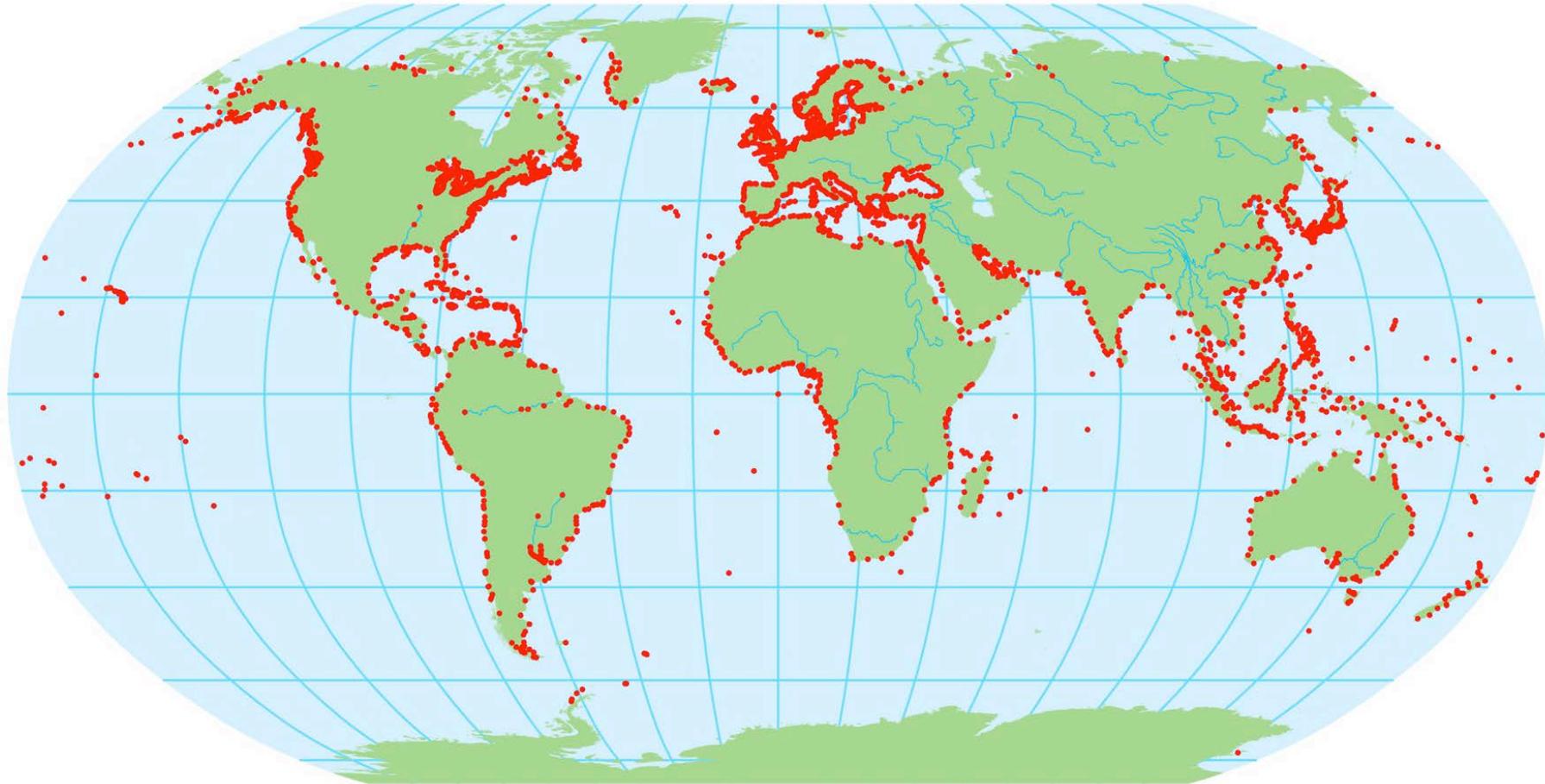
# Where does Geographic Analysis fit?



# How does GIS contain geographic knowledge?

- Base data
  - Commercial or free
  - Downloaded or online
- User generated data
  - Private or public
  - Authentic or crowd-sourced
  - Actively or passively generated
  - Measured or model-derived
- The model itself is an important part of geographic knowledge
  - Turns raw data into meaningful data
  - Built into GISystem or coupled with one

*Case 1:* Shipping distance between any two ports in the world



# Modeling the Global Maritime Network

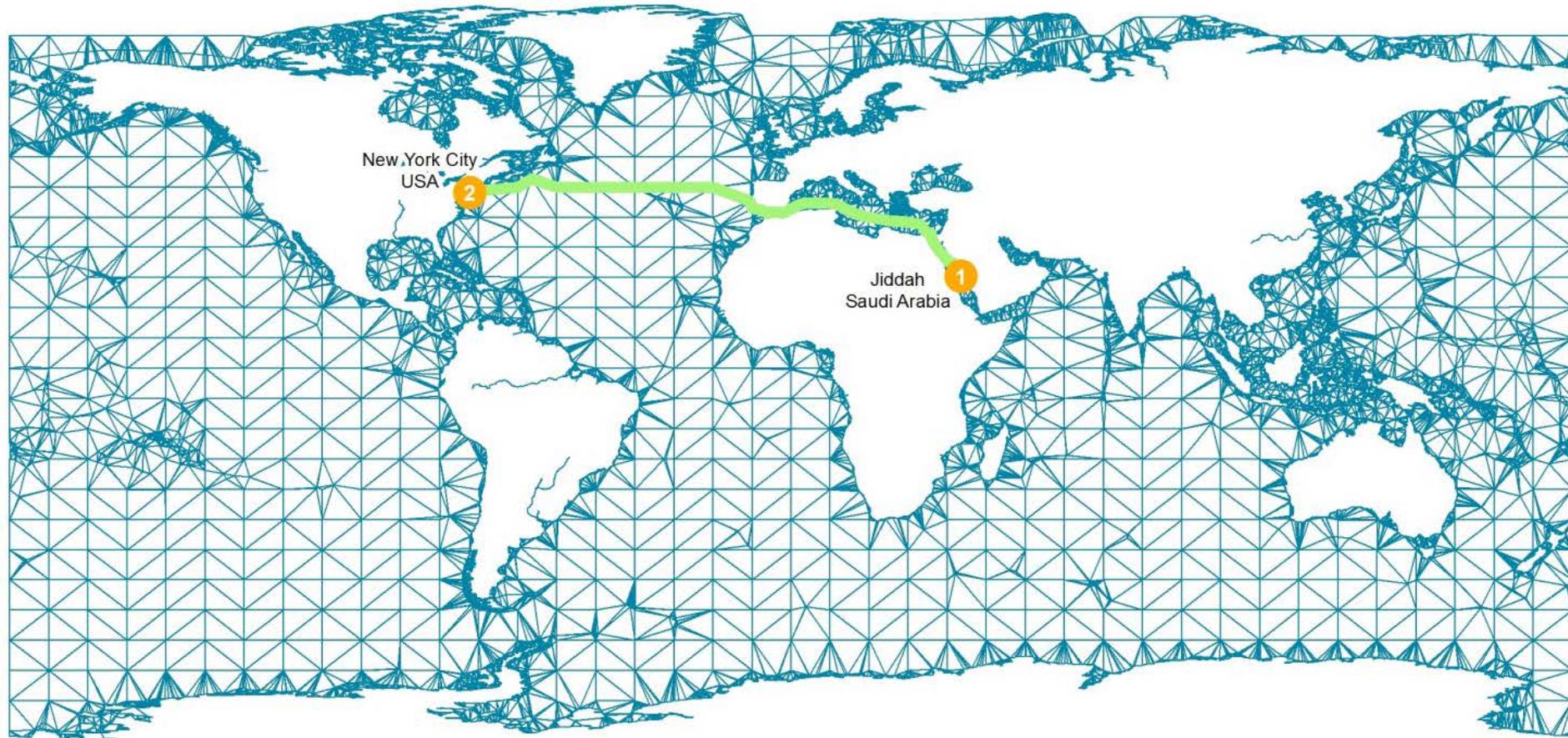
## **Problem:**

- No freely available dataset offering a network over the oceans.
- Online calculators offer distances between two ports at a time.
- Programming a query of online calculators would have offered a matrix of known ports, but would not have been flexible for new ports.

## **Solution:**

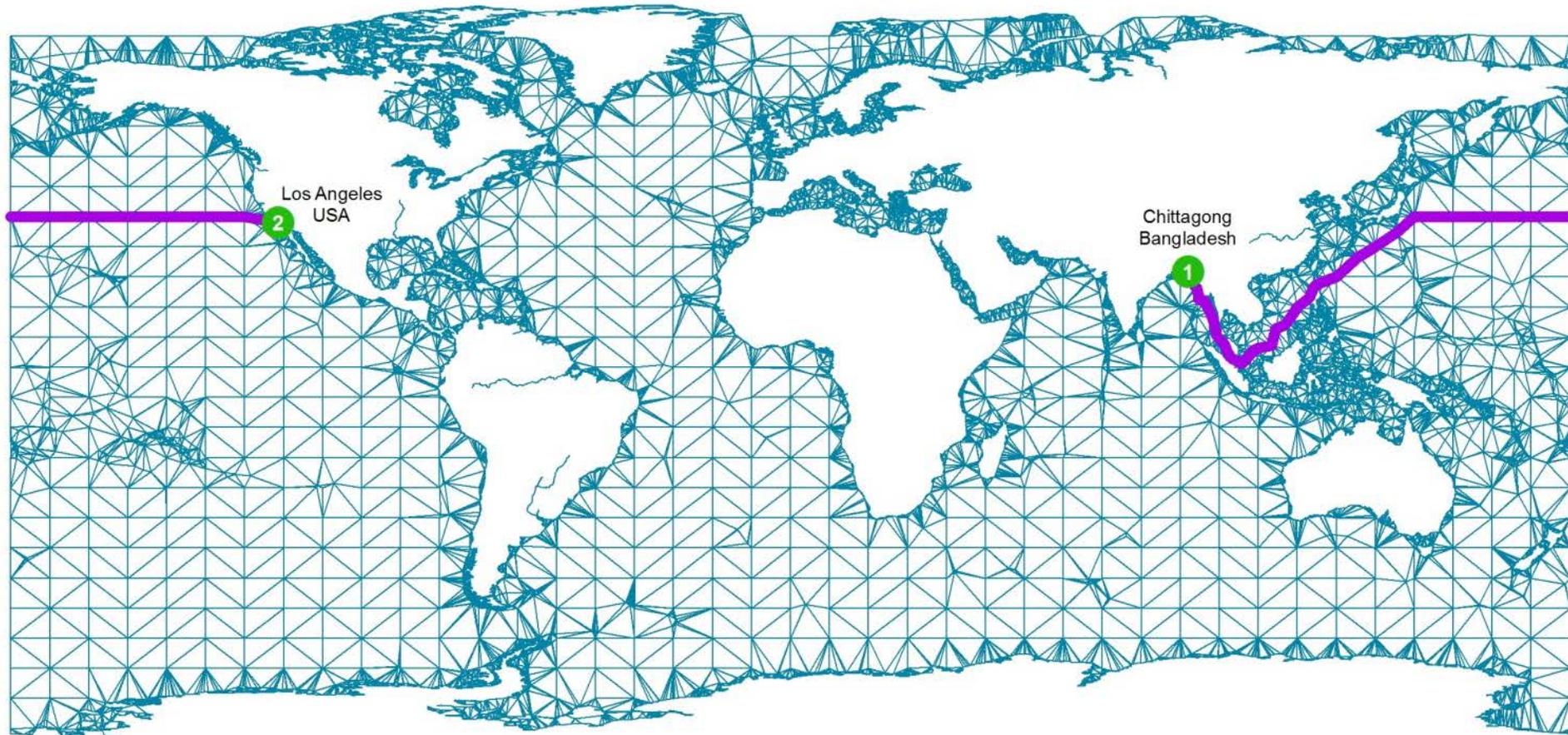
- Allows the calculation of distance between any two ports in the world.
- Each line in the network is informed of its great circle length.
- Assumes a ship can travel anywhere in the oceans.

# Saudi Arabia to New York City



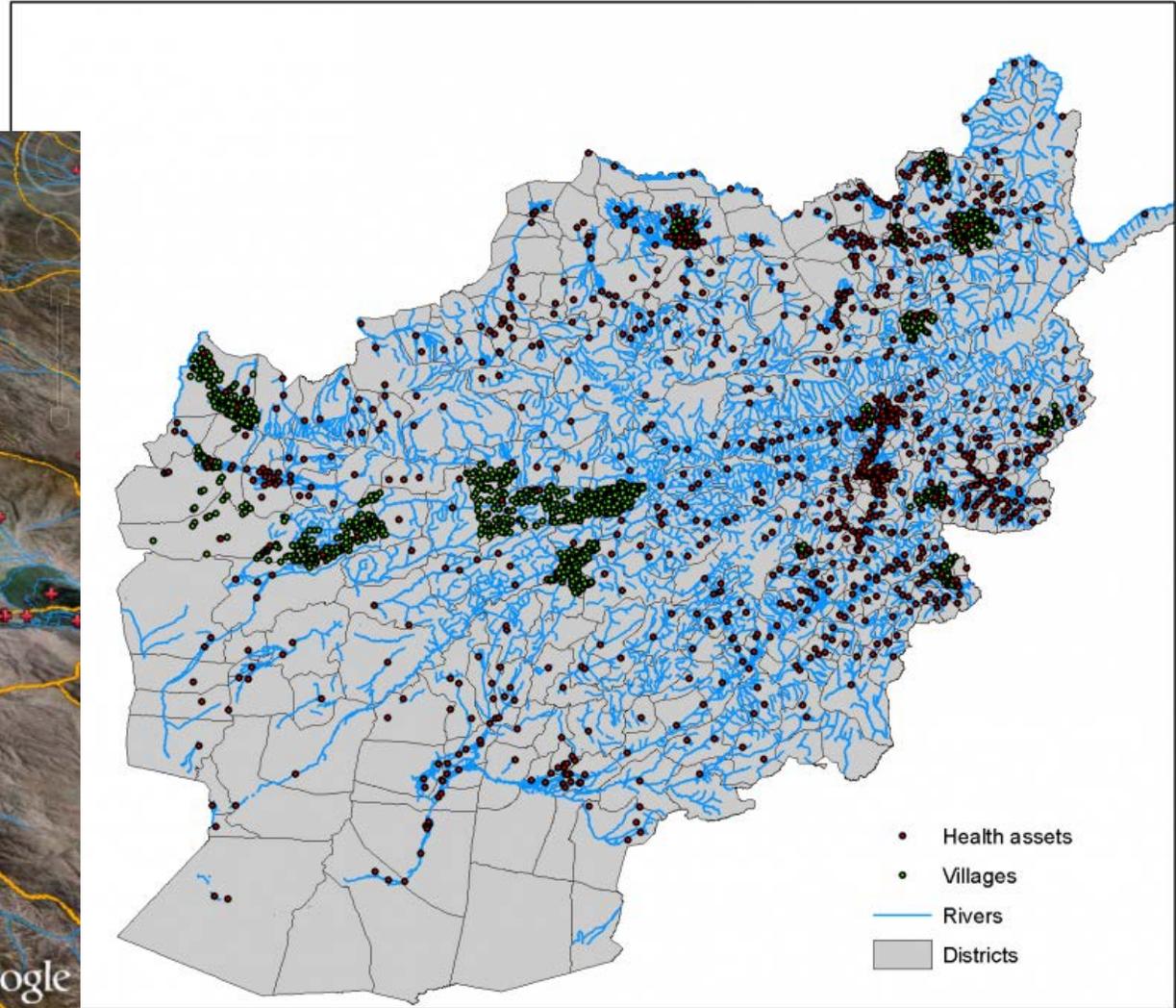
Distance: 11,268 Kilometers  
6,084 Nautical Miles

# Bangladesh to Los Angeles



Distance: 17,730 Kilometers  
9,573 Nautical Miles

# Case 2: Access to health facilities from Afghan villages



# How does geographic knowledge apply here?

- Distance from village to clinic (data needed)
  - Euclidian distance (coordinates)
  - Great circle distance (datum)
  - Distance on terrain (DEM)
  - Distance along roads (road network)
  - Shortest walkable distance (road network + overland path analysis)
  - Shortest walkable distance for specific time of year and time of day (seasonal condition, lighting condition)
- Is it conceivable for a GISystem to have such level of knowledge built-in?
  - If yes, who is responsible for building it?

# Challenges in building a comprehensive global geographic knowledgebase for GIS

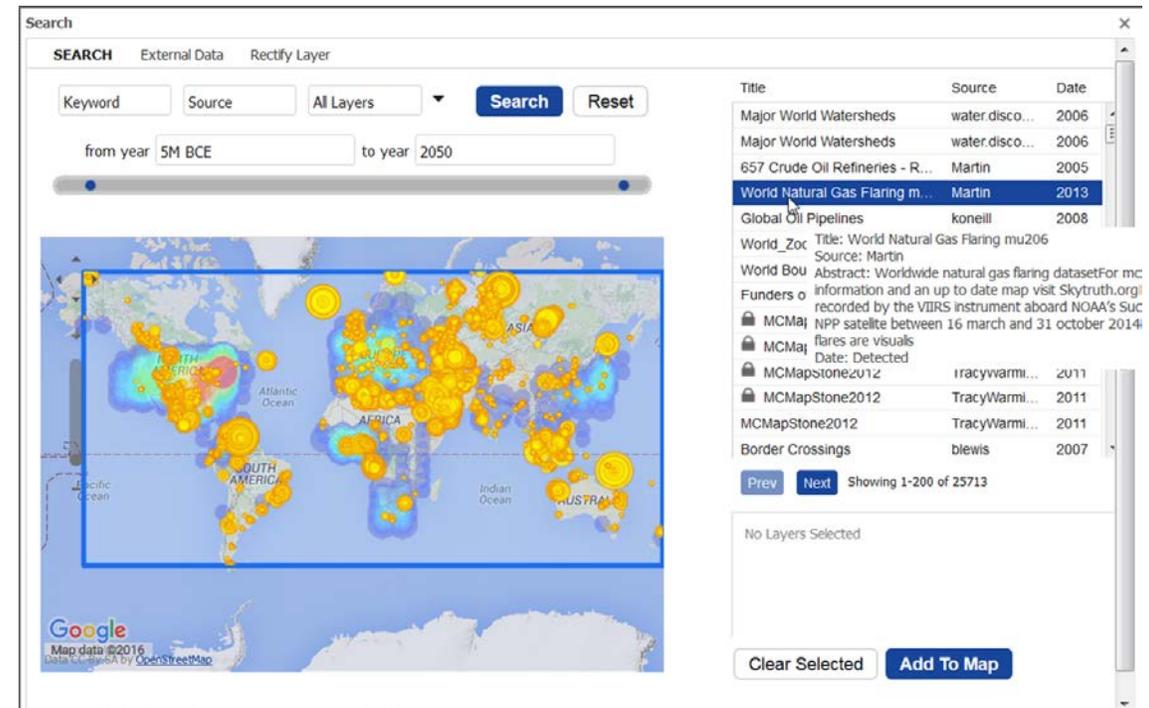
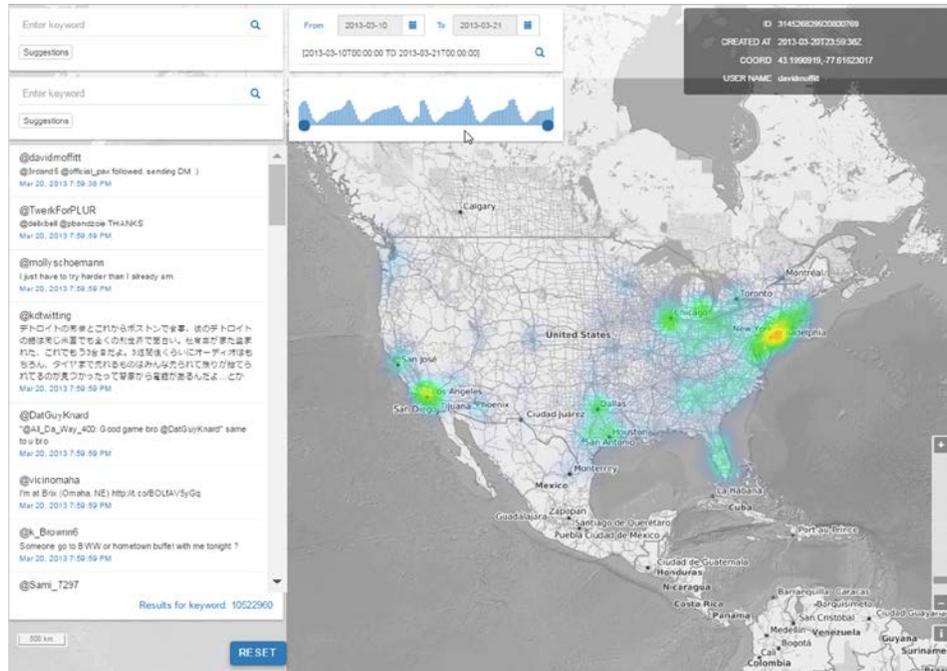
- Existing data are scattered
- Places are evolving
- Things are related in reality, much more so than in our databases
- Geographic objects are often fuzzy and uncertain
- Time is hard to handle
- ... ..

Next are some efforts at the CGA in searching for solutions.

# Existing data are scattered

Finding, accessing, selecting and visualizing data across the Internet

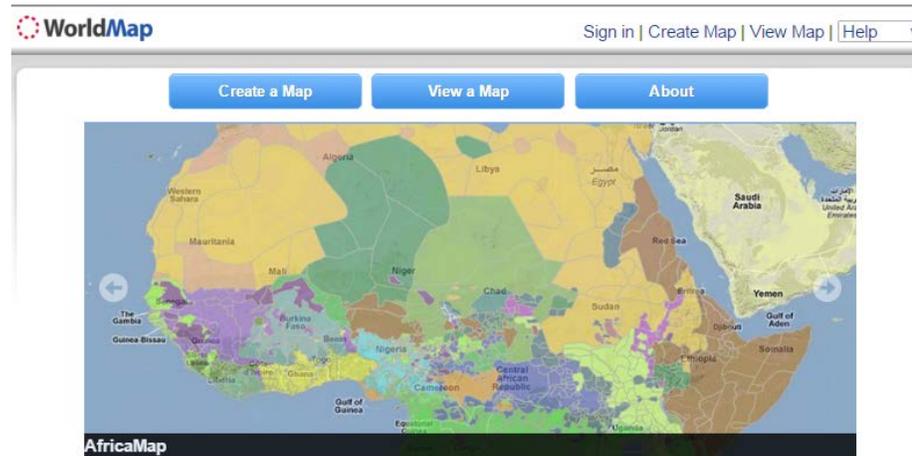
- HHypermap – Global Map Registry
- The Billion Object Platform (BOP)



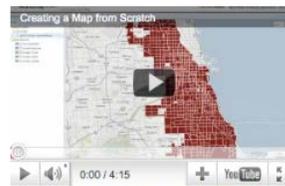
# Places are evolving

Attempts in building spatiotemporal gazetteers

- [CHGIS](#)
- [WorldMap](#)



Build your own mapping portal and publish it to the world or to just a few collaborators. WorldMap is open source software.



[Watch the WorldMap Quick Start video](#)

WorldMap is being developed by the [Center for Geographic Analysis](#) at [Harvard University](#).



## China Historical GIS



- [Gazetteer Search Engine](#)
- [List of Free Datasets](#)
- [Skinner Map Collection](#)

home  
intro  
data  
members  
meetings  
docs

search tools

maps

with funding from the [Henry Luce Foundation](#), the [National Endowment for the Humanities](#) and support from

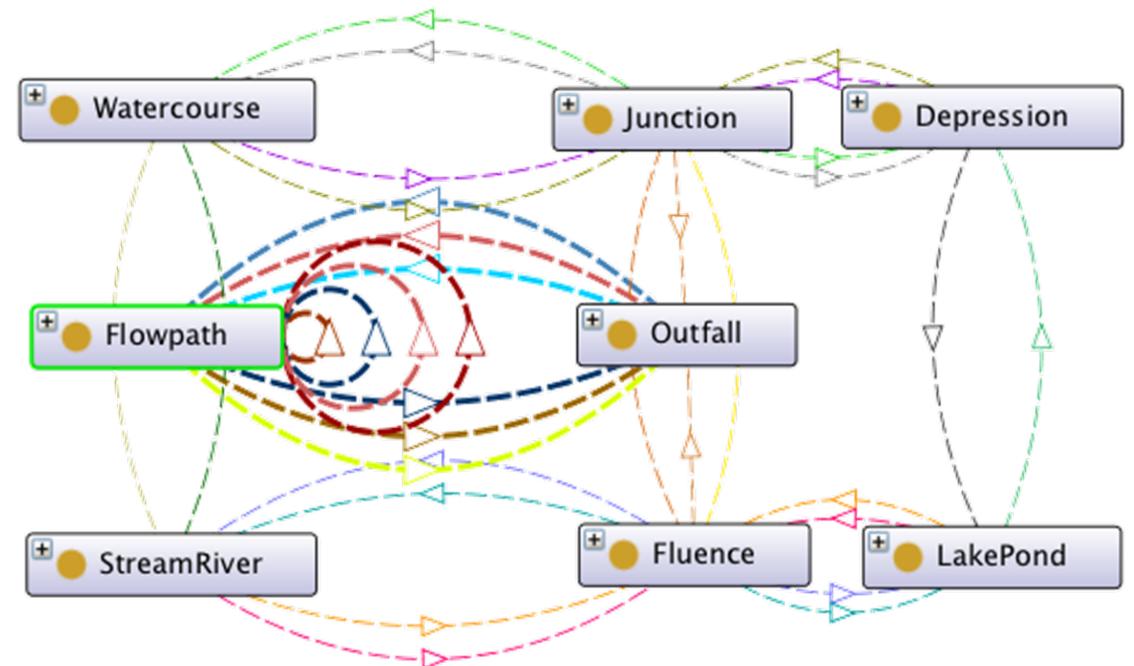
[Fairbank Center for Chinese Studies](#)  
[Harvard Asia Center](#)  
[Harvard Yenching Library](#)  
[Harvard Yenching Institute](#)

© 2001-2010 - [Harvard University](#) and [Fudan University](#)

# Things are related in reality, much more so than in our databases

Attempts in studying geographic ontologies

- Spatiotemporal Applications of [the National Map \(TNM\) Ontologies](#)

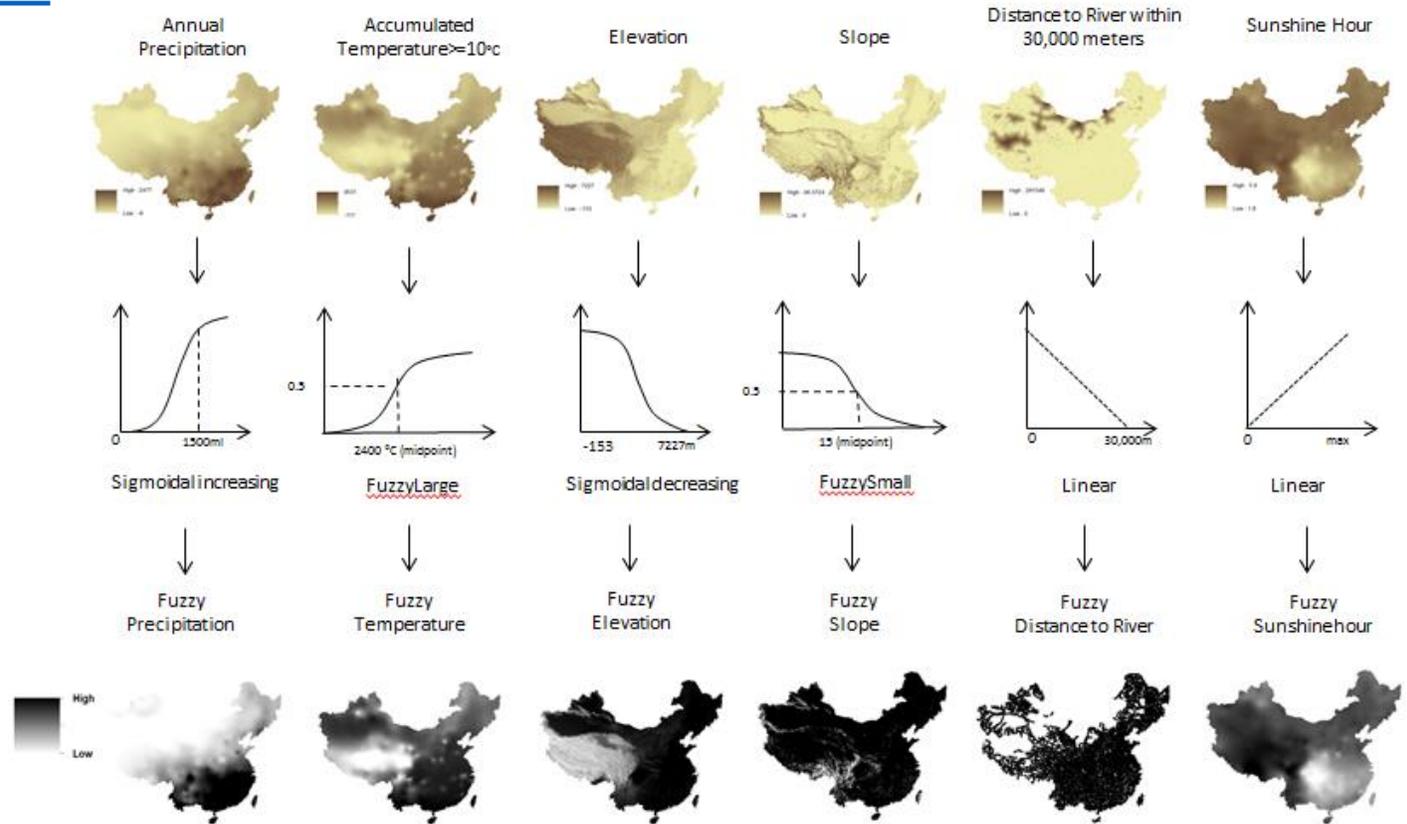


Wet-Dry-HydroNet Pattern

# Geographic objects are often fuzzy and uncertain

Attempts in modeling probability in space-time

- [Agriculture feasibility in China](#)

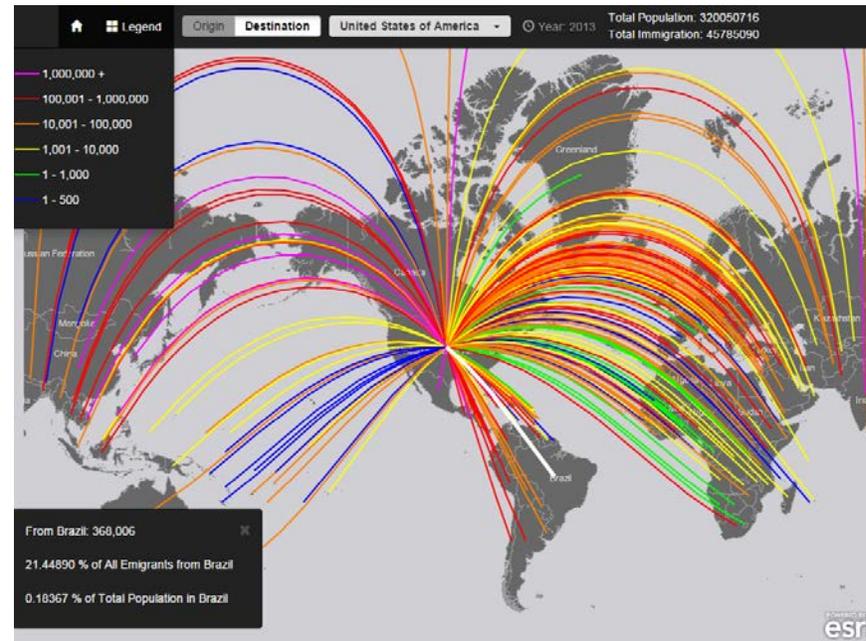


# Time is hard to handle

Attempts in handling time as the 4th dimension in the coordinate system

Or just rendering time in space

- [Crossroad migration](#)
- China's bullet trains



# GISystem vs. GIScience

- Does GISystem equal to GISoftware?
  - If yes, is GISystem reduced to “pushing buttons”?
- Can GISystem be conceptualized as a continuum from “tool usage” to “tool construction” to “study of methodology” to “study of theory”?
  - If yes, how to include the information content (geographic knowledge) in this continuum?
- Does GISystem equal to GIScience – a discipline of science that applies existing scientific knowledge to develop more practical applications such as technology or inventions, in a systematic way?
  - If yes, what are the fields which provide the exiting scientific knowledge?
    - Computer/Information Science?
    - Geography?
    - ... ..?

What is geography's contribution to GIS?

How to incorporate geographic knowledge into GISystem?

Wendy Guan

Center for Geographic Analysis, Harvard University

<http://gis.harvard.edu/>; [wguan@cga.harvard.edu](mailto:wguan@cga.harvard.edu)

***Acknowledgement:***

Ideas presented here resulted from discussions with **Anne Knowles**, professor of history at University of Maine.