



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

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

StatGis Team

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

William Gibson



<http://machinabernardini.com/2013/06/06/the-future-in-1900/>



<http://artematon.com/works/organic-grid-00-bggg>



<http://www.greenlogic.org/2011/02/21/portugal-the-future-is-green-and-outside/>

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William Gibson



<http://www.fox.com/2013/06/06/>



BY HANGELSMAN FOR NYTIMES

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



<http://i.hqblogpost.com/~se/MzVfctr8UJOnk7AeIhNlWAAAAAACS5Y/igQUrBIQJ84/s1600/mad-scientist-meme.jpg>



<http://www.sciencephoto.com/image/464909/150wm/0051449>
Scientist using tablet computer in lab-SPL.jpg

SCIENCEPHOTOLIBRARY

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 electromagnetism
 - 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

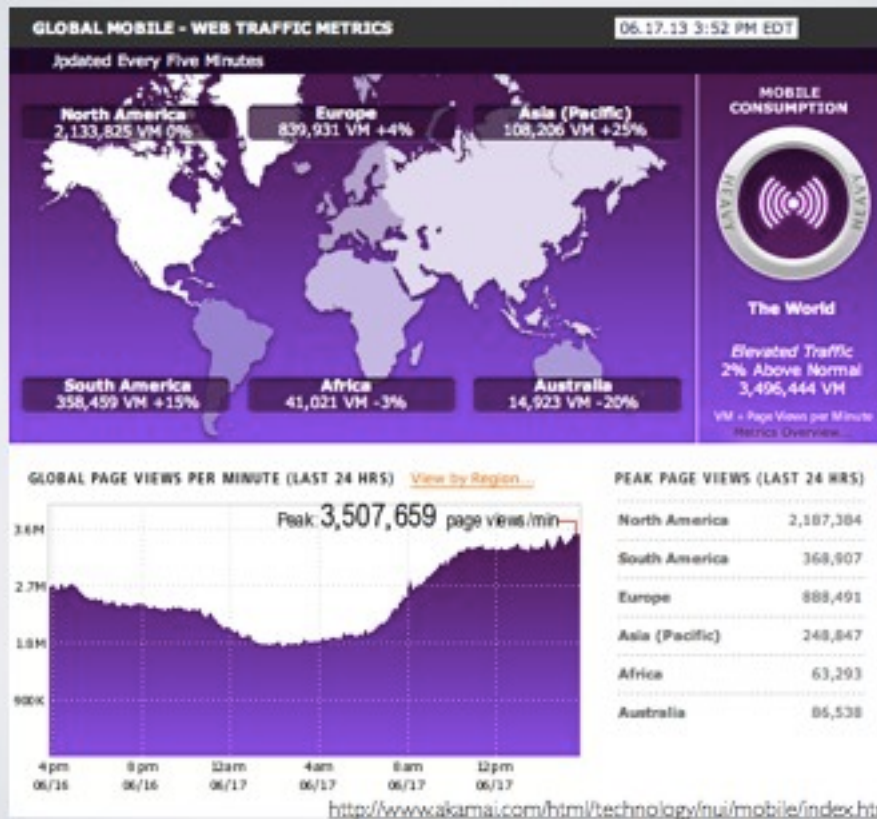


<http://www.aag.org/galleries/project-programs-images/research.jpg>

BEYOND GIS OR THE *POST-GIS ERA*



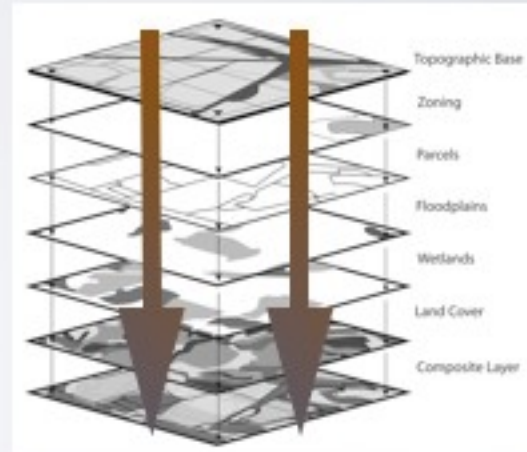
Pulse of the World



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.zoinal.ca



www.gis.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)



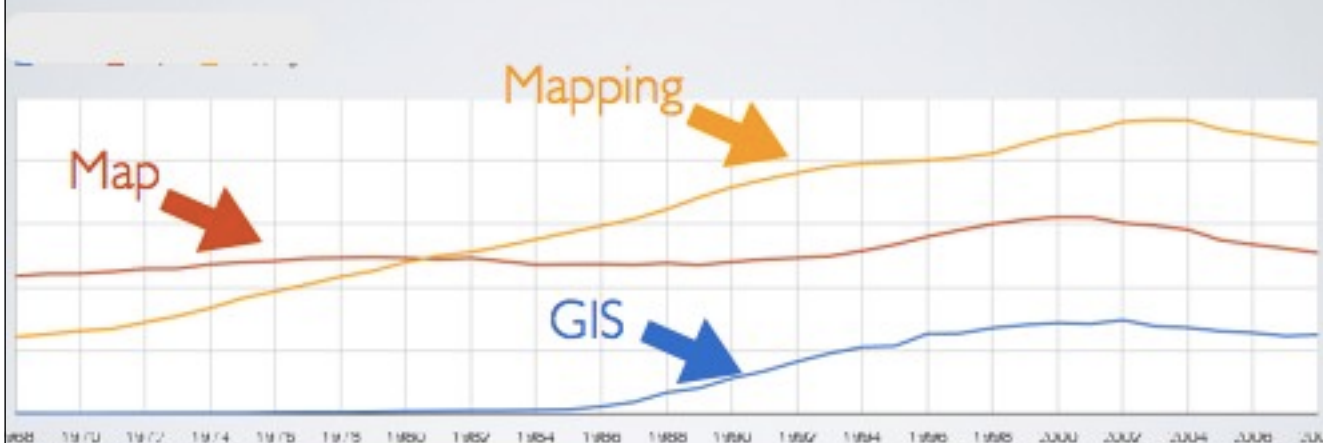
COMPLEX DATA FOR COMPLEX PROBLEMS

- 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

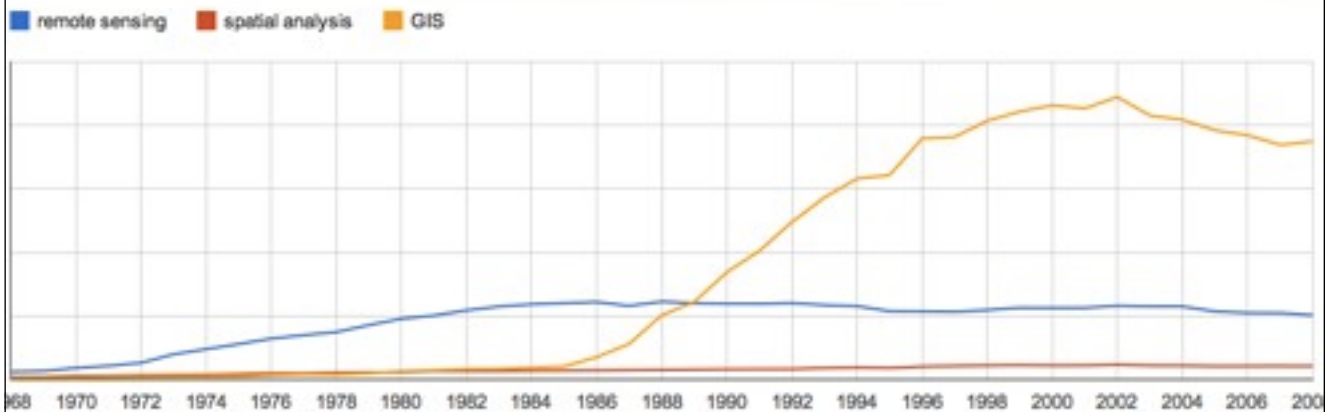
GIS COMPUTATIONAL DEVELOPMENTS

- 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?

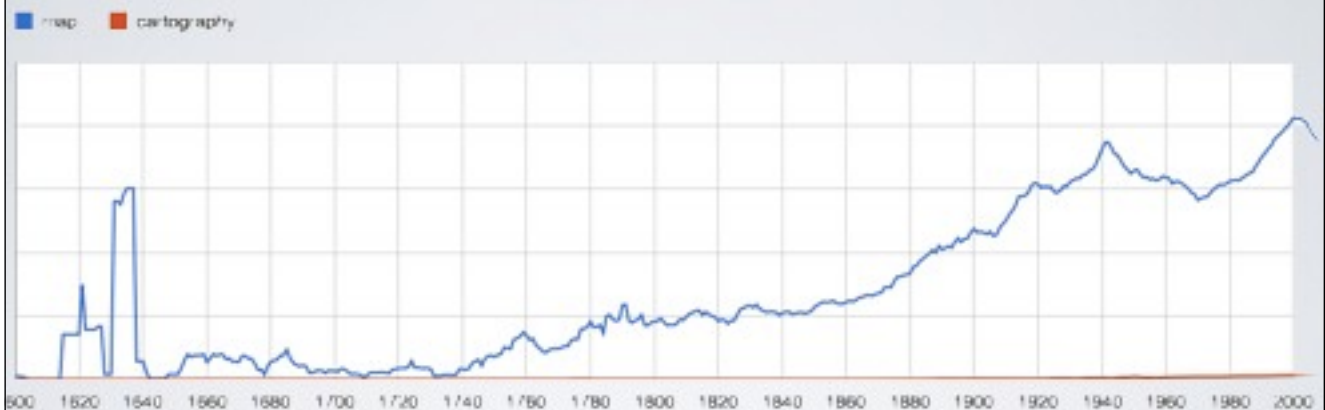
GIS Isn't Alone



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

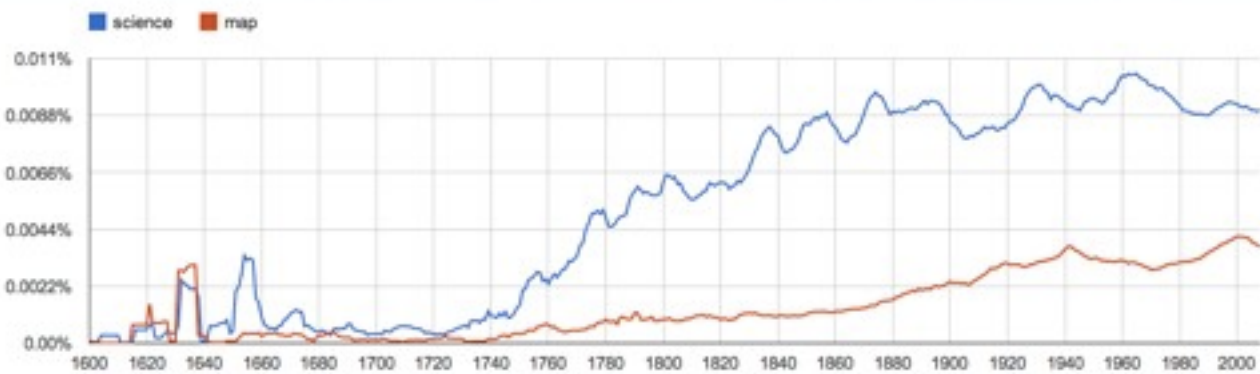


INFRASTRUCTURE

Recently A Much More Important Term

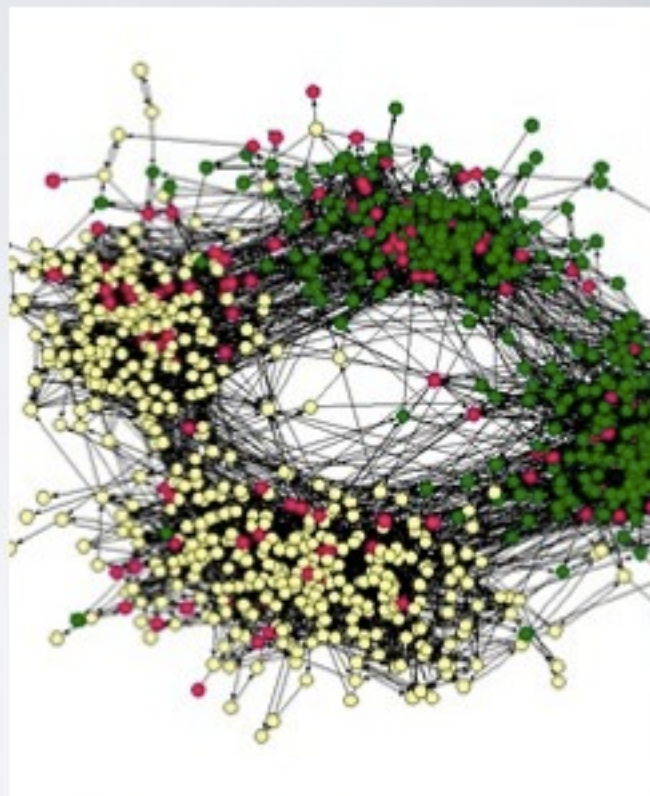


GIS IN SCIENCE'S FUTURE



FOURTH PARADIGM

- Data Intensive Scientific Discovery



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

SCIENTIFIC PROGRESS WILL COME FROM WORKING WITH DATA

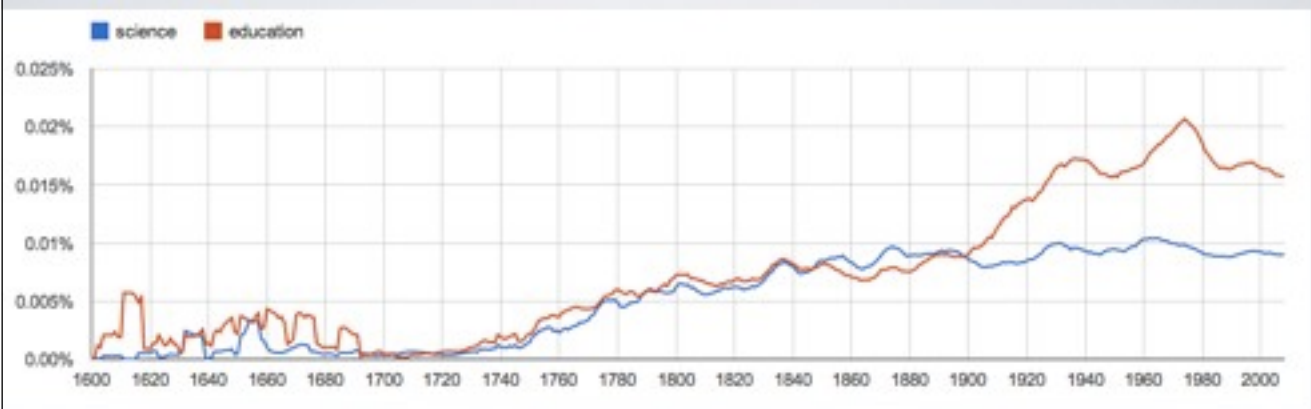
- GIS becoming a fundamental technology for working with data
- Big Data in the media
 - ITa meets science
- Look at seven aspects (domains) of changing GIS uses in data-based scientific discovery



Complexity of planetary life-interactions

<http://www.sarthine.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

INCITS 455 - 2009

GeoTIF

HEF 5

INCITS 145 - 1996

Architecture & Framework

ISO 19101 - Reference Model

ISO 19101-2 - Reference Model-Imagery ISO 19103 - Conceptual Schema Language ISO

ISO 19104 - Technology

ISO 19105 - Conformance and Testing

ISO 19106 - Profiles

ISO 19107 - Cross-domain Vocabularies ISO 19108 - Ontology

ISO 19109 - Place Identifier Architecture

ISO 19110 - Data Content & Definitions

ISO 19111 - Methodology for Feature Cataloguing

ISO 19112 - Metadata

ISO 19113-2 - Metadata for Imagery and Gidded Data

ISO 19126 - Feature Concept Dictionaries and Registers

ISO 19139 - Metadata XML Schema Implementation

OGC 01-094 - Classification Systems-Part 1: Classification System Structure ISO 19144-2 -

Classification Systems-Part 2: Land Cover Classification SystemCore Data Model

ISO 19107 - Spatial Schema

ISO 19108 - Temporal Schema

ISO 19109 - Rules for Application Schema

OGC 05-017 - Metadata

ISO 19137 - Municipal Identifier Coding Standard

ISO 19141 - Core Profile of the ISO 19103 Schema

ISO 19149 - Rights Expression Language for Geographic Information ISO 19152 -

Geoposition Domain Model

ISO 19153 - Geospatial Digital Rights Management Reference Model ISO 19158 -

Classifications & Measurements

OGC 01-094 - Data Exchange Formats TIF Revision 5.0

ISO 19115 - Metadata

OGC 01-094-2 - Metadata for Imagery and Gidded Data ISO 19118 - Encoding

ISO 19136 - Geography Markup Language

OGC 05-078-1

Data Interchange and Services

ISO 19116 - Positioning Services

ISO 19117 - Portrayal

ISO 19119 - Services

OGC 05-078-2 - Simple Feature Access

ISO 19120 - Simple Feature Access

ISO 19121 - Web Map Server Interface

ISO 19122 - Location Based Service-Reference Model

ISO 19123 - Location Based Service-Transfer

ISO 19124 - Location Based Services-Multimodal Routing and

Navigation ISO 19135 - Procedure ISO 19136 - ISO 19135 Cor. 1:2006

ISO 19142 - Web Feature Service

ISO 19143 - File Encoding

ISO 19144 - Registry of Representations of Geographic Features

ISO 19147 - Location Based Services-Transfer

ISO 19148 - ISO 19148:2006

ISO 19149 - ISO 19149:2006

ISO 19150 - ISO 19150:2006

ISO 19151 - ISO 19151:2006

ISO 19152 - ISO 19152:2006

ISO 19153 - ISO 19153:2006

ISO 19154 - ISO 19154:2006

ISO 19155 - ISO 19155:2006

ISO 19156 - ISO 19156:2006

ISO 19157 - ISO 19157:2006

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ISO 19298 - ISO 19298:2006

ISO 19299 - ISO 19299:2006

ISO 19300 - ISO 19300:2006

ISO 19301 - ISO 19301:2006

ISO 19302 - ISO 19302:2006

ISO 19303 - ISO 19303:2006

ISO 19304 - ISO 19304:2006

ISO 19305 - ISO 19305:2006

ISO 19306 - ISO 19306:2006

ISO 19307 - ISO 19307:2006

ISO 19308 - ISO 19308:2006

ISO 19309 - ISO 19309:2006

ISO 19310 - ISO 19310:2006

ISO 19311 - ISO 19311:2006

ISO 19312 - ISO 19312:2006

ISO 19313 - ISO 19313:2006

ISO 19314 - ISO 19314:2006

ISO 19315 - ISO 19315:2006

ISO 19316 - ISO 19316:2006

ISO 19317 - ISO 19317:2006

ISO 19318 - ISO 19318:2006

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.dvax.com/2013-2-13/under-armour-shows-interactive-running-suit-future>



<http://abcnews.go.com/blogs/headlines/2013/08/baby-monitor-hacking-arms-law-suits-parents/>

CONNECTIVITY IN N-DIMENSIONS

Found 49 points of interest



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



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

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