Geographic Information Science and Technology

Overview of Geospatial Computing at Oak Ridge National Laboratory

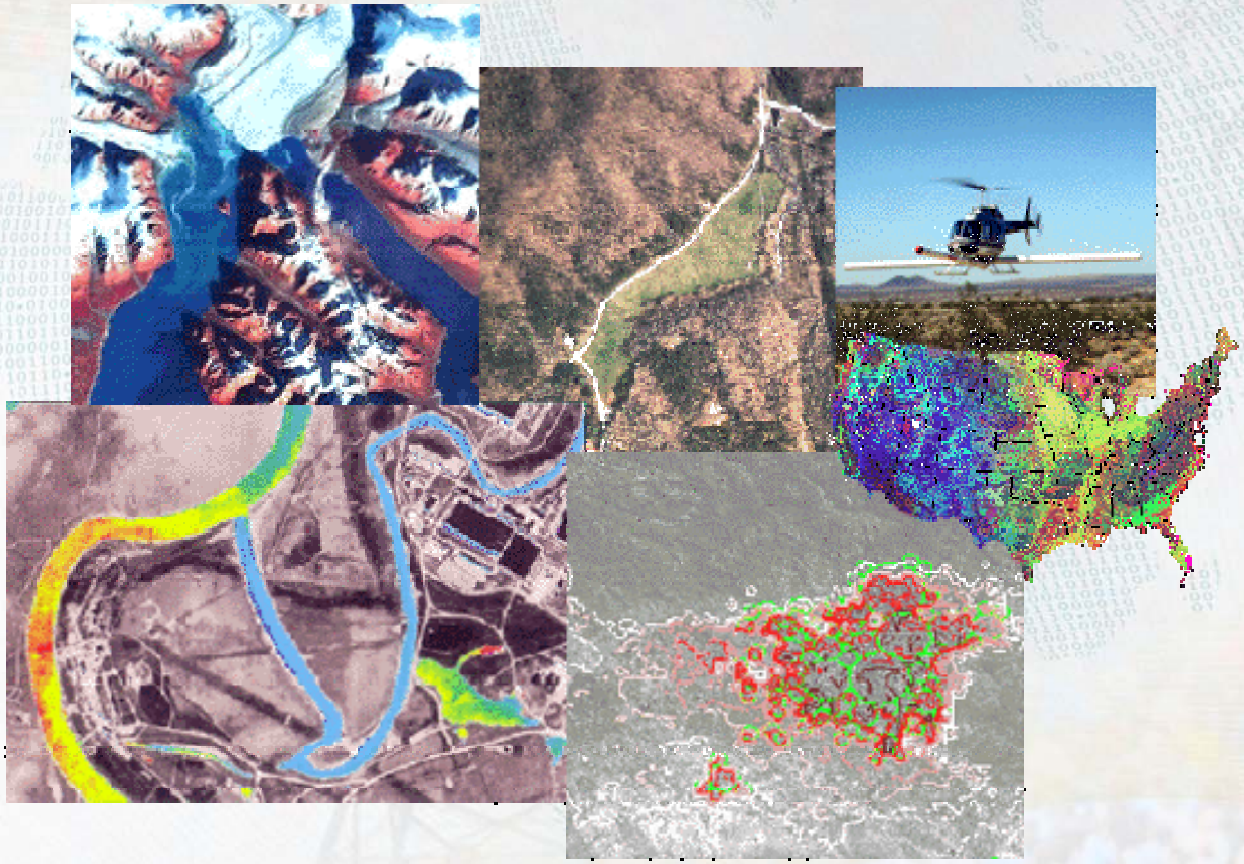
Budhendra Bhaduri

Managed by UT-Battelle
for the Department of Energy

OAK RIDGE National Laboratory

ORNL: A pioneer in Geospatial Science and Technology

Geographic Information Science and Technology



Rich History Spanning 35 years

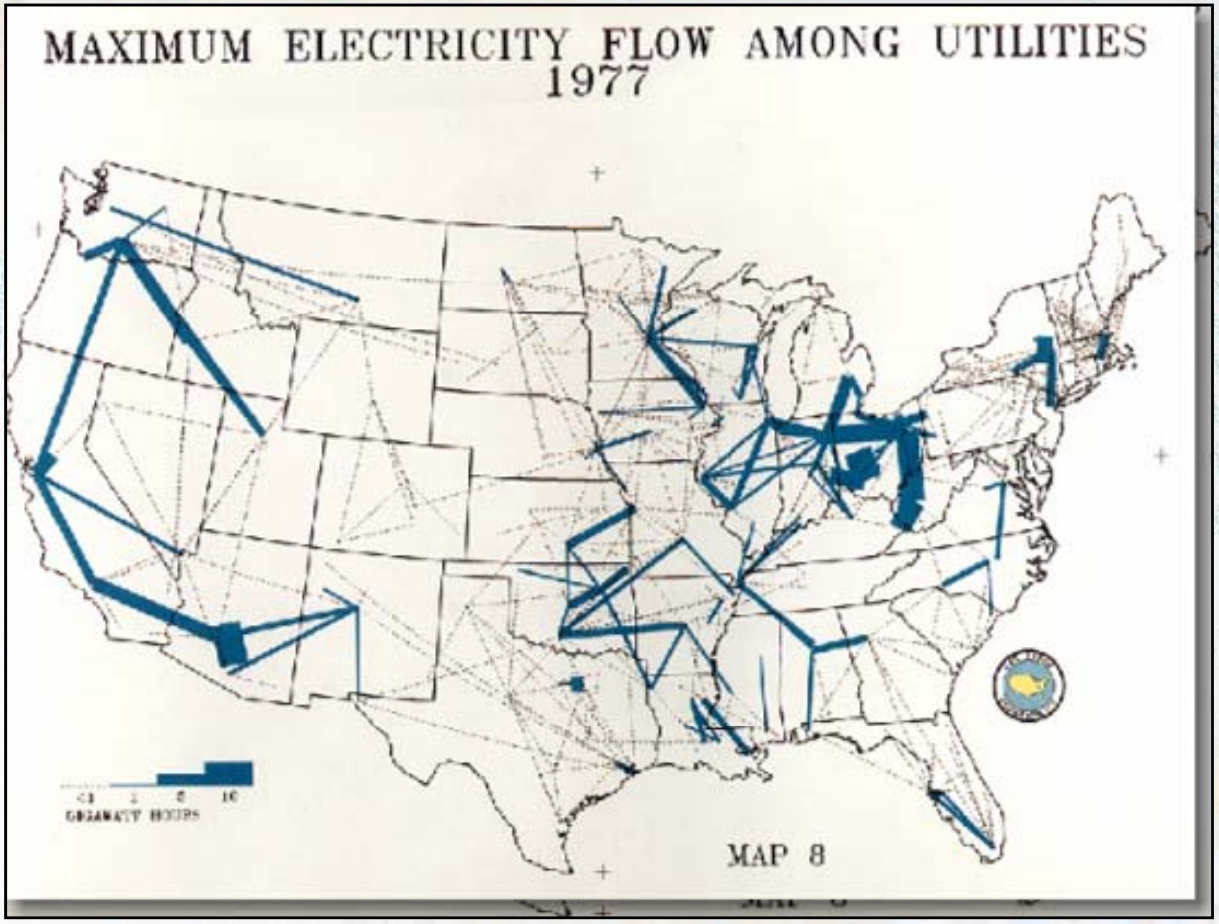
Defining Geospatial Research Agendas

Developing New Algorithms, Software, and Data

Conducting Verification & Validation Studies

Geospatial Legacy

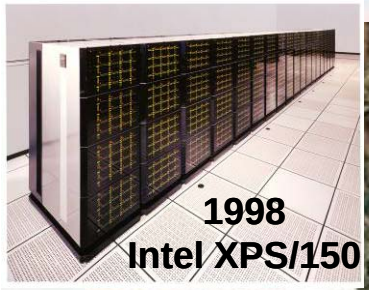
Geographic Information Science and Technology



1977
Energy Flow Among Utilities

High Performance Geocomputation

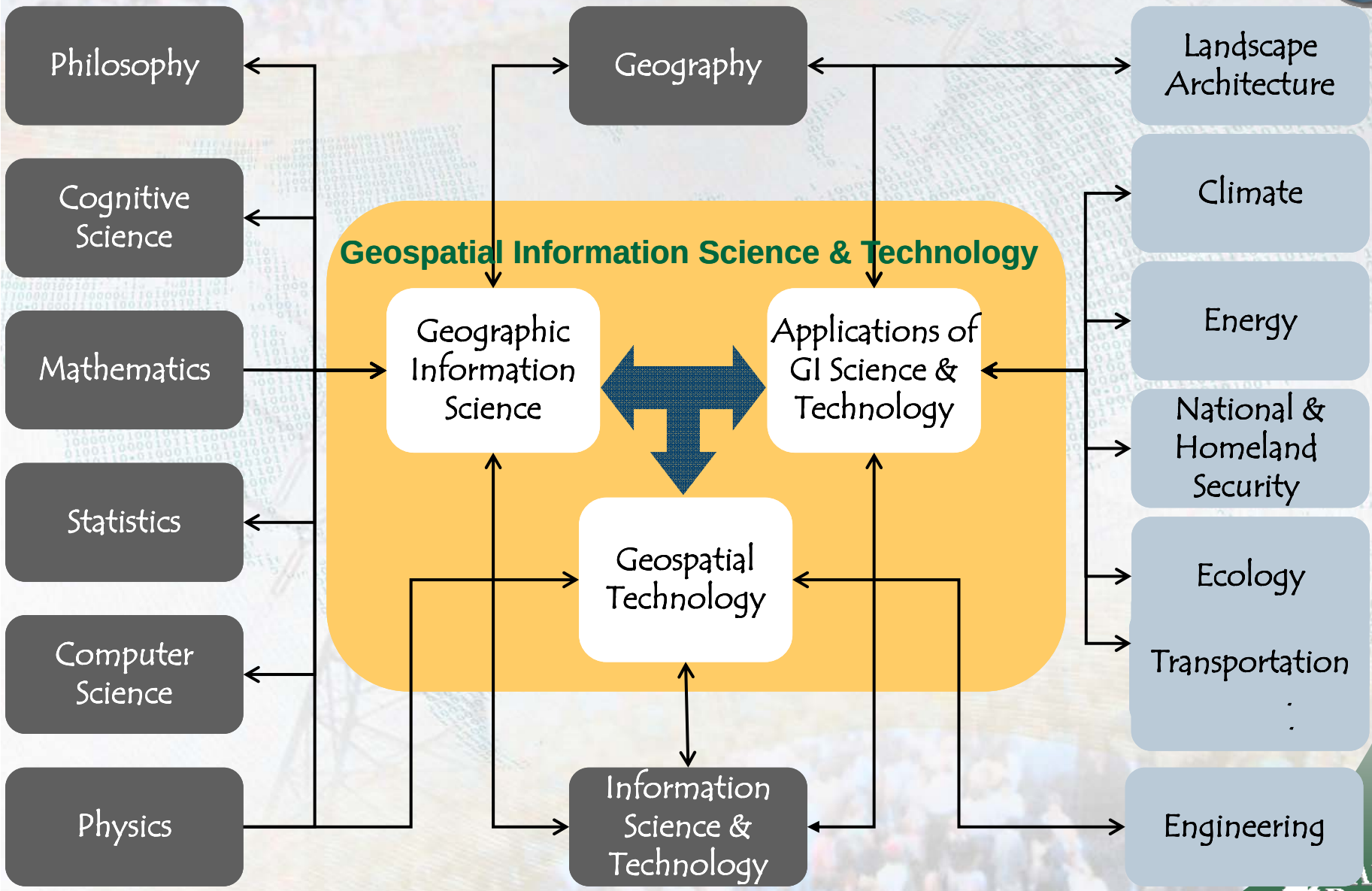
Geographic Information Science and Technology



Oak Ridge Reservation After Color Balancing

Cross-disciplinary Approach Fosters Innovation

Geographic Information Science and Technology



Geographic Information Science & Technology

Geographic Information Science and Technology

Staff Members

B. Bhaduri, Ph.D. Earth Sciences
E. A. Bright, M.S., Geography
P. R. Coleman, M.S., Mathematics
S. J. Fernandez, Ph.D., Analytical Chemistry
R. E. Flanery, Jr., M.S., Mathematics
A. R. Ganguly, Ph.D., Civil Engineering
D. J. Getman, M.S., Remote Sensing and GIS
A. Y. Hamby, B.S., Organizational Management
P. E. Johnson, M.S., Geography
A. L. King, B.A., History
D. B. Koch, Ph.D., Electrical Engineering
R. W. Lee, M.S., Computer Systems
C. Liu, Ph.D. Geography; M.S., Computer Science
R.S. Middleton, Ph.D., Geography
A.N. Rose, M.S., Geography
A. Sorokine, Ph.D., Geography
E. P. Tinnel, M.S., Computer Science
M. A. Tuttle, M.A.., Geography and Computer Mapping
M. L. Urban, M.S., Geology
R. R. Vatsavai, Ph.D., Computer Science

Research Associates

A.M. Cheriyadat, M.S., Electrical Engineering
U. Dadi, M.S., Geography
N. Datar, M.S., Computer Science
H. Li, M.A., Political Science
W. C. Jochem, B.A., Geography
L. E. Laurent, B.S., Geography
E. J. Middleton, Ph.D., Geography
A. T. Myers, M.S., Geography
Y. S. Noh, M.S., GIS
O.A. Omitaomu, Ph.D., Industrial Engineering
S. K. Peterson, Ph.D., Geography
N. Singh, M.S., Geology
M. R. Stevens, B.A., Economics & Geography
V. Vijayaraj, M.S., Electrical Engineering
D. R. Wortham, B.S., Geography

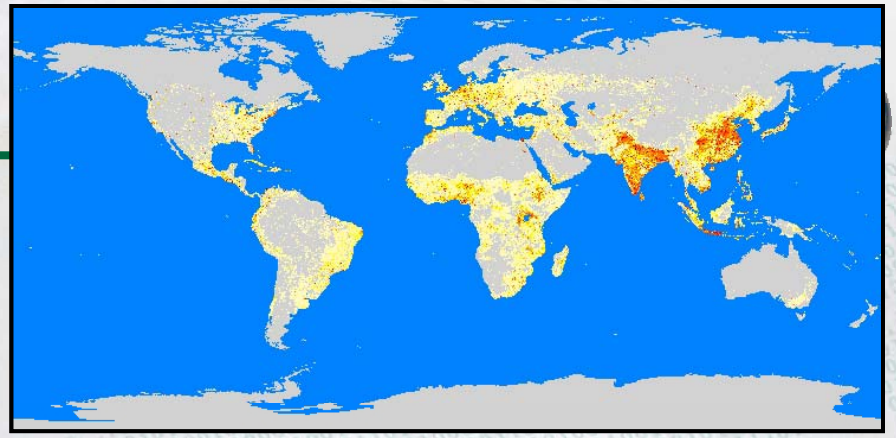
Geospatial Knowledge Discovery

Geographic Information Science and Technology

- **High Resolution Population and Social Dynamics**
  - Geographic Pattern Recognition
  - Demographic Analysis
  - Population-Infrastructure Dependency
  - Spatial Epidemiology
- **Geographic Data Sciences**
  - Geospatial-temporal Statistics and Data Mining
  - Geospatial Data Uncertainty Analysis
  - Climate Extremes
  - Landscape Process Characterization
  - Interoperability & Standards
  - Geospatial Ontology and Semantics
- **High Performance Geocomputation and Visualization**
  - Scalable Visualization
  - Parallelization
- **Development of Advanced Geospatial Tools**
  - Real Time Data Integration
  - Intuitive (HCI) Geospatial Application Development
- **Geocomputing for Transportation M&S**
  - Multimodal Route Optimization
  - Intelligent Evacuation Planning
  - Data Driven Scalable Simulations
- **Emergency Preparedness and Response**
  - Time Critical Decision Support
  - Climate Change Impacts on Critical Infrastructure
  - Disaster Risk Analysis
  - Community Resiliency

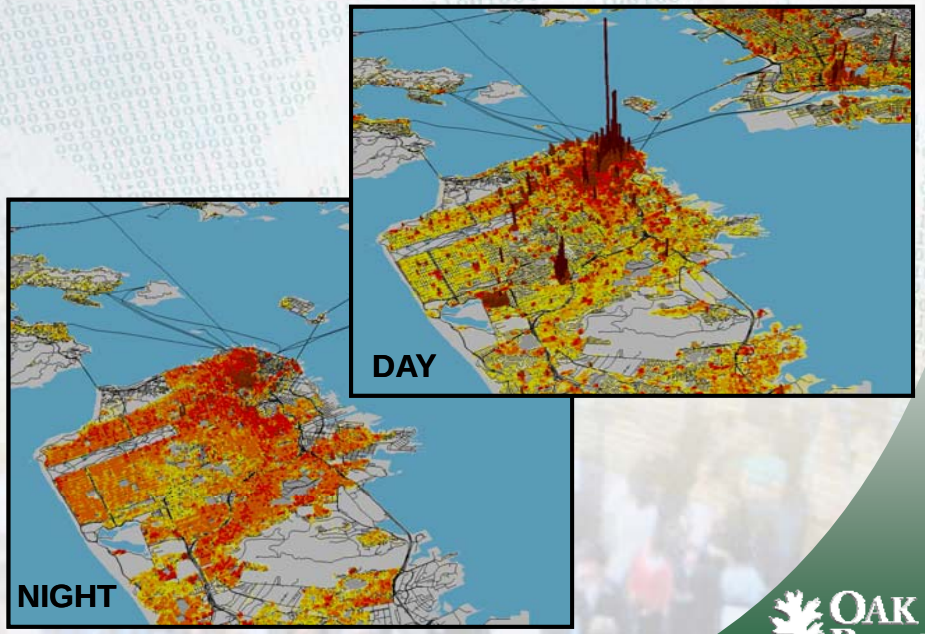
LandScan Population

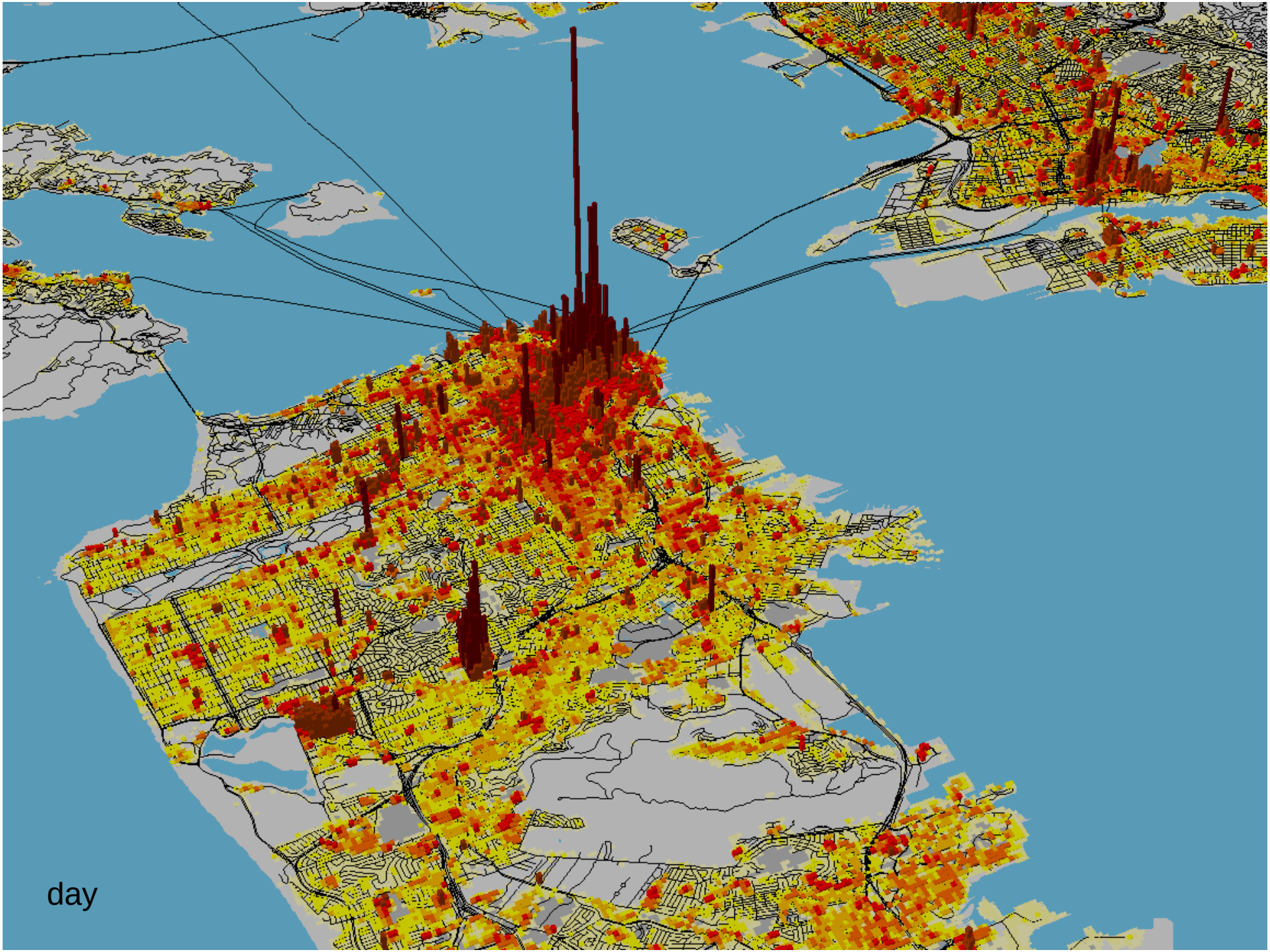
Geographic Information Science and Technology



- **Population**
  - Census Polygons; Tract-to-track worker flow; BLS quarterly updates.
- **Roads**
  - VMAP, GDT Dynamap; TIGER;
- **Railroads**
  - 1:100K national railway network
- **Land Cover/Land Use**
  - Geocover, MODIS, National Land Cover Data (NLCD); State GIS;
- **Slope**
  - DTED, National Elevation Data (NED)
- **Academic Institutions**
  - Department of Education; ESRI; GDT;
- **Prisons**
  - National Jail Census
- **Hospitals**
  - American Hospital Association (AHA)
- **Business Employment**
  - InfoUSA
  - Dunn and Bradstreet
- **Ortho Imagery**
  - EarthViewer; Terra Server, Google

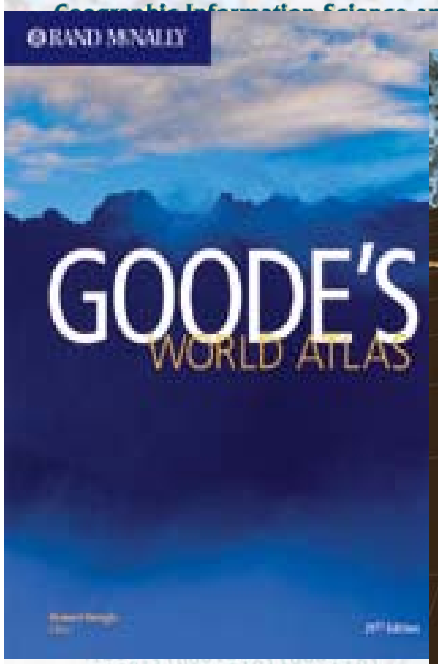
Improving Knowledge of Population Dynamics

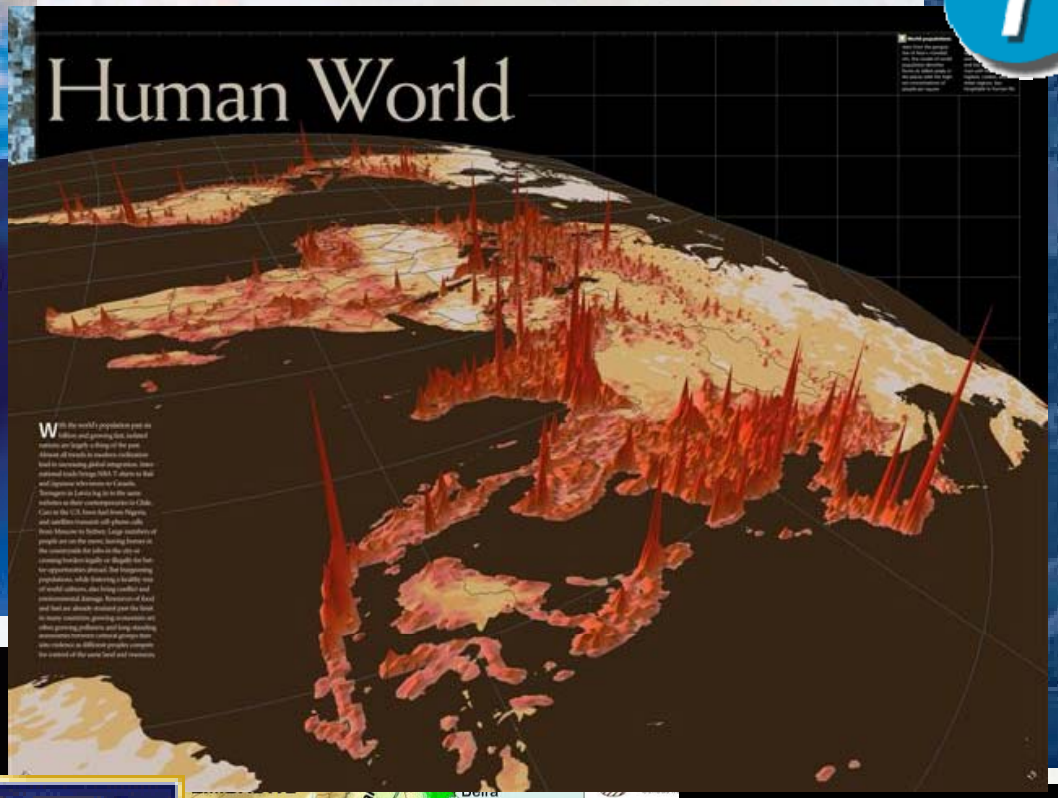


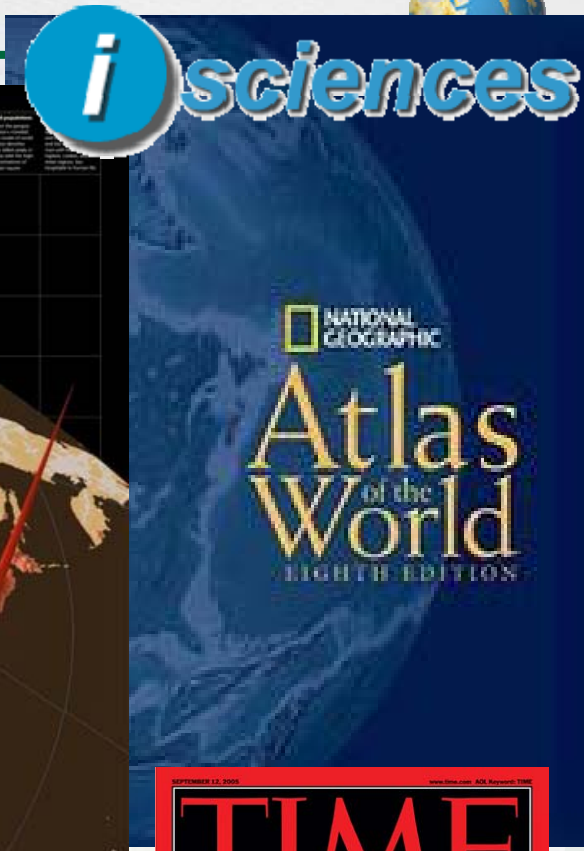

day

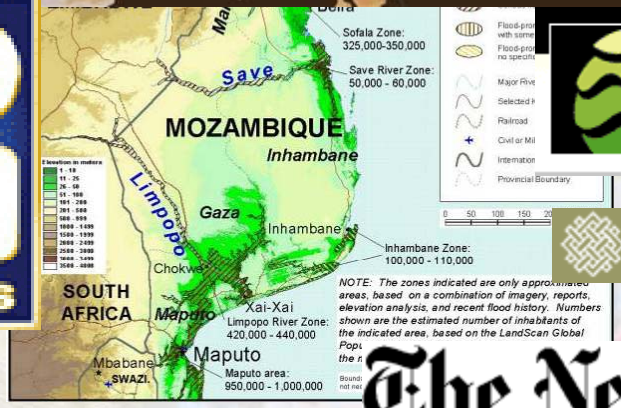
Community Standard for Population

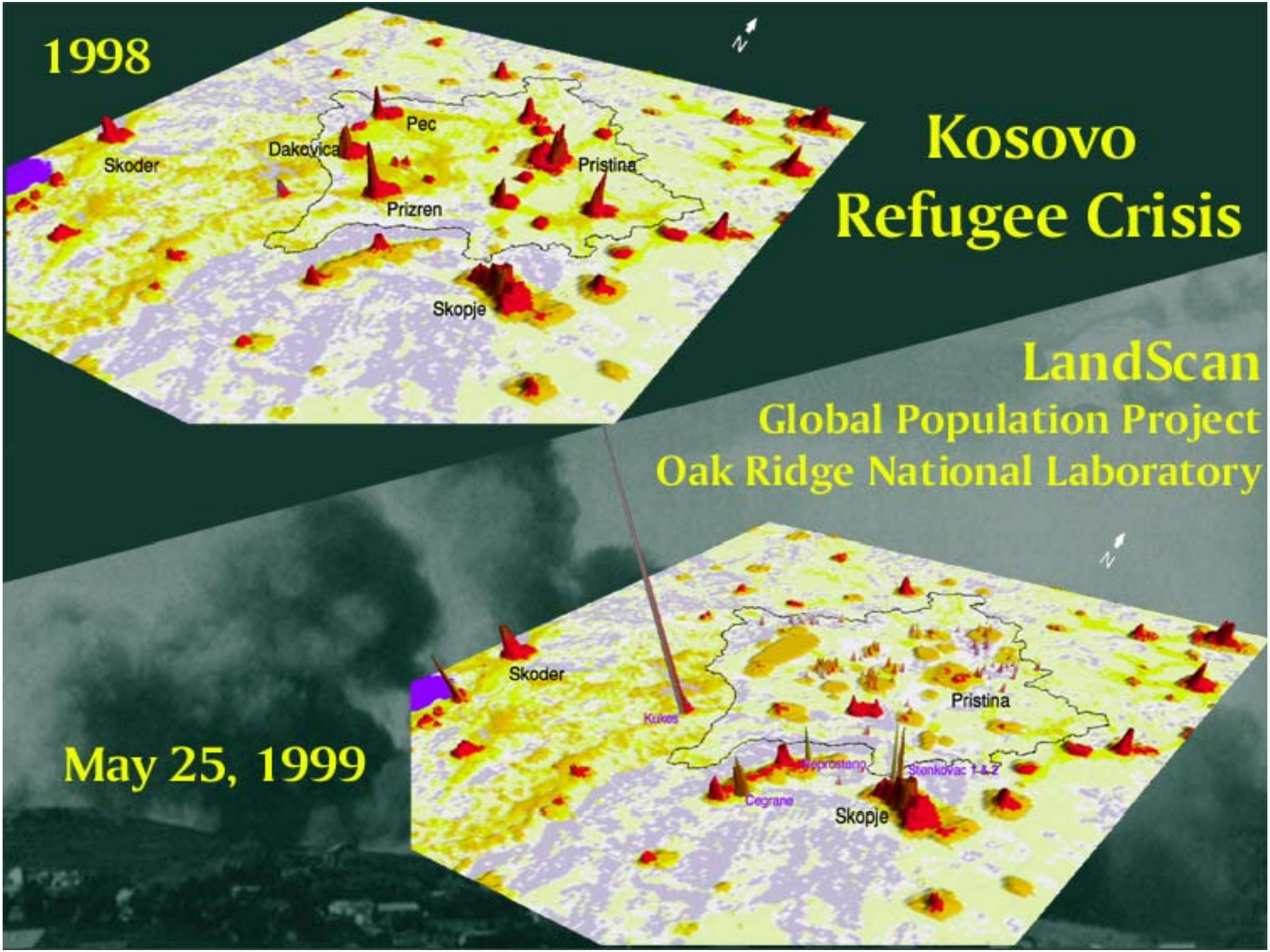
Technology





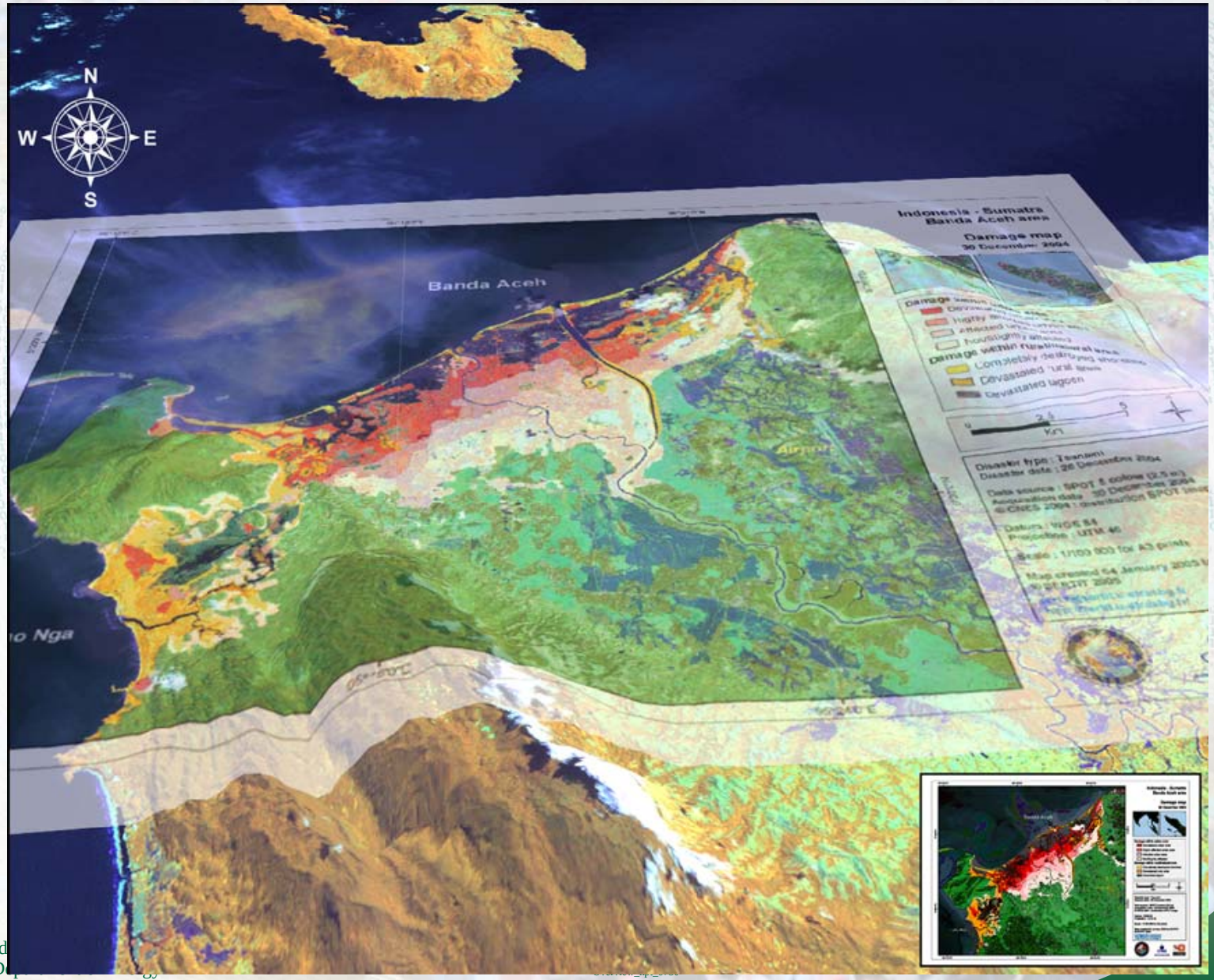





1998
Pec
Dakovica
Skoder
Pristina
Prizren
Skopje
Kosovo
Refugee Crisis
LandScan
Global Population Project
Oak Ridge National Laboratory
May 25, 1999
Skoder
Kukes
Pristina
Cegrane
Skopje

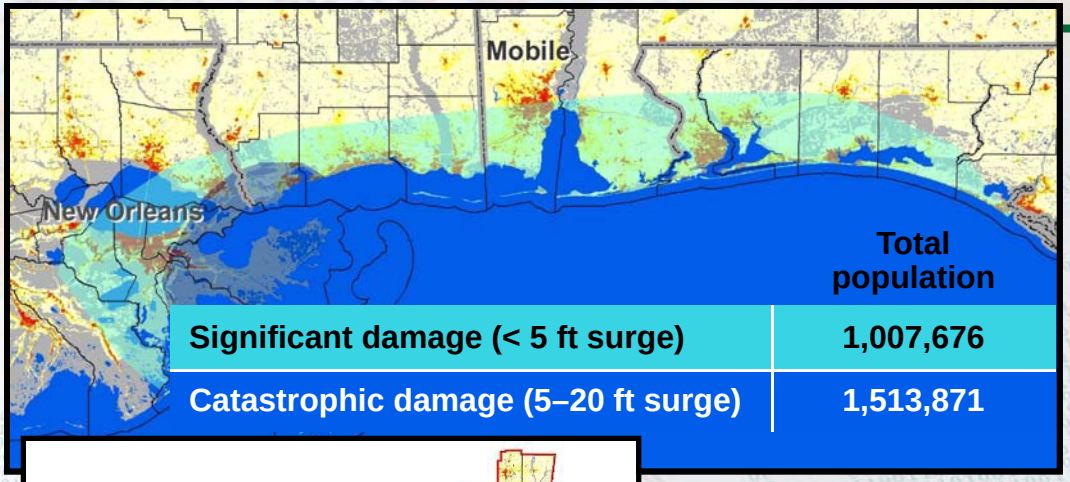
2004 Tsunami Response

Geographic Information Science and Technology

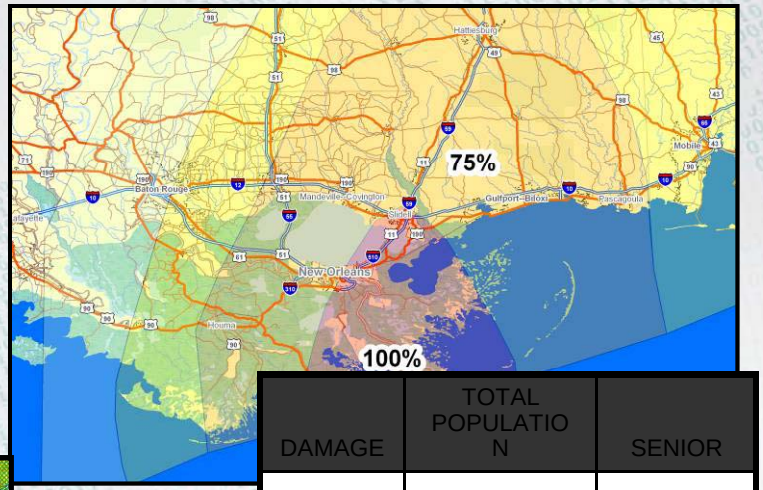


OAK RIDGE National Laboratory

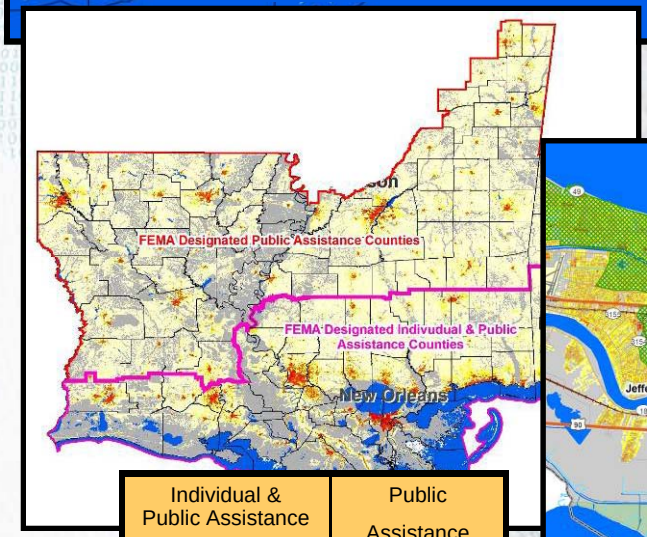
Hurricane Preparedness and Response



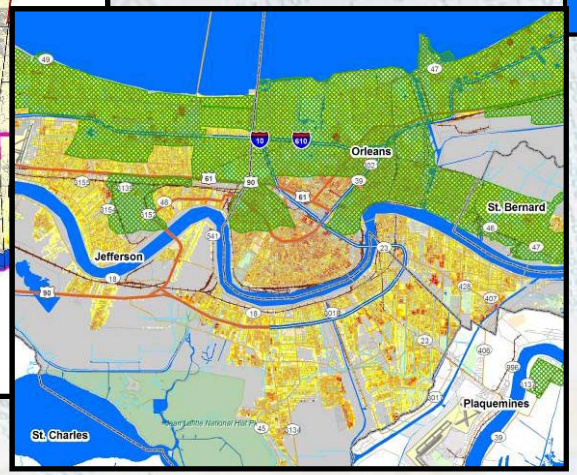
	Total population
Significant damage (< 5 ft surge)	1,007,676
Catastrophic damage (5–20 ft surge)	1,513,871



DAMAGE	TOTAL POPULATION	SENIOR
100%	791,361	90,773
75%	1,594,806	187,677
50%	1,505,196	184,372
25%	1,701,593	224,279
Total	5,592,956	687,101



	Individual & Public Assistance	Public Assistance
Alabama	575,133	56,801
Mississippi	707,506	1,391,233
Louisiana	3,153,293	1,362,477



FEMA Impacted Areas

Source: FEMA Impacted Areas, August 31, 2005

A Day in America

Geographic Information Science and Technology

GOING TO WORK

VISUALIZING RUSH HOUR

The U.S. has **303 million** people

242 million live in a city or suburb

141 million work outside the home

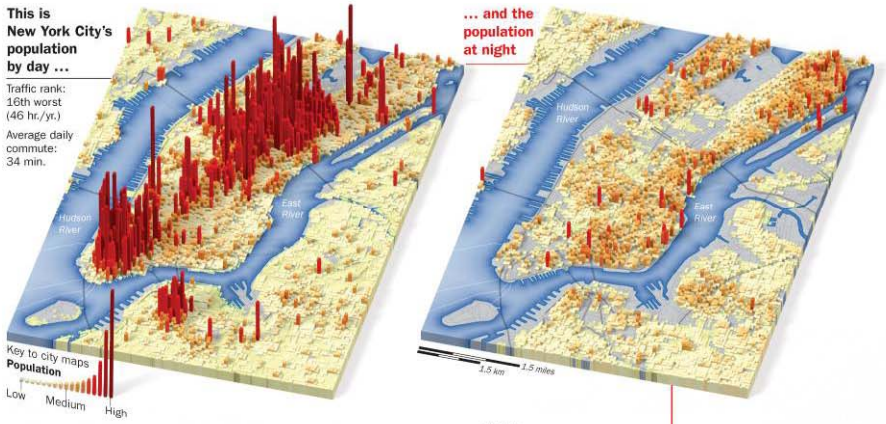
107 million drive to work alone

70 million leave for work between 6:30 and 8:30 a.m.

Each dot represents 1 million people

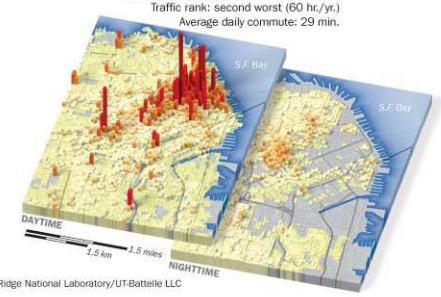
■ All told, more than 4 in 10 Americans are on the move during a two-hour window each weekday morning, once you add in carpoolers, buses, taxis, motorcycles, commercial trucks and children on their way to school.

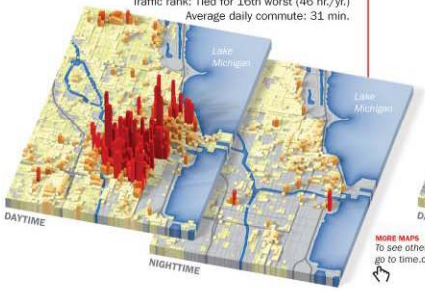
■ Another way to understand our daily migratory patterns is to compare daytime with nighttime populations of urban centers. The Geographic Information Science and Technology group at the Oak Ridge National Laboratory has developed LandScan USA, the most detailed population model available. By integrating Census data with extensive information on other daily activities, LandScan can predict the population of any U.S. location at any time of day. Some examples of U.S. cities are shown here.

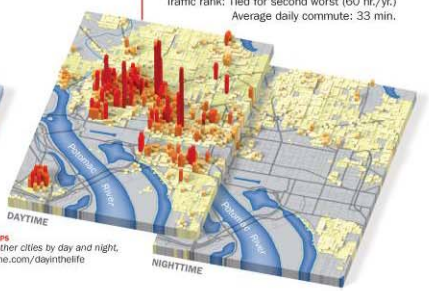


WHY RADIO EXISTS

On average, Americans sit in traffic for 38 hr. a year, wasting an estimated 26 gal. of gas per person. Here are the worst metro areas for traffic delays:







MORE MAPS
To see other cities by day and night, go to time.com/dayinthelife

WHO'S HOME

...households, by type

Married couples, no children at home
31.4 million

Married couples with children under 18
24.2 million

Unmarried, with children under 18
11 million

Unmarried, no children
8 million

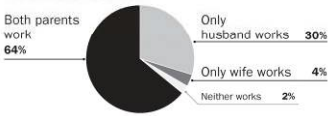
Nonfamily households *(a person living alone, unrelated people living together or people in group settings)*
37 million

■ Large families are vanishing: only 10% of U.S. households have five or more people. In 1970, 21% did.

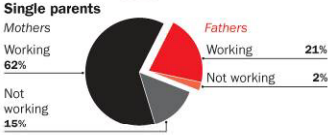
■ One-third of households have just two people (that includes older couples whose children are grown).

■ More than 37 million Americans are older than 65. Among those 65 to 74, 1 in 4 is still working.

Married with children

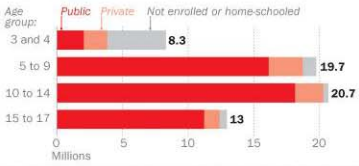


Single parents



GOING TO SCHOOL

Every morning, 55 million U.S. children head off to 124,110 schools. The huge majority—86%—attend public schools. Just 7.7 million kids attend the nation's 28,384 private schools. In addition, more than 6 million other kids aren't enrolled—they're too young, home-schooled or have dropped out.



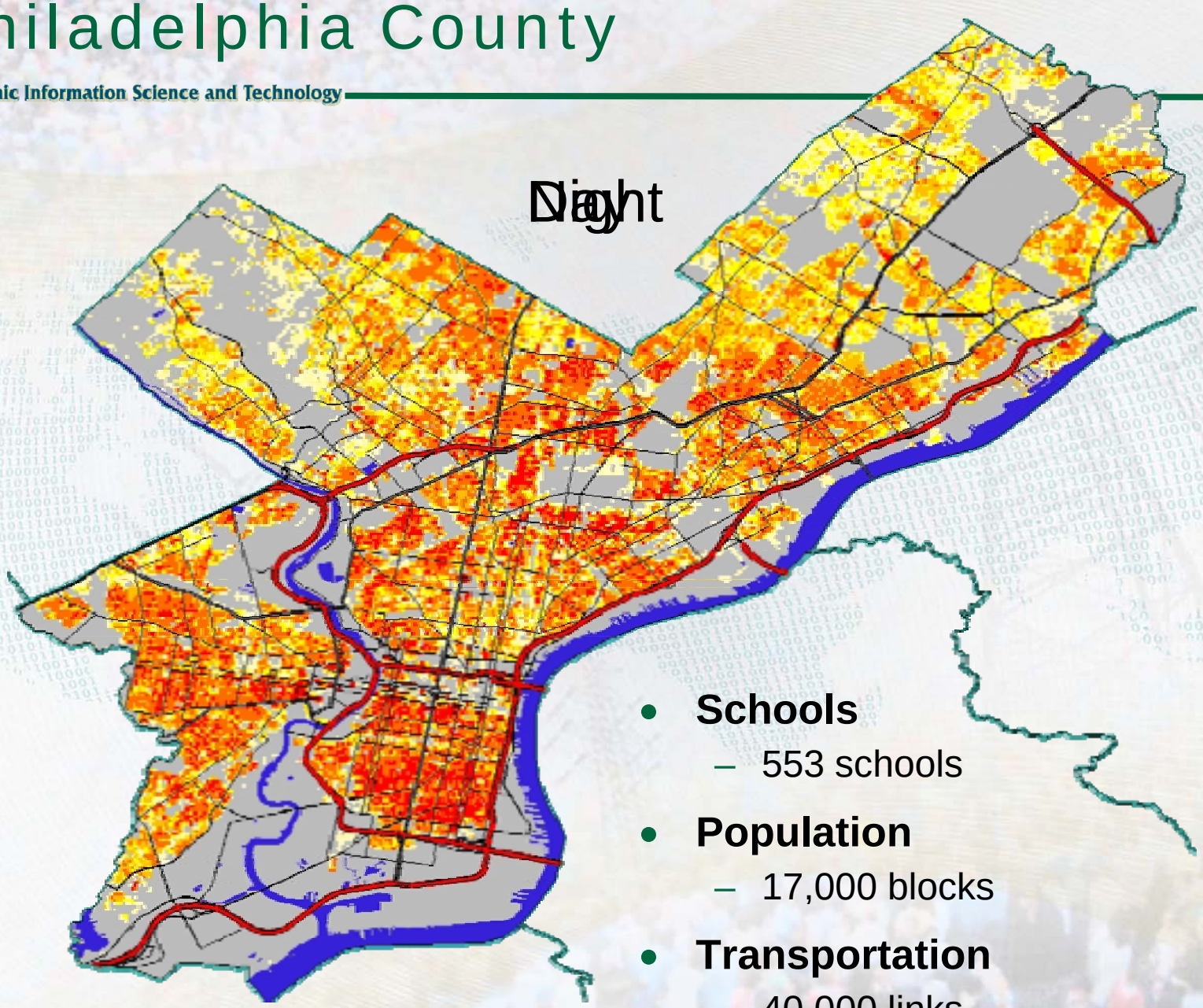
Sources: Census Bureau; Bureau of Labor Statistics; National Center for Education Statistics; Texas Transportation Institute; Oak Ridge National Laboratory/UT-Battelle LLC

2005 RAMS Students: Jermaine and Janel (Winston Salem State University)

Geographic Information Science and Technology

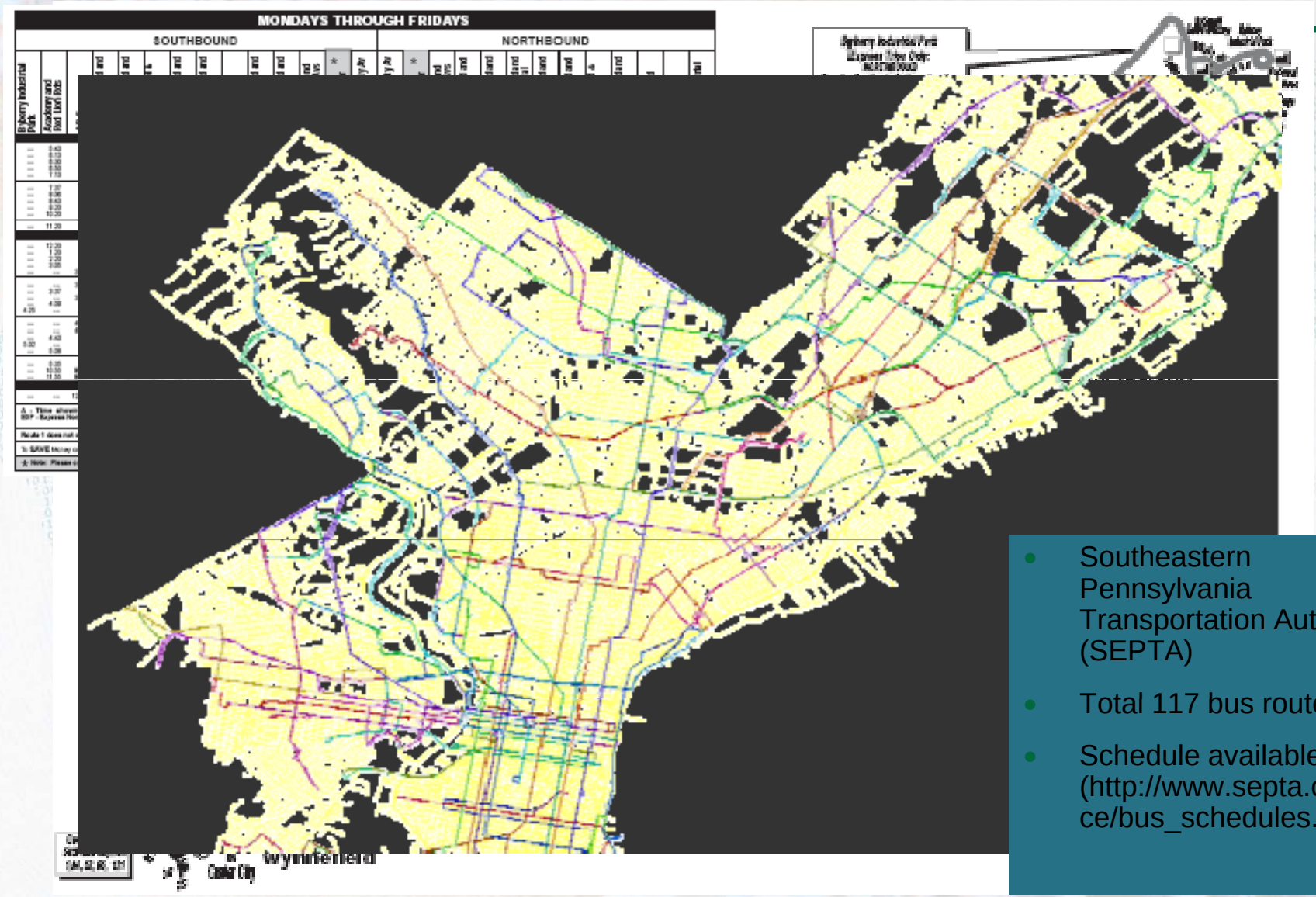
Philadelphia County

Geographic Information Science and Technology



- **Schools**
  - 553 schools
- **Population**
  - 17,000 blocks
- **Transportation**
  - 40,000 links

Public Bus Routes

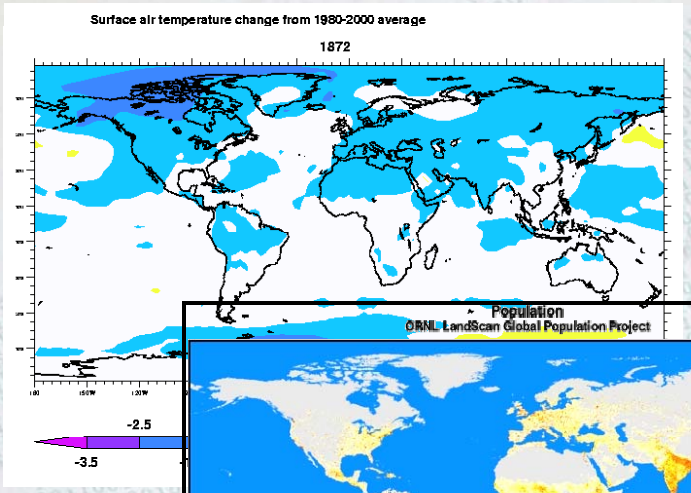


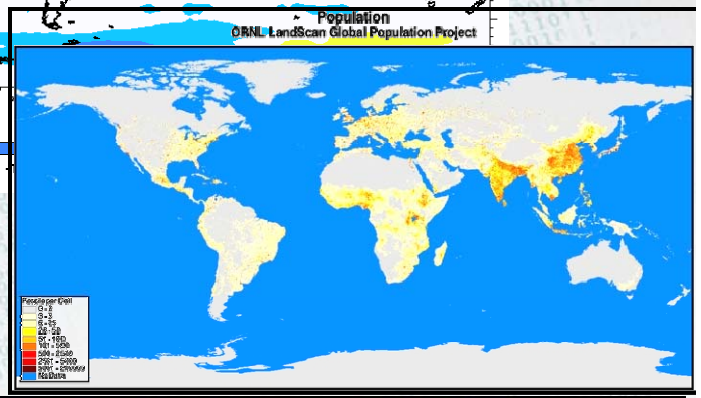
- Southeastern Pennsylvania Transportation Authority (SEPTA)
- Total 117 bus routes
- Schedule available (http://www.septa.org/service/bus_schedules.html)

Climate Change Science

Geographic Information Science and Technology

- **Feedback among climate, land use, and population distribution**
- **Climate induced hazards and infrastructure impacts**
- **Spatiotemporal translation of regional climate impacts on local decisions**

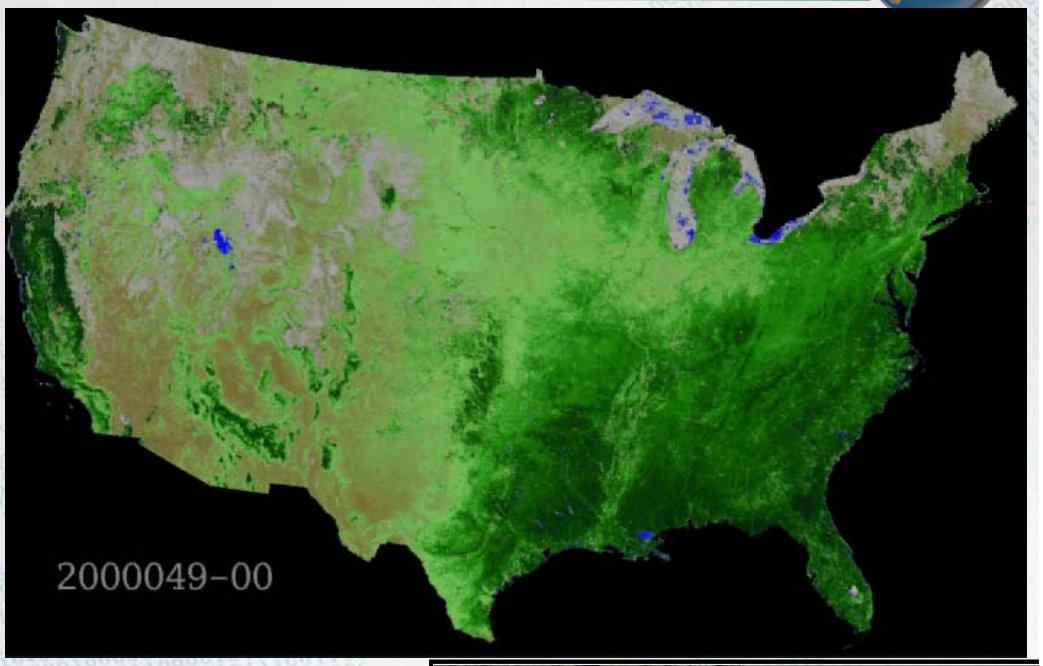


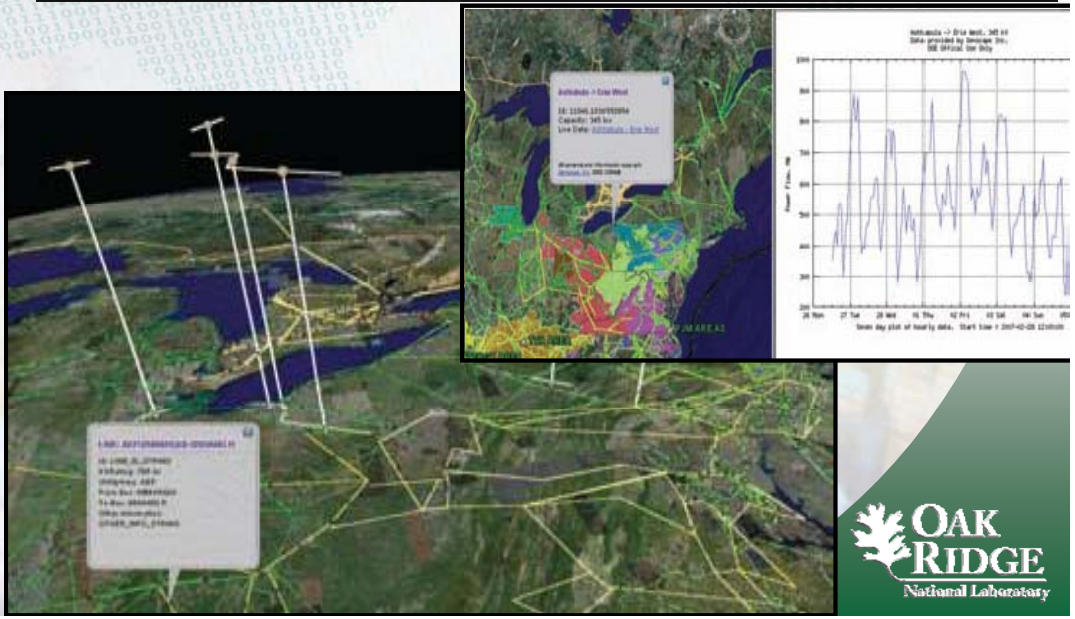


Energy Assurance

Geographic Information Science and Technology

- **Spatiotemporal assessment of renewable energy potential**
- **Bioresource monitoring for energy security**
- **Geographically scalable spatiotemporal optimization for energy supply chain**





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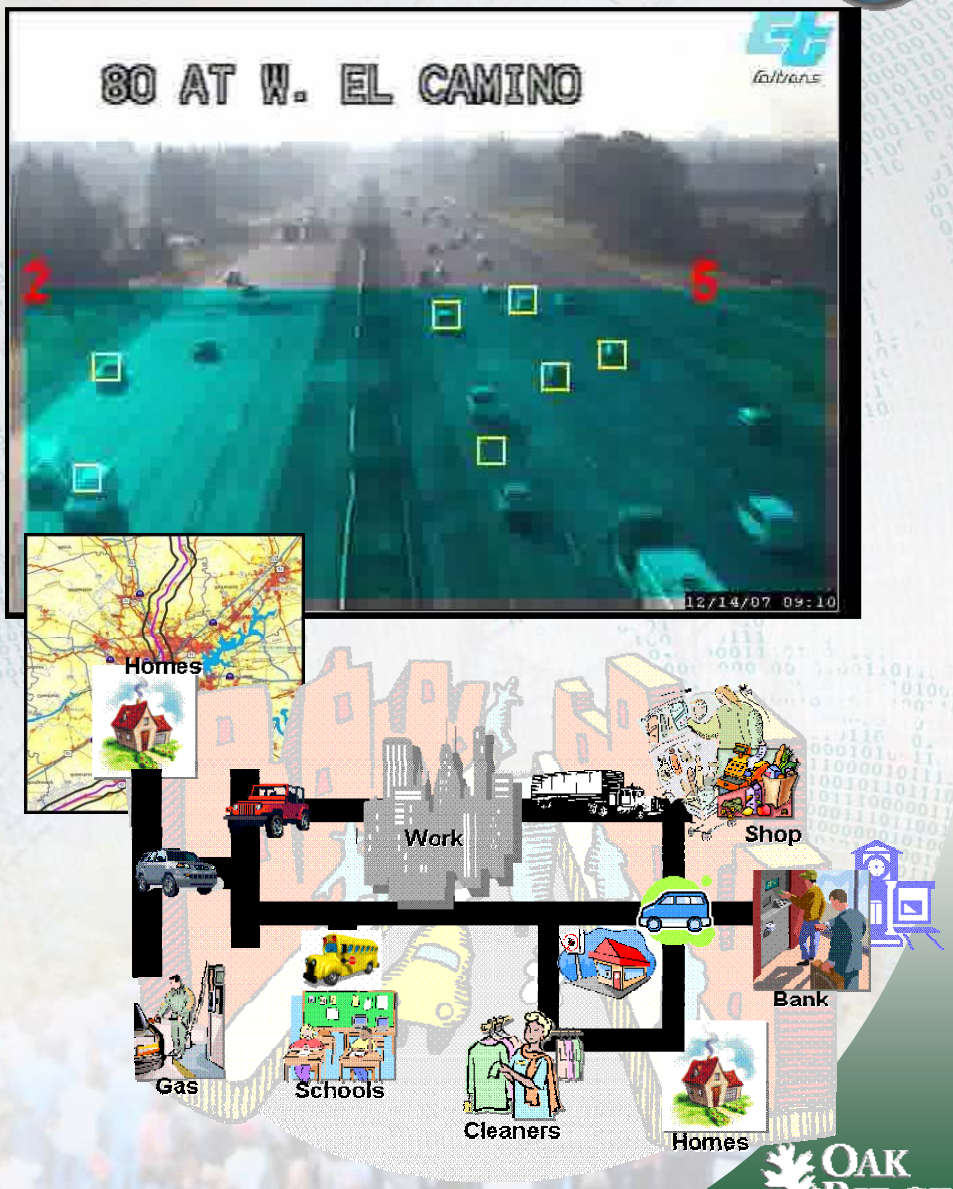
Transportation

Geographic Information Science and Technology

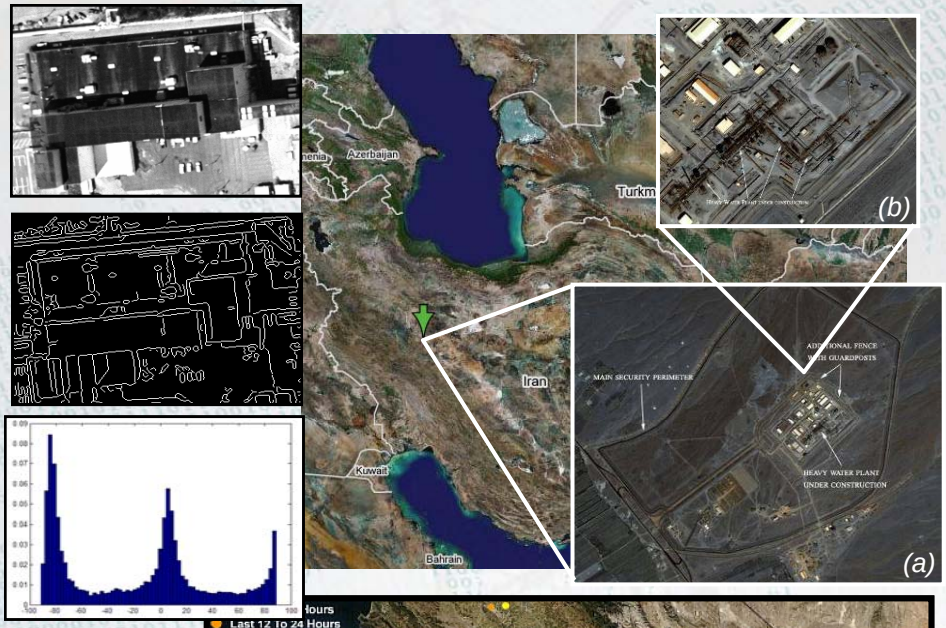
- **Dynamic tracking of fleet movement from multisensor data**
- **Travel behavior modeling for congestion and safety**
- **Spatiotemporal data mining and visualization for improved operations and communication**



National & Homeland Security

Geographic Information Science and Technology

- **On demand and just-in-time delivery of geospatial intelligence for time critical decision support**
- **Image and video based object recognition and tracking for nuclear nonproliferation**
- **Multimodal data fusion for landscape process characterization**
- **Extraction and integration of voluntary geographic information for rapid response and recovery**



Climate Change and Impacts Research

Geographic Information Science and Technology

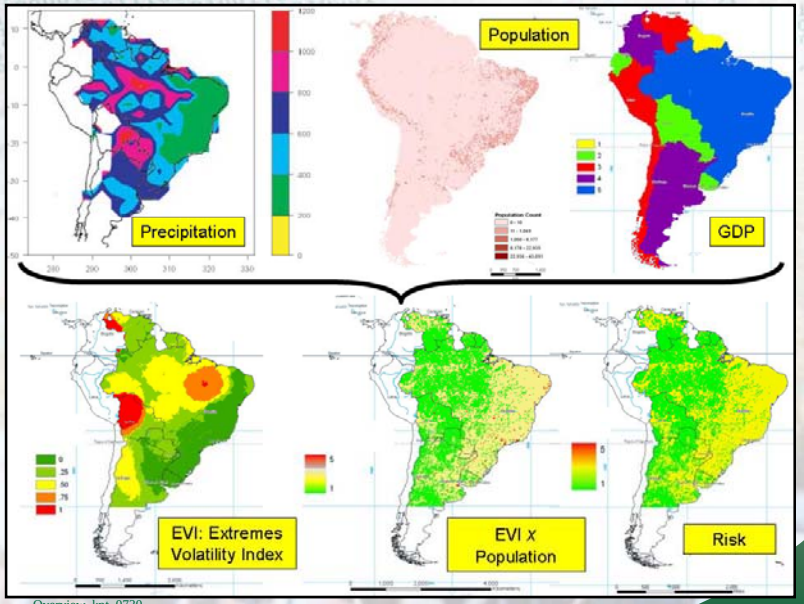
- Student: **Christopher Fuller**
- University: Winston Salem State University, Winston Salem, NC
- Topic: *Quantification and Visualization of the Human Impacts of Anticipated Extreme Events*
- Mentor: Auroop Ganguly
- Group: GIST (CSED)
- Synergistic Project: Multivariate dependence in climate extremes (ORNL SEED; PI: Ganguly)

Presented at the 2006 Fall Meeting of the American Geophysical Union (AGU) in SFO

Selected for AGU Press Conference

Wide Media Publicity (Science Daily, UPI…)

Fuller, C.T., Sabesan, A., Khan, S., Kuhn. G., Ganguly, A.R., Erickson, D., and G. Ostrouchov (2006), *Quantification and visualization of the human impacts of anticipated precipitation extremes in South America*, **Eos Trans. AGU**, 87(52), Fall Meet. Suppl., Abstract GC44A-03.



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OAK RIDGE National Laboratory

Current and Future Student Projects

- **Climate Extremes Science**
  - Uncertainty in Climate Projections
  - Uncertainty in Climate Extremes
  - Extreme Weather and Hydrologic Events
  - Extreme Hydro-Meteorological Stresses
  - Attribution of Climate Extremes
- **Climate Impacts Science**
  - Hydraulic and Environmental Infrastructures
  - Water and Nutritional Resources
  - Natural Hazards and Humanitarian Aid
  - Migration and Population Impacts
  - Emission and Mitigation Policies
  - Risk Analysis and Management
  - Visualization and Geographic Analysis

Contact: Auroop Ganguly
(gangulyar@ornl.gov)
GIST / CSED, ORNL