esf
european
social fund in the
czech republic

EUROPEAN UNION

MINISTRY OF EDUCATION, YOUTH AND SPORTS

OP Education
for Competitiveness

INVESTMENTS
IN EDUCATION
DEVELOPMENT

The Next Age of Discovery and a Future in the Post-GIS World

Francis Harvey
University of Minnesota
fharvey@umn.edu
@fhap13

**Registry number: CZ.
1.07/2.3.00/20.0170**

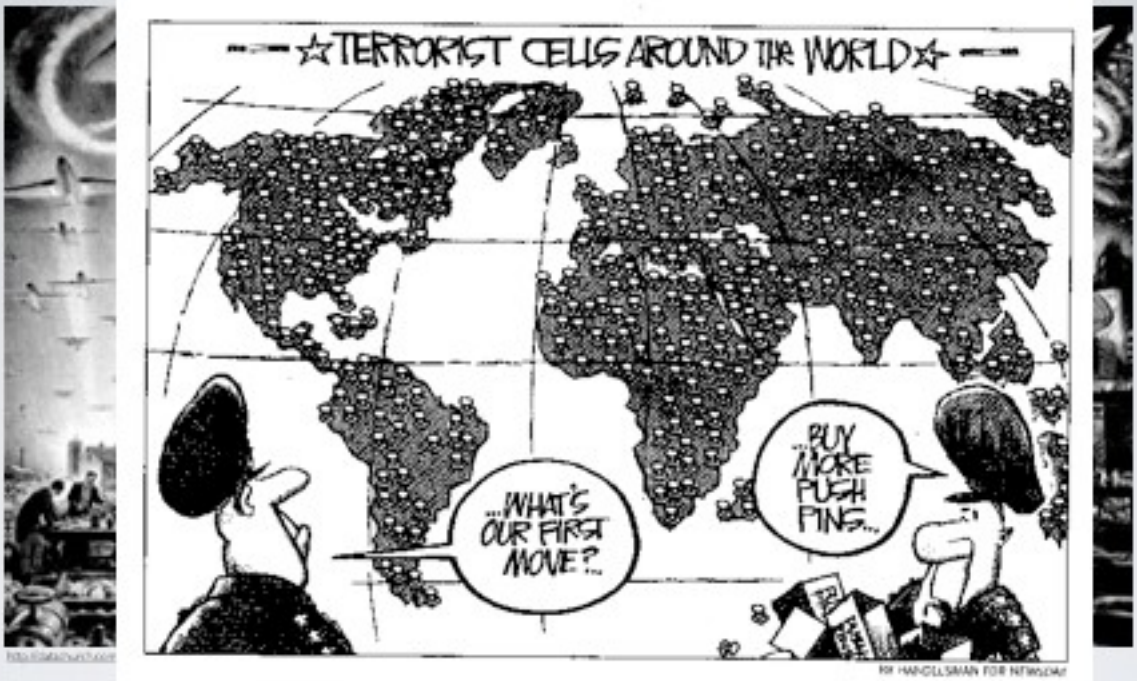
StatGis Team

THE FUTURE IS ALREADY HERE, IT'S JUST UNEVENLY DISTRIBUTED

William Gibson

THE FUTURE IS ALREADY HERE, IT'S JUST UNEVENLY DISTRIBUTED

William Gibson



KNOWLEDGE & PERCEPTIONS OF THE FUTURE GUIDE OUR PROJECTIONS OF THE FUTURE

http://1.bp.blogspot.com/-seM8zVTctz8/UOnk7AeI-hI/AAAAAAAAAC5Y/eQUn8IQJ84I/s1600/mad-scientist-movie.jpg

http://www.sciencephoto.com/image/464909/350wm/T0051449-Scientist_using_tablet_computer_in_lab-SPL.jpg

SCIENCE PERCEPTIONS TOO

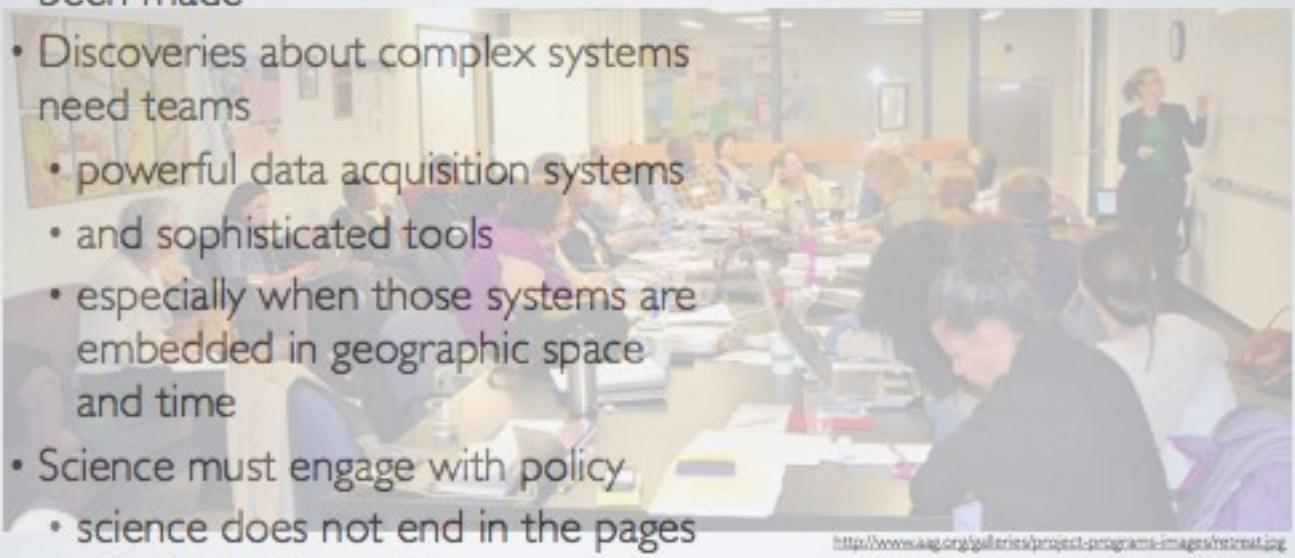
https://commons.wikimedia.org/wiki/File:Compound_Microscope_1876.JPG

SCIENTIFIC TRADITION

- The lone investigator looking for truths
  - Newton's gravitation
  - Mendel and inheritance
  - Mendeleev's periodic table
  - Maxwell's electromagnatism
  - Schrödinger's quantum mechanics
- Science by teamwork
  - James Watson and Francis Crick
  - Rosalind Franklin's observations

SCIENCE AS TEAMWORK

- All of the simple discoveries have been made
- Discoveries about complex systems need teams
  - powerful data acquisition systems
  - and sophisticated tools
  - especially when those systems are embedded in geographic space and time
- Science must engage with policy
  - science does not end in the pages of refereed journals
  - packaging science for general consumption



BEYOND GIS OR THE *POST-GIS ERA*

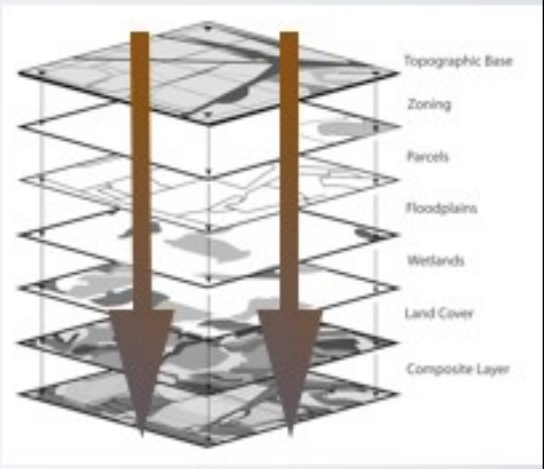
Pulse of the World

http://www.akamai.com/html/technology/nui/mobile/index.html

GIS

AUTOMATED MAPS - COMPUTATIONAL MACHINES FOR GEOGRAPHIC INFORMATION PROCESSING

- Early map-based GIS
  - 2D and static
  - matched the availability of data
  - matched our conceptual abilities
    - The essential approach
    - overlay, the "GIS spike"



A SHORT HISTORY OF GIS

- Canada Geographic Information System (1965)
  - all inputs from digitized area-class maps
- US Bureau of the Census (1972)
  - reporting zones as polygon coverages
- Topological Data Structures (1970s)
  - ODYSSEY, ARC/INFO
  - Intergraph's TIGRIS
- One data model, multiple applications
  - economies of scale in software development

blog.zolnai.ca

www.gsd.harvard.edu

NEED FOR SPATIOTEMPORAL

- Policy and public interest are driven by change (Frank)
  - Everything that happens happens somewhere in space and time (Wegener)
  - Every major issue has a time scale
    - climate change (decades)
    - climate tipping points (years)
    - economic meltdown (months)
    - infectious diseases (weeks)
    - disasters (days)

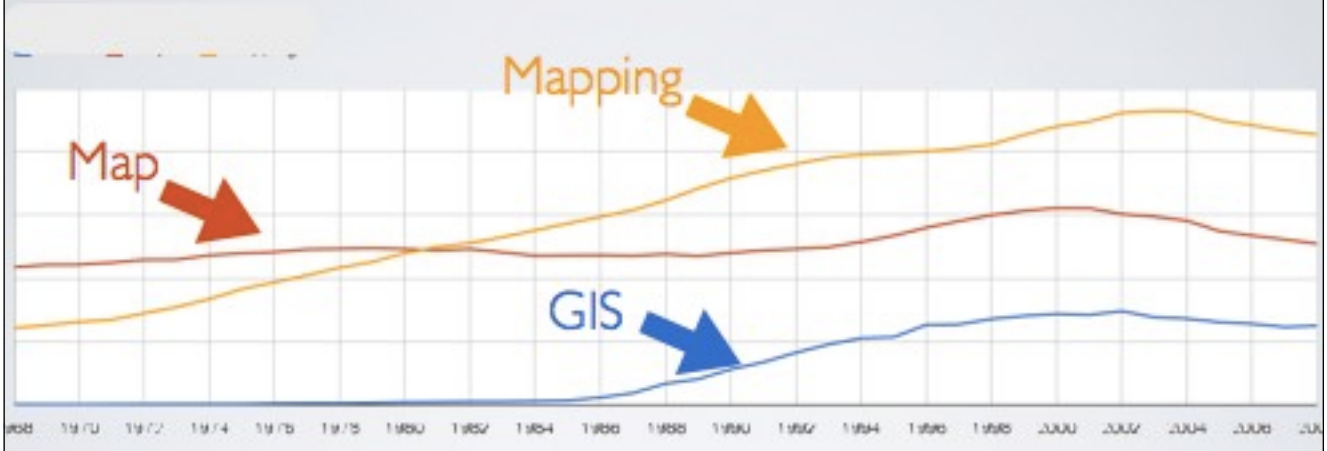
COMPLEX DATA FOR COMPLEX PROBLEMS

- In space and time
  - Using sophisticated tools and voluminous data
  - Impossible to incorporate all aspects of the problem
    - detail, variables, effects, factors must be left out
- a lab (or sandbox) for every team
  - defined by the tools, data, and assumptions of the team
    - how to compare one sandbox to another?
    - how many sandboxes are possible?
  - this is not traditional science!
- GIS has been of limited use--although still very useful
  - the "spatial" tool for all science

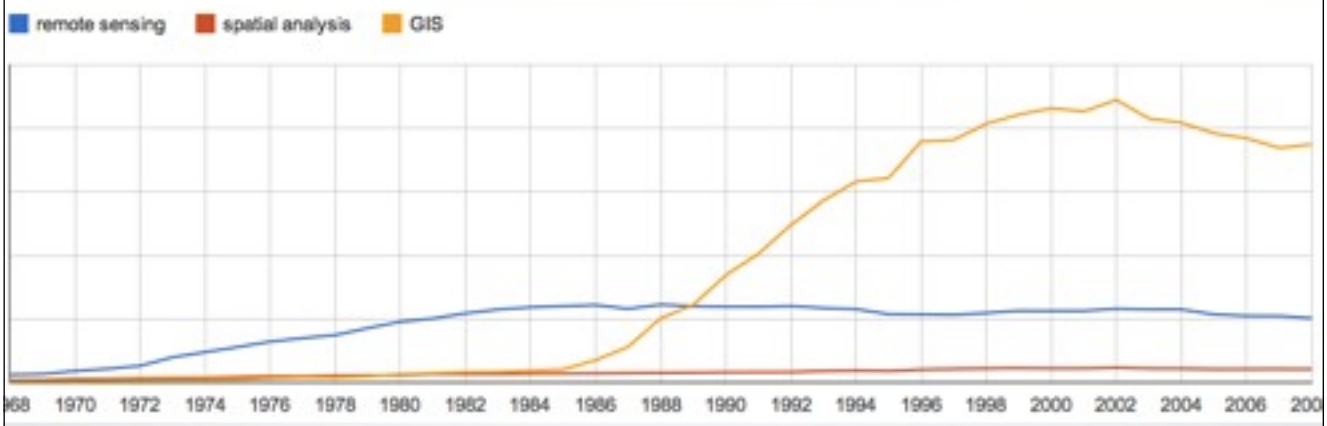
GIS COMPUTATIONAL DEVELOPMENTS

- Added many more data types
  - Object-oriented paradigm
  - Data are increasingly 3D, dynamic
- Is there any potential left for a unified GIS approach?
  - with its massive scale economies?
- What divisions exist within the spatiotemporal domain?
  - how will science and engineering develop GIS?

GIS Isn't Alone



COMPARISONS



A Bigger Picture: Spatialization of Society

POST-GIS: A PART OF INFORMATION SOCIETY'S INFRASTRUCTURE

- Already instances of spatial data infrastructure
- Evolving terminology points to increased embedding
- Students train to operate and solve problems with this infrastructure

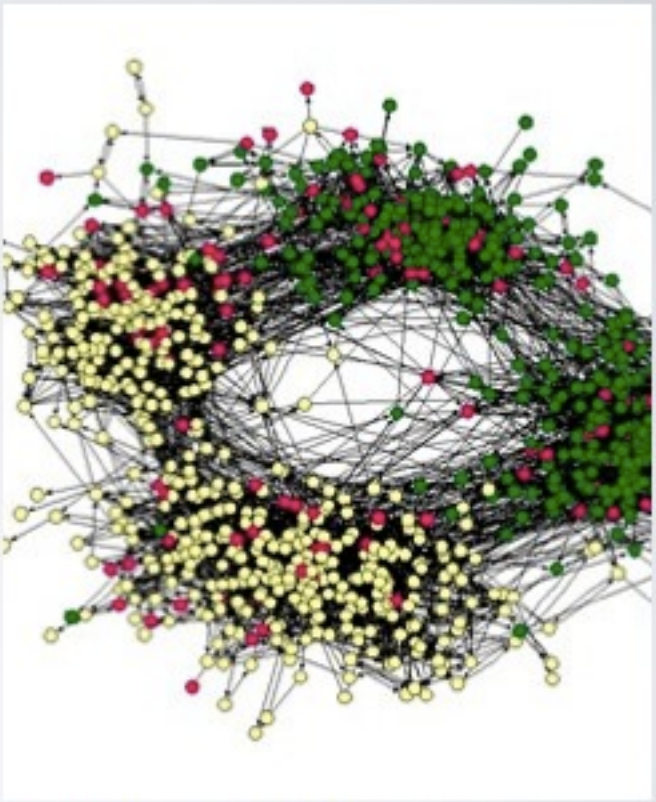
INFRASTRUCTURE

Recently A Much More Important Term

GIS IN SCIENCE'S FUTURE

FOURTH PARADIGM

- Data Intensive Scientific Discovery



Friendship network of children in a US school
http://hqinfo.blogspot.com/2010/01/information-revolution-fourth-paradigm.html

SCIENTIFIC PROGRESS WILL COME FROM WORKING WITH DATA

- GIS becoming a fundamental technology for working with data
- Big Data in the media
  - ITa meets science
- Look at seven aspects (domains) of changing GIS uses in data-based scientific discovery

Complexity of planetary life-interactions

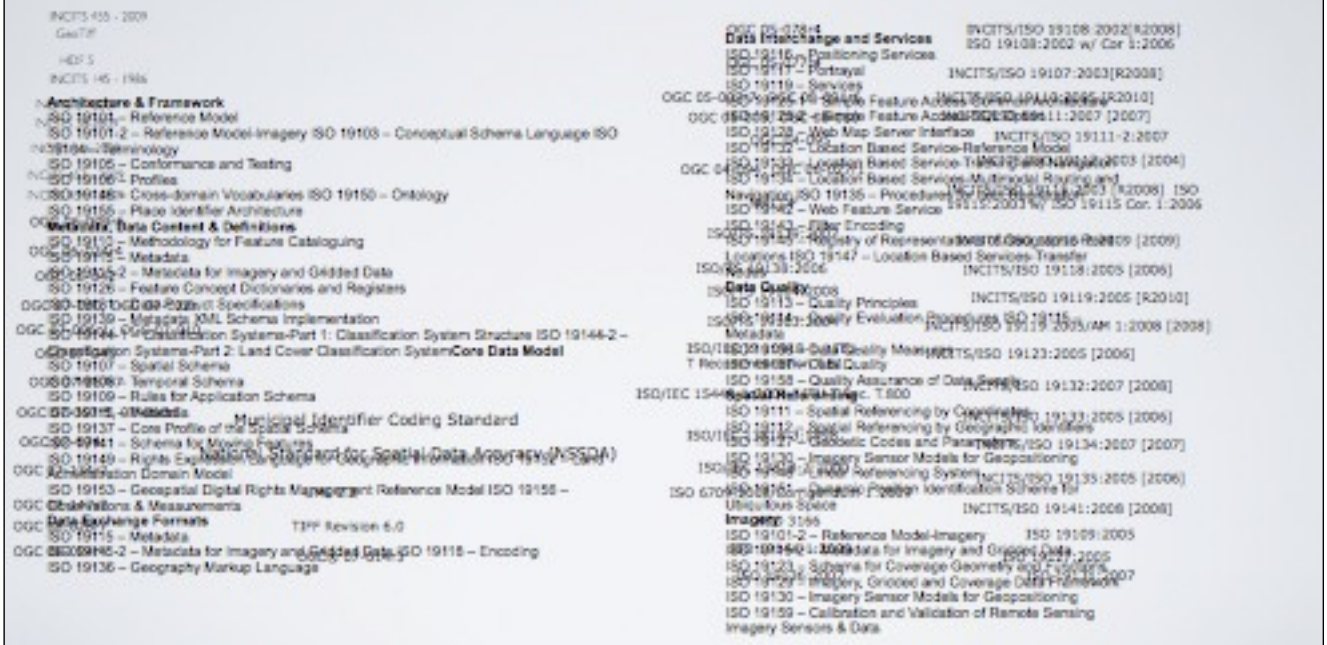
http://www.earthzine.org/2010/03/22/observing-the-oceans-a-2020-vision-for-ocean-science/

EDUCATION FOR THE FUTURE

NETWORKED DIGITAL INFRASTRUCTURES

Standards
We love them so much

That's why there are so many



INTENSIVELY COLLABORATIVE LARGE GROUP RESEARCH

TASKS FOR THE RESEARCH COMMUNITY

- What are the research questions?
  - what are the use cases?
  - some domains are driven by data availability rather than research needs
- What are the functions?
  - at what level of granularity?
  - standardized for discovery
  - elusive even for traditional GIS
- What are the data models?
  - the focus of much of the research to date

SCIENCE AND ENGINEERING

- Processing large data sets
- Error detection
- Automated learning
- Spatio-temporal analysis
- Visualization
- *Capture, curation, analysis*

NEW DATA MEANS NEW CONCERNS

- Concerns about privacy
  - used to have a reliable sense of public/private distinction; now easy to collect patterns and assemble detailed mosaics; even for predicting behavior
- Challenges of storage
  - power consumption of server farms
- Flipside of "control"

http://www.dvice.com/2013-2-13/under-armour-shows-interactive-running-suit-future

http://abcnews.go.com/blogs/headlines/2013/08/baby-monitor-hacking-alarms-houston-parents/

CONNECTIVITY IN N-DIMENSIONS

Mike Kelley: Repressed Spatial Relationships Rendered as Fluid, No. 4: Stevenson Junior High and Sateilites

Connections beyond the screen
Transcending environmental space/time

Design I/O Interactive Installation Test: http://vimeo.com/39122852

World of Sensors

Example Touché

- http://youtu.be/EcRSKEIucjk
- http://youtu.be/E4tYpXVTjxA

PHYSICAL AND VIRTUAL WORLDS

PARA-EMPIRICS

- Linda Kurgan, *Close Up, At A Distance*
  - Para-empirics: data is never facts, but representations
  - Measurements based in conventions, aesthetics, and rhetorics we associate with images
  - Data is para-empirical
  - Room for everyone to participate/engage

CENTRAL ISSUES

CHALLENGES

- Ubiquity of geographic information and limits of the GIS concept
- Changing modes of interactivity and of space/time
- New spatial-cultural practices
- Adapting to the ubiquity of tools

ACKNOWLEDGEMENTS

To Professor Michael Goodchild for various slides and colleagues at the University of Minnesota for comments and sharing materials.

And again to the StatGIS team.

Thank *you*

fharvey@umn.edu @fhap13