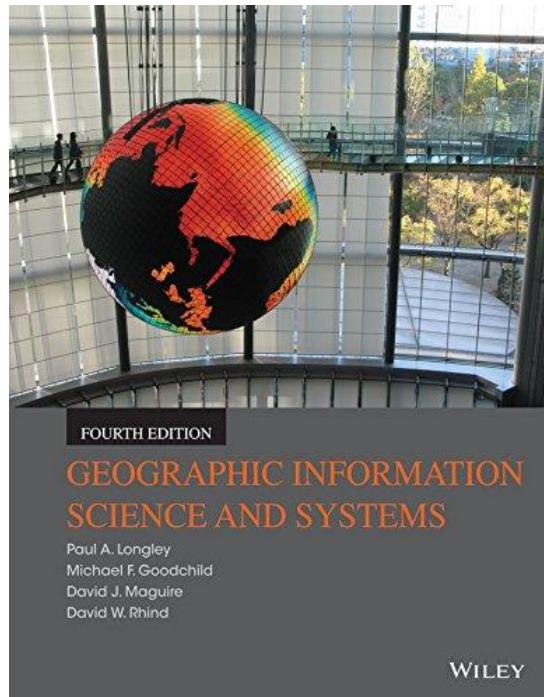




# 1. Systems, Science, and Study





# Learning Objectives

- Know definitions of the terms used throughout the book, including geographic information (GI)
- Be familiar with a brief history of GI technology
- Recognize the sometimes invisible roles of GI in everyday life, business, and government
- Understand the significance of GI science, and how it relates to GI systems
- Understand the many impacts GI technologies and their underpinning science are having on society and the need to study those impacts.



# Outline

- Introduction: What are GI science and systems and why do they matter?
- Data, information, knowledge, evidence, wisdom
- GI science and systems (GISS)
- The technology of problem-solving
- The disciplinary setting of GISS
- GI science and spatial thinking
- GI systems and science in society



# What is a Geographic Information System?

- **Geographic** – relates to a specific place on or in relation to the Earth's surface
- **Information** – is data to which some value or interpretation has been added. In GI, the information relates to measurements, maps, images, sounds etc. of the Earth's surface
- **Systems** – a system designed to perform a wide range of functions on and with GI



# The Importance of Location

- Geographic location is an important attribute of activities, policies, strategies, and plans.
- *Geographic problems* involve an aspect of location, either in the information used to solve them, or in the solutions themselves



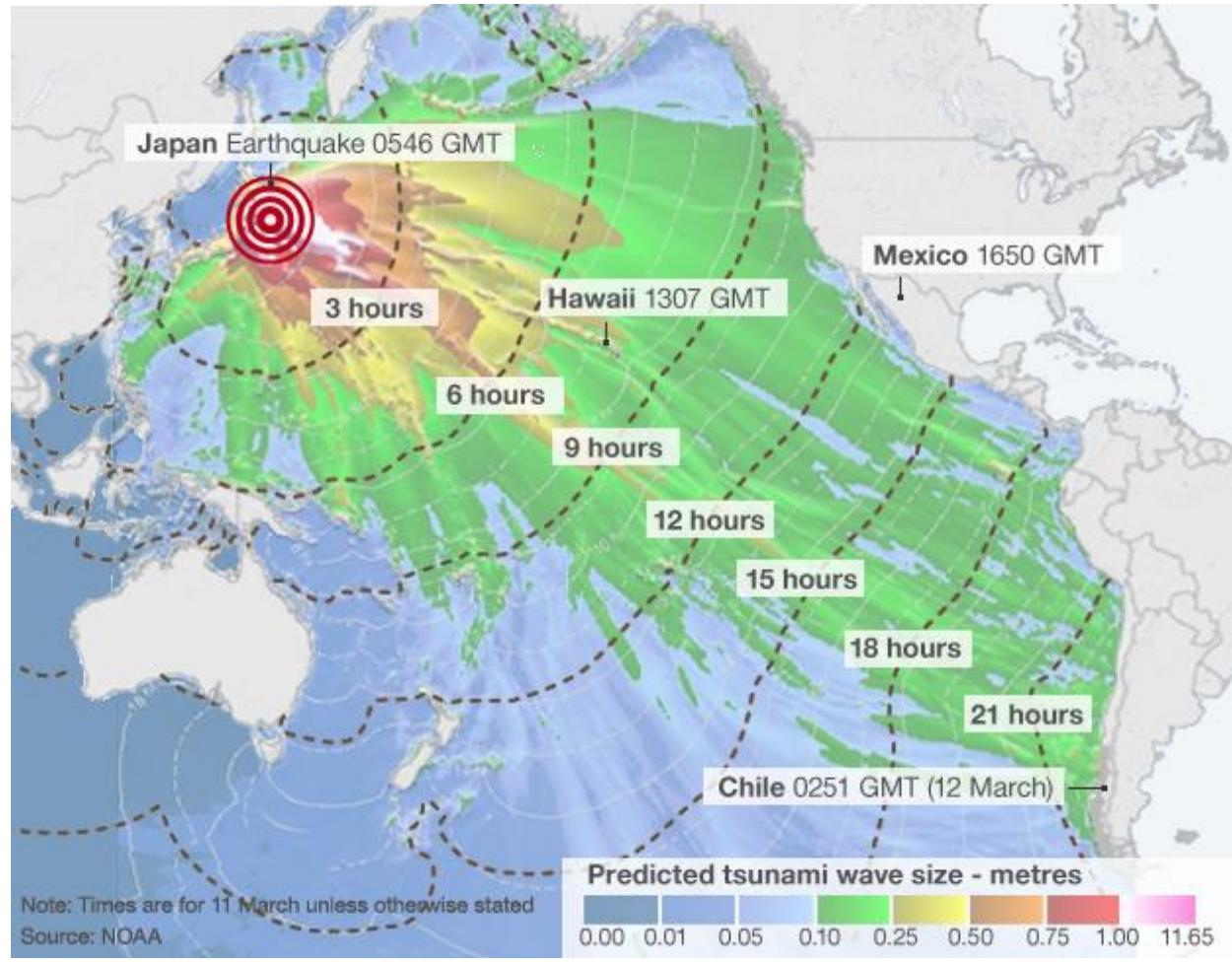
# The Importance of Location





# The Importance of Location

- Tōhoku earthquake and tsunami
- GI science and systems are integral to response and recovery

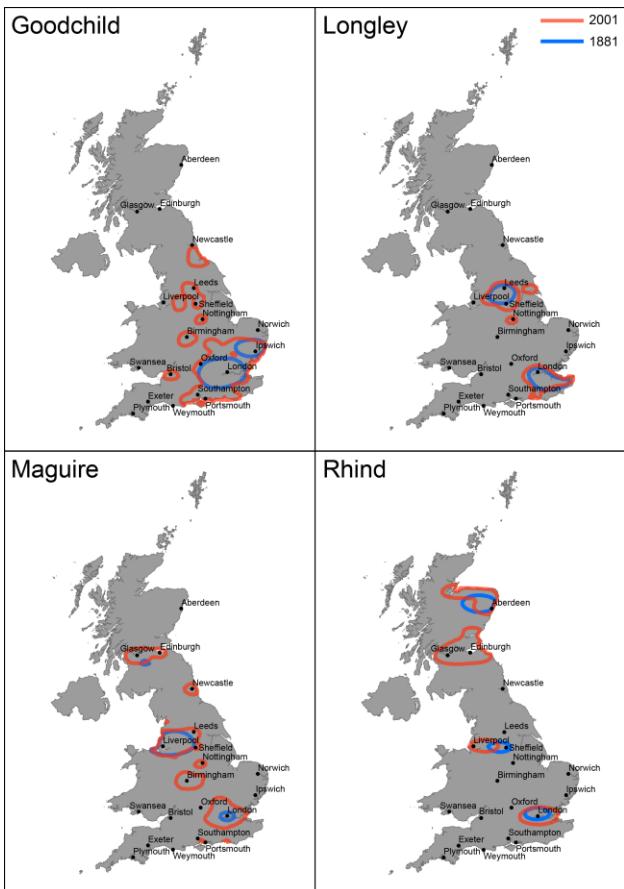


Source: NOAA



# The Importance of Location

- Researching family histories and geo-genealogy illustrates curiosity-driven research



Courtesy: James Cheshire



# Spatial is Special

- **Geographic:** the Earth's surface and near-surface
- **Spatial:** any space (not just the space of the Earth's surface)
- **Spatial Analysis:** application of techniques (in GI technology) to geographic and non-geographic spaces
- **Geospatial:** (subset of spatial, applied specifically to the Earth's surface and near-surface)

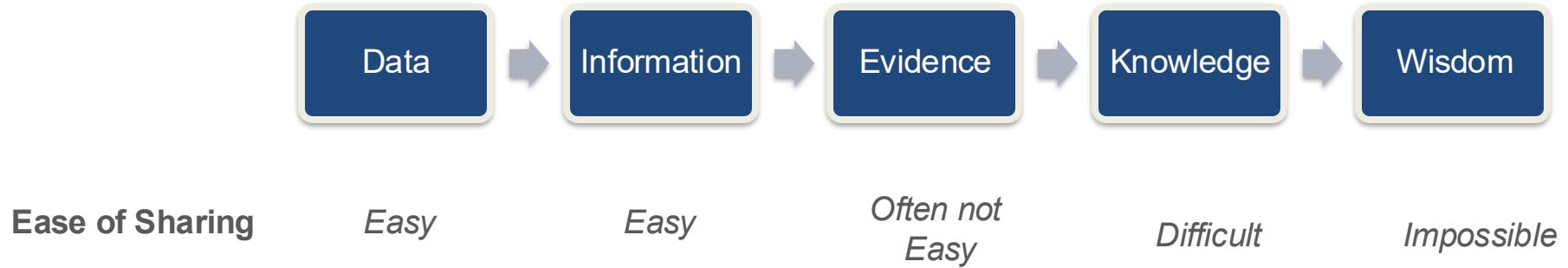


# Spatial is Special

- **Why is spatial special?** (Industry, hundreds of courses, millions pounds etc.)
  - almost all human activities and decisions involve an important **geographic component**
  - Crucial to understanding both **physical** and **human geography**
  - working with geographic information involves **unique, complex** and **difficult choices**
  - **For example...**

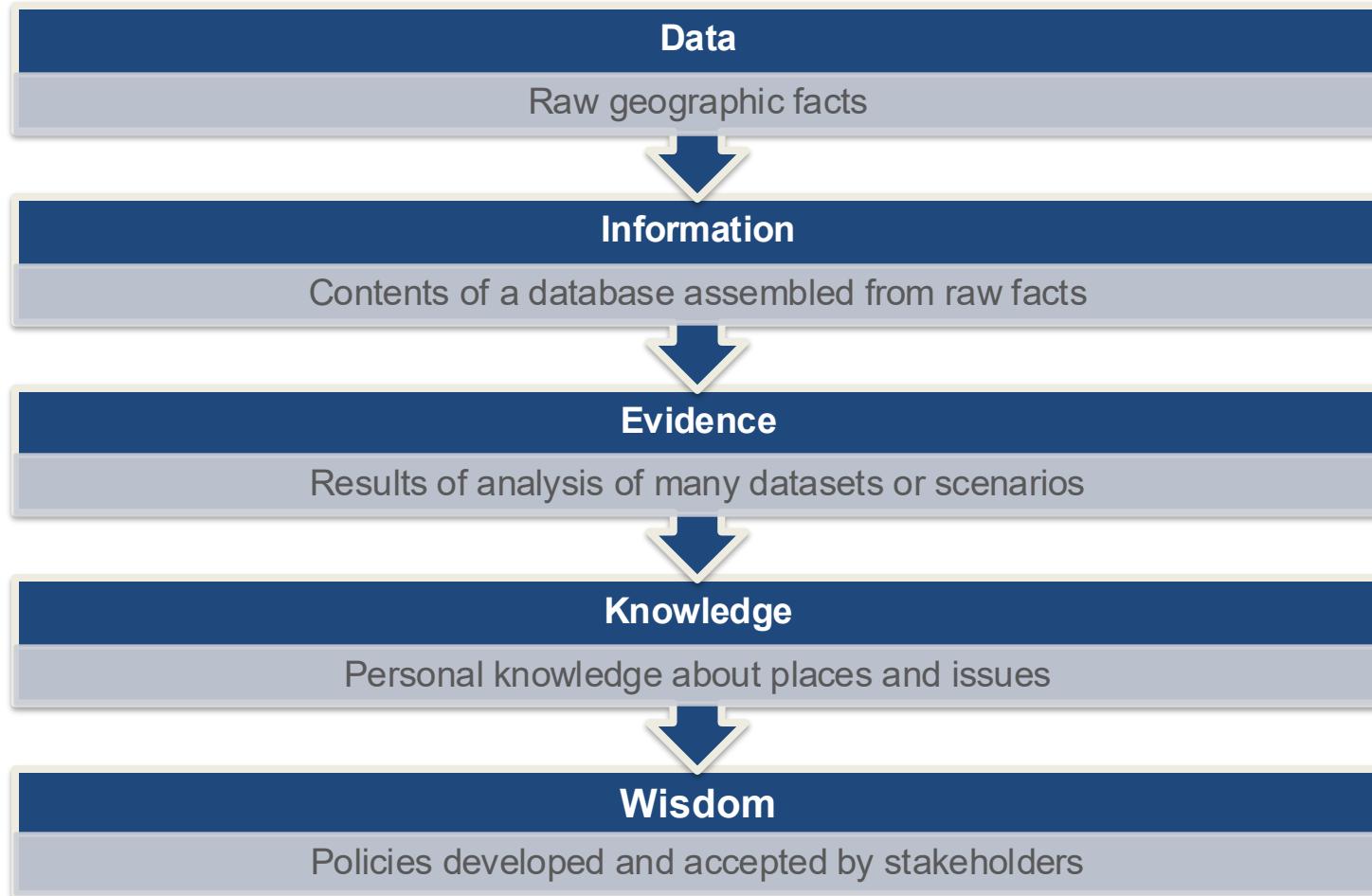


# Decision-Making Support Infrastructure



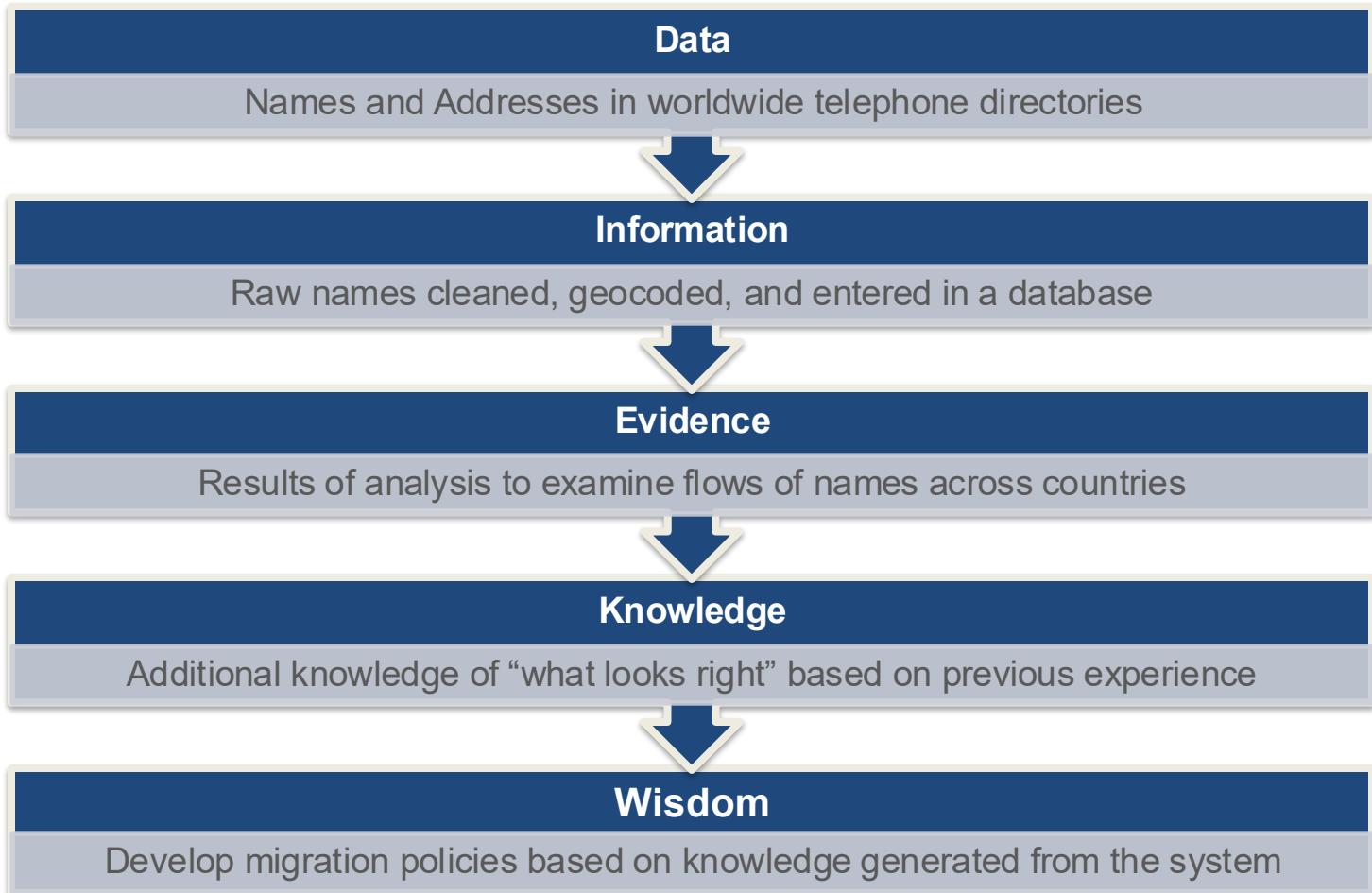


# Decision-Making Support Infrastructure





# Example...





# What are Information Systems?

- **Knowledge** is information to which **value** has been added by **interpretation** (*particular context, experience, purpose*)
- Information becomes **knowledge** only when it has been **read and understood**



# What are Information Systems?

- Information systems help us to manage “**what we know**”...
  - **organize** and **store**
  - **access** and **retrieve**
  - **manipulate** and **synthesize**
  - apply to the solution of **problems**
- **Data** are numbers or text (almost context-free)
  - raw geographic facts
    - e.g., a temperature at a given location
  - transmitted as a stream of bits
    - Binary – 1,0



# What are Information Systems?

- **Information** has multiple definitions
  - Narrow...
    - essentially synonymous with data
  - Broad...
    - **Processed**: anything which can be represented in digital form – but different from data as implies **selection**, **organization**, and **preparation** for purpose



**Knowledge about how the world works is more  
valuable than knowledge about how it looks,  
because it can be used to predict**



# The Science of Problem-Solving

- Form varies geographically, but processes can be very general
  - (landscapes vs. effects of burning fossil fuels)
- Reflects traditions in academic geography:
  - **idiographic** focuses on the description of form and unique characteristics of places
  - **nomothetic** seeks to discover general processes

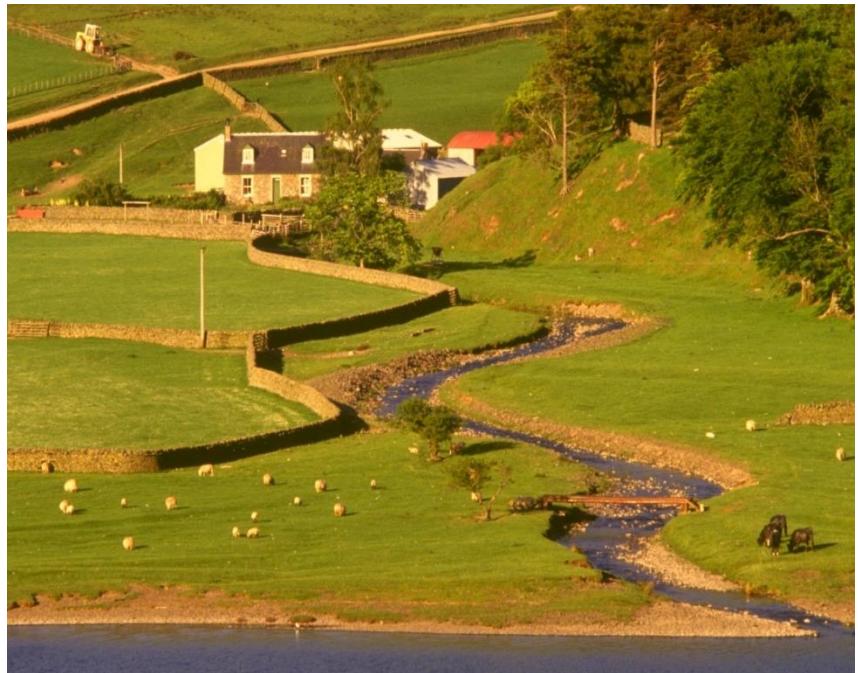


# The Form of the Earth's Surface Shows Enormous Variability (Idiographic)

**Southwest USA**



**Northern England**





# The 6 Components of a GI system

- Hardware
- Software
- Network
- Data
- People
- Procedures





# The Technology of Problem Solving

GI technology is a combination of:

- a software product, acquired to perform well-defined functions (***GI software***)
- digital representations of aspects of world (***GI***)
- a community of people who use these tools for various purposes (the ***GI community***)
- the **activity** of using GI systems to solve problems or advance science (***'doing GIS'***)



# The Disciplinary Setting of GI Science and Systems (GISS)



# Brief History of GI Technology...

- Mid 1960s - the first GI system was the **Canada Geographic Information System**
  - Mid 1960s computerized mapping system
  - Land-use management
  - Resource monitoring
  - Regulatory procedures
- Late 1960s U.S. Bureau of the Census developed **DIME** (Dual Independent Map Encoding)
  - Digital records of all US streets, for automatic referencing and aggregation of census records



# Brief History of GI Technology...

- Early GI system developers recognized that the same basic needs were present in many different application areas, from resource management to the census
- Harvard University – Laboratory for Computer Graphics and Spatial Analysis
  - Developed general-purpose GI system – 1970s ODYSSEY GIS



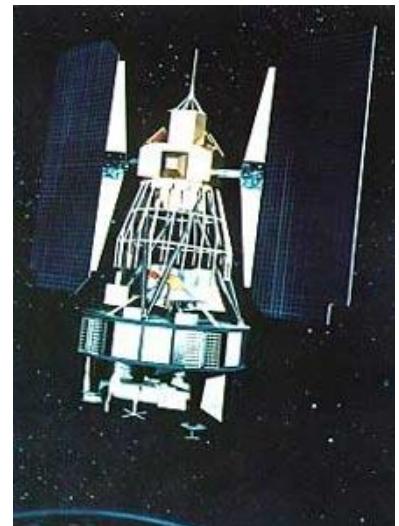
# Brief History of GI Technology...

- Separate needs of cartographers and mapping agencies
  - The quest to reduce the cost and time of map production
  - Computer support for map editing
  - Partial computerization of cartographic agencies by the late 1970s
  - Great Britain – first country with national digital map coverage (1995)



# Brief History of GI Technology...

- Role of remote sensing
  - military satellites of the 1950s  
→ early 1970s civilian systems
  - military needs also developed the GPS
  - many technical developments originated in the Cold War



Landsat 2



# Brief History of GI Technology...

- Early 1980s take-off (hardware prices could sustain software industry) \$250,000 computers and \$100,000 software (large-scale resource managers)
- The modern history of GI technology dates from the early 1980s, when the **price of sufficiently powerful computers fell below a critical threshold**



# The Business Perspective

- Includes
  - The software industry
  - The data industry
  - The GI services



# Computer-Science and Information-Science Perspectives

- Information science is a broad multidisciplinary area with a practical focus upon the collection, classification, manipulation, storage, retrieval, analysis, movement, and dissemination of information.
- Raise questions of GI as a fundamental part of computer sciences, or class of applications



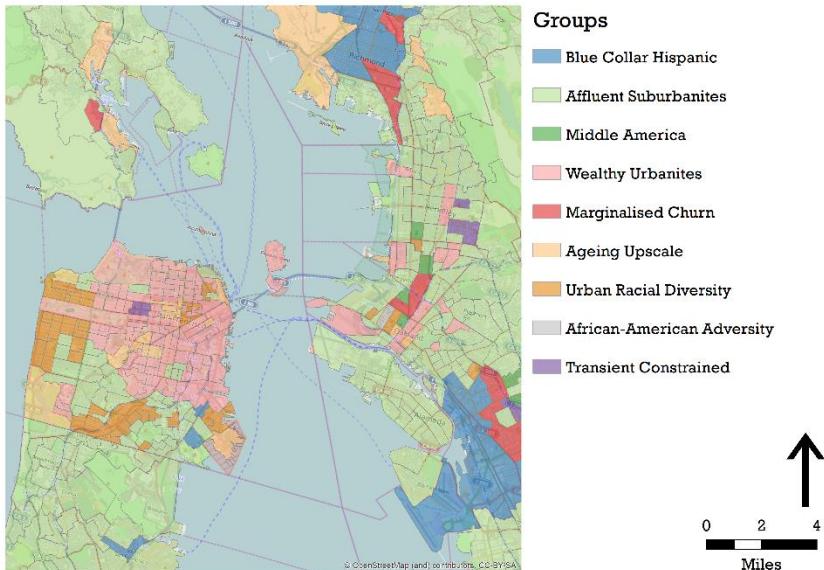
# The Government Perspective

- Public-sector information (PSI) is often expensive to initially produce, but then cheap to reproduce
- Open Data – data which can be used, re-used, and re-distributed freely by anyone, subject only at most to the requirement to attribute and share-alike

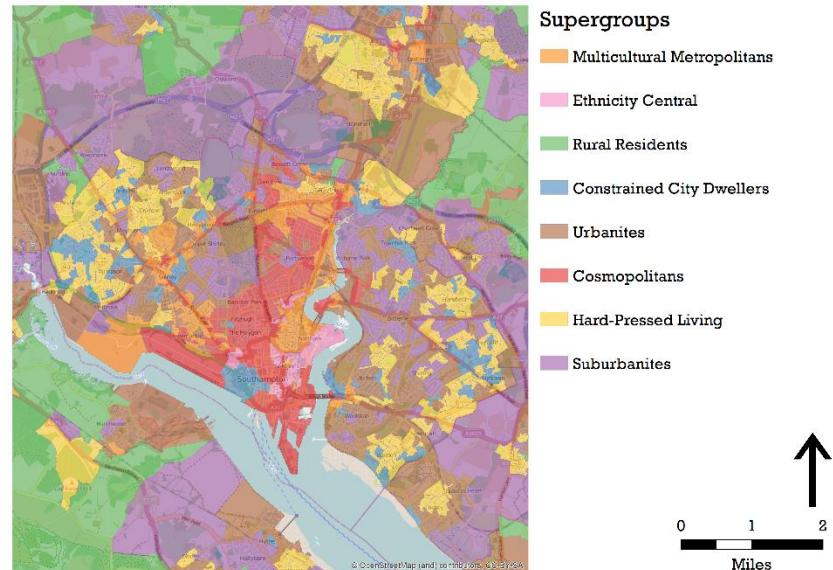


# The Geography Perspective

Geodemographic neighborhood classifications make it possible to quantify how similar one place is to another, subject to the availability of consistent data across a jurisdiction.



A classification based on 2010 U.S. Census data, showing part of San Francisco

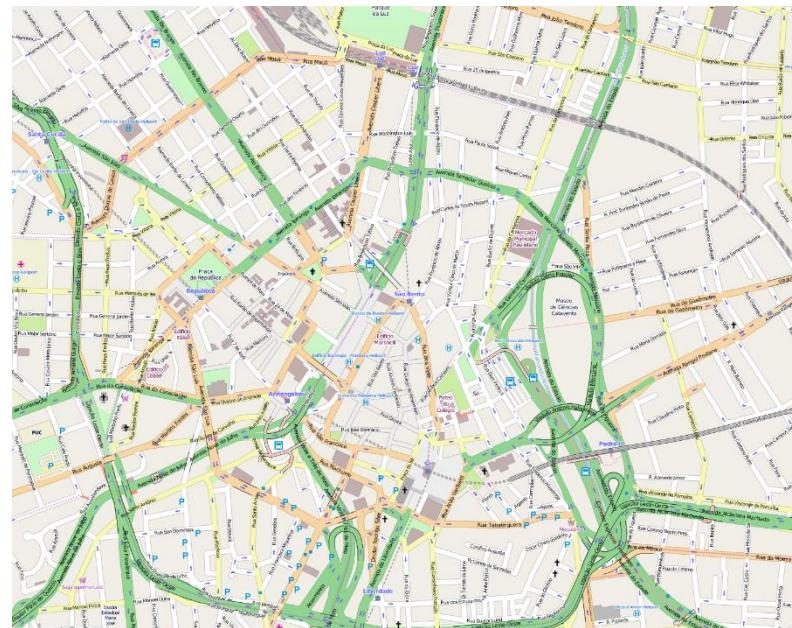


The UK 2011 Output Area Classification, showing part of Southampton



# Neogeography

- Neogeography to describe developments in Web mapping technology and spatial data infrastructures that have greatly enhanced our abilities to assemble, share, and interact with geographic information online.
- Open-StreetMap is a free-to-use global map database which has been created through assimilation of digitized satellite photographs with GPS tracks supplied by volunteers



Source: OpenStreetMap



# The Societal Perspective

- Today we are rarely if ever cognizant that we are ‘doing GIS’
- “Internet behemoths foist use of cookies on us users that betray our locations and many characteristics of our online identities, and we may resent the sophistication of the resulting advertising that is targeted upon us”
- However, there is enduring unease in some academic quarters about GIS applications and their social implications, including
  - GIS favors certain phenomena and perspectives
  - Often used for purposes that may be ethically questionable or invade individual privacy
  - Concern about a field led by the technology and the marketplace rather than human need (as articulated by academics)
  - Exclusively a positivist tool and a normative tool



# A Tool or a Science?

- GI systems = a technology for collecting, managing, storing, analysing, and visualizing geographic information
- GI science = a fundamental field of study which examines the representation, storage, analysis, and visualization of geographic information (Longley et al, 2005)



# Conclusions

- GI Systems are systems used to handle data pertaining to geographic locations
- Information systems help us manage and interpret data
- Spatial information is important as almost all human decisions involve a spatial component
- Knowledge about how the world works is more valuable than knowledge about how it looks, because it can be used to predict