Activity Profile

Geospatial Science at The Department Of Energy

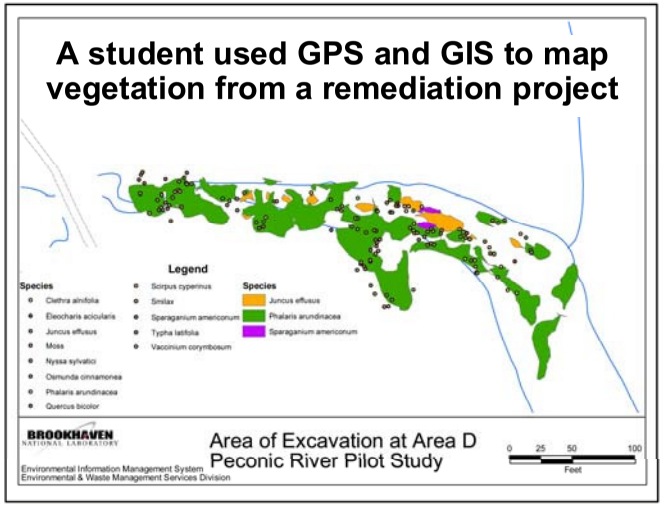
Mapping The Mission

- Defense
- Energy
- **Science**
- Environment

Training the Next Generation

Geospatial Science Program

Locating GPS coordinates to take sediment samples



Need

Baseline ecological information is needed to assist in management decisions. There is an abundance of data collection and monitoring to be conducted.

Approach

Interns, through the Office of Educational Programs, spend 10 weeks using radio telemetry, GPS, GIS, and conducting field research.

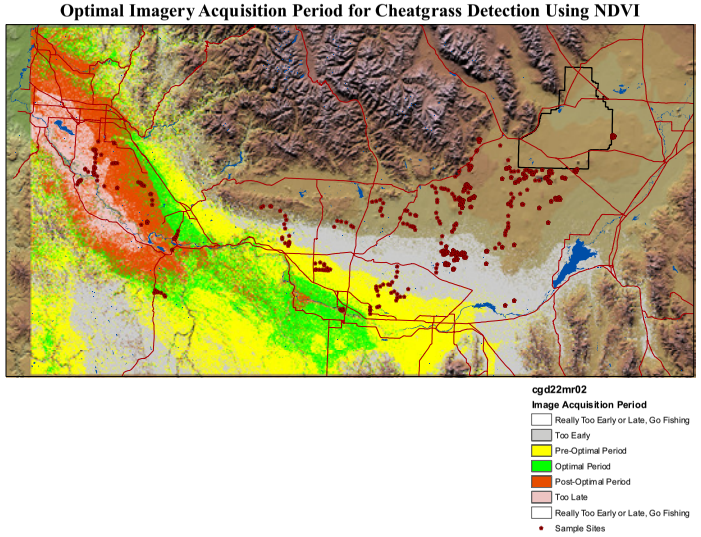
Benefits

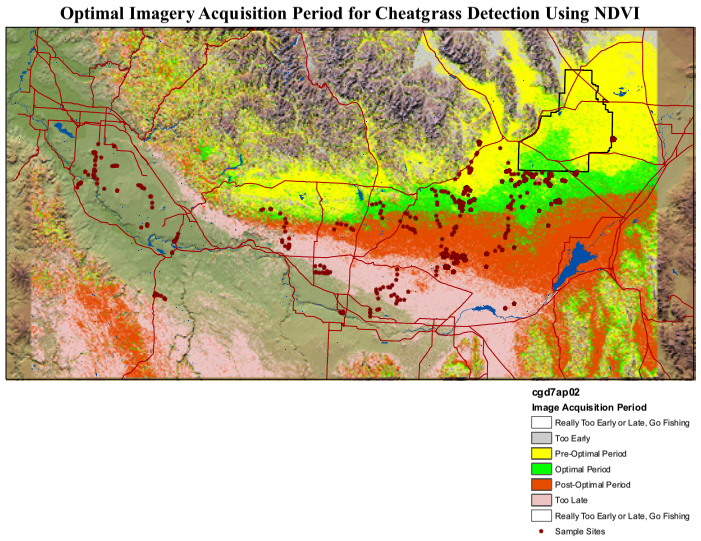
Students obtain hands on experience learning field techniques and using GIS and GPS systems. BNL gains a wealth of information that the current staff would not be able to obtain without assistance.

POC: Jennifer Higbie, higbie@bnl.gov

Cheat Grass Phenology Model

Geospatial Science Program





Need

A model that relates climate and topographical data to cheat grass green up and senescence in order to determine optimal time windows to collect satellite imagery for detection and mapping.

Approach

Compare MODIS NDVI, with field, climate, and topographical data to develop a model for when cheat grass greens up.

Benefits

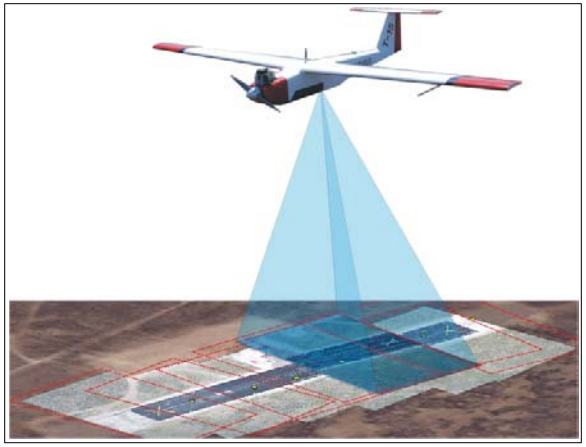
Model will allow end-users to save money on imagery and analysis costs by reducing data redundancy.

Model may also increase accuracy of other detection and mapping methods by reducing the amount of unneeded data that may add error to or “confuse” currently used detection and mapping techniques.

POC: Randy Lee, Randy.Lee@inl.gov

Data Acquisition and Direct Referencing

Geospatial Science Program



Need

Method to accurately georeference imagery collected using unmanned autonomous vehicles without the use of ground control points.

Approach

Utilize data collected by the inertial navigation system on the aircraft along with GPS position to calculate ground position of imagery.

Benefits

Imagery can be viewed in real-time by an analyst or mission commander from which decisions can be made without the need for manned aircraft or putting ground personnel in a possible dangerous situation. Imagery can be quickly analyzed with other geospatial information in a GIS.

POC: Randy Lee, Randy.Lee@inl.gov

Mapping Microbial Diversity

Geospatial Science Program

Need

Establish a single point from which scientists and researchers can locate physical characteristics and associated microorganisms of Yellowstone National Park hot springs.

Approach

Collect existing papers, studies, and maps of YNP hot springs related to extreme microorganisms and place in a relational database. Tie data to spatial features and develop map server to access information.

Benefits

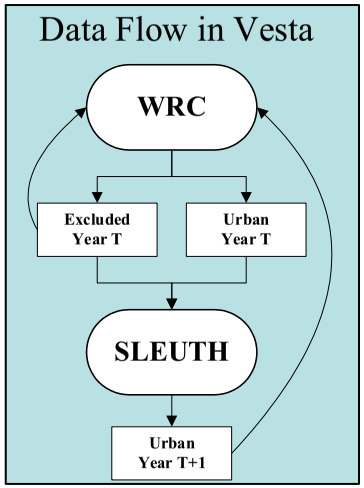
Provides an efficient planning tool for researches who are looking for specific microorganisms and serves as a data repository for future studies.

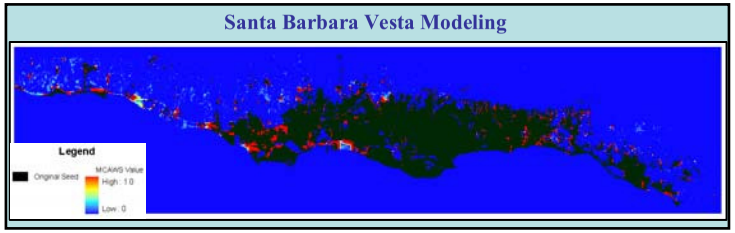
POC: Randy Lee, Randy.Lee@inl.gov

Challenges of Coupled Spatial Dynamic Modeling

Geospatial Science Program

The schematic for a coupled dynamic Urban-Wildfire Risk model, using real GIS data





Need

Spatial models of single systems lend insight into processes, but not their context. Changes in components external to models can have severe ramifications to modeling results.

Approach

Coupling two dynamic spatial models necessitates the understanding of both the processes being modeled as well as the computational needs of each model.

Benefits

In the example presented here, the consequences of severe Wildfire Risk and Urbanization can be taken into account in making management decisions about each domain.

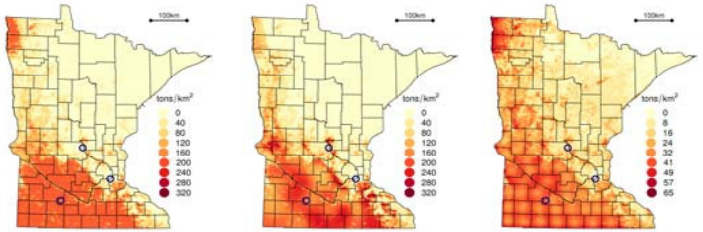
This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7450-Eng-48. UCRL-PRES-218050

POC: *Noah Goldstein (Goldstein8@llnl.gov), Jeff Stewart (Stewart28@llnl.gov)*

Developing Techniques for the Statistical Resampling of Geographic Data

Geospatial Science Program

Prediction of crop residues density on 4x4km pixels using spatial modeling approach that takes advantages of the land use data and spatial correlation in the data. The fine-resolution prediction is such that when aggregated to counties it yields the aggregated, observed, county data

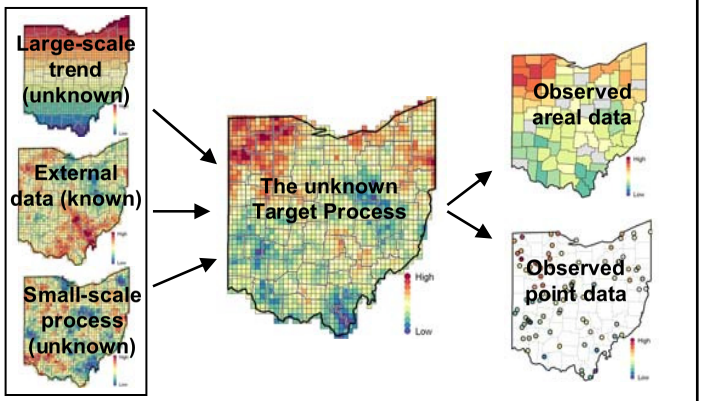


Large scale trend based on landuse pattern

Predicted crop residues density

Prediction errors (SD)

The goal is to construct a model that relates the observed spatial data to the unknown process of interest and can be used to predict the process at any site/area of interest, along with an uncertainty measure



Need

Energy modeling and analysis often relies on data collected for other purposes such as census counts, atmospheric and air quality observations, economic trends and other primarily non-energy related uses.

Approach

By using exploratory and modeling techniques of spatial statistics, auxiliary data can be incorporated into energy models, at different spatial scales.

Benefits

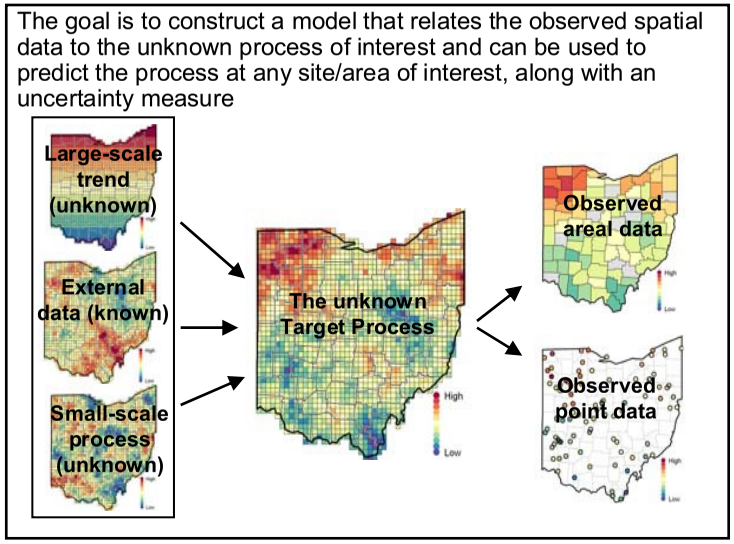
Generalized models of known data can be made, and estimates of error in models can be assessed, leading to a better understanding of error in the underlying processes going into energy models.

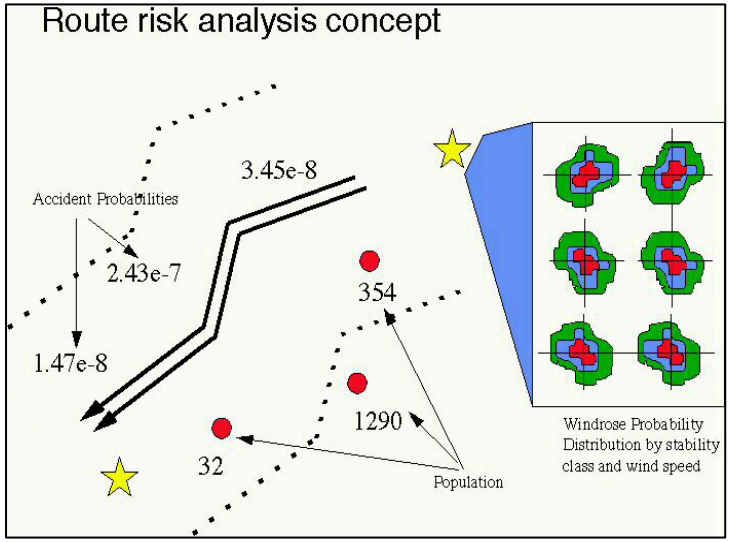
This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7450-Eng-48. UCRL-PRES-218050

Lawrence Livermore National Laboratory POC: Gardar Johanesson (Johannesson1@llnl.gov), *Jeff Stewart (Stewart28@llnl.gov)*

Geospatial Applications of the System and Decision Sciences Section

Geospatial Science Program





Need

Advanced Geospatial statistics and Spatial Dynamic Modeling have long been left out of solutions to solve the DOE's Mission's Goals.

Approach

The LLNL GeoSpatial Analysis and Modeling Team is a group of multidisciplinary scientists who use the latest in advanced techniques to solve GeoSpatial problems.

Benefits

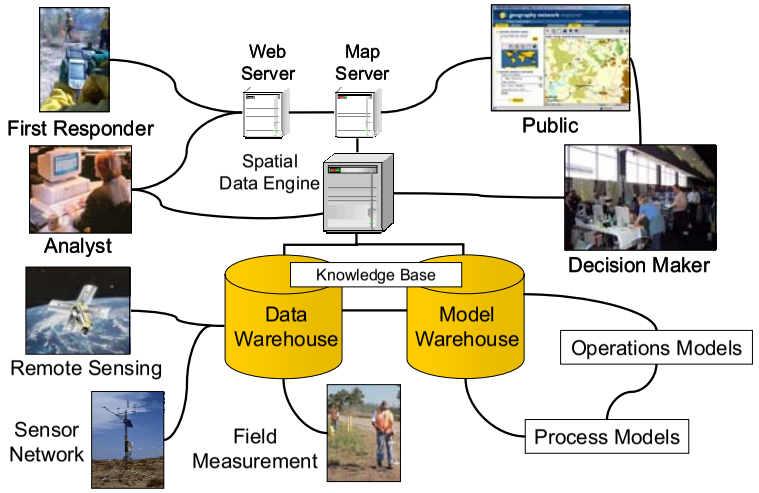
By incorporating GeoSpatial and Dynamic Modeling techniques, we can produce better estimates of energy and security problems, accounting for the spatial and temporal dimensions of the data, as well as the variance and dominant trends in the process or system.

This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7450-Eng-48. UCRL-PRES-218050

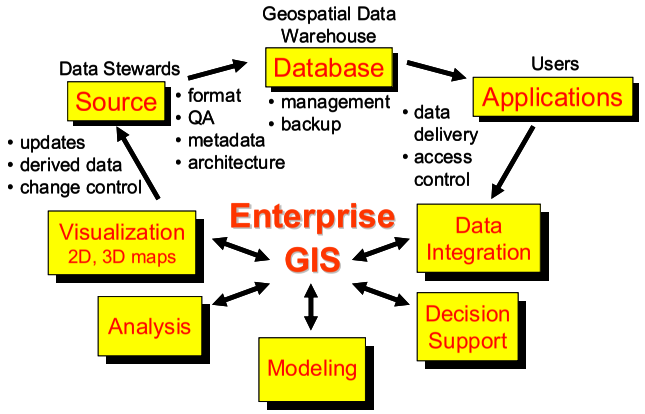
POC: *Jeff Stewart (Stewart28@llnl.gov), Noah Goldstein (Goldstein8@llnl.gov)*

Enterprise GIS Design

Geospatial Science Program



Cyberinfrastructure: Integration of GIS



Complete "Geospatial Data Cycle"

Need

Provide access to shared geospatial data and analysis capabilities.

Approach

Cyberinfrastructure = integrated computing environment for access to key data and GIServices.

Complete Geospatial Data Cycle ensures data are reliable, documented, secure, and accessible.

Consider diverse stakeholder needs.

Employ out-of-the-box solutions where available and custom tools where necessary.

Benefits

Enhanced ability of projects to employ GIS capabilities; cost savings through shared GIS infrastructure.

POC: Paul Rich, pmr@lanl.gov

GIS Education and Outreach

Geospatial Science Program

Need

GIS education and technical outreach for Native Americans.

Approach

Focus on Accord Pueblos (San Ildefonso, Santa Clara, Cochiti, Jemez) adjacent to Los Alamos National Laboratory.

GIS education for tribal high schools.

Technical assistance to build tribal GIS facilities.

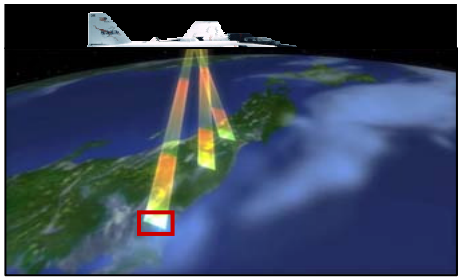
Benefits

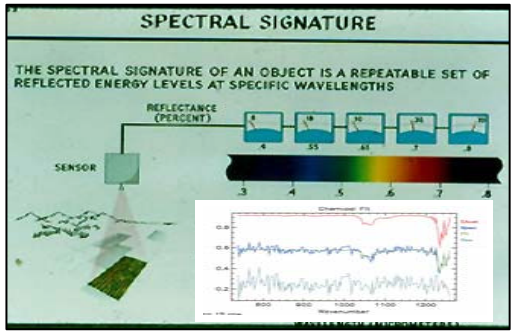
Near-term enhancement of tribal GIS facilities and long-term development of Native American technical work force.

POCs: Byron Yepa, byepa@lanl.gov / Doug Walther, walther@lanl.gov

GIS Links with Remote Sensing

Geospatial Science Program





Need

GIS support for Advanced Chemistry Identification Technology (ACIT), Airborne Spectral Photometric Collection Technology (ASPECT), and Angel Fire.

Approach

Develop GIS links with remote sensing (file conversion, vector overlay on imagery, etc.).

Develop multi-scale base map catalog.

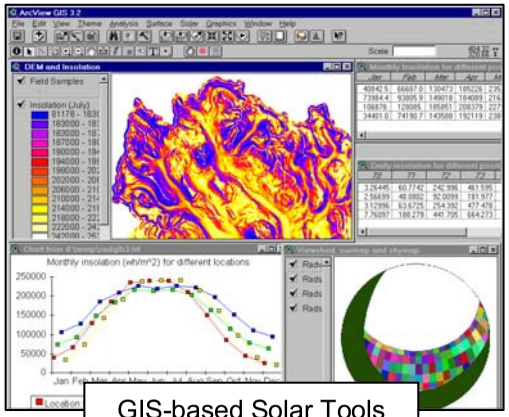
Provide access to GIS tools for visualization, analysis, and data management.

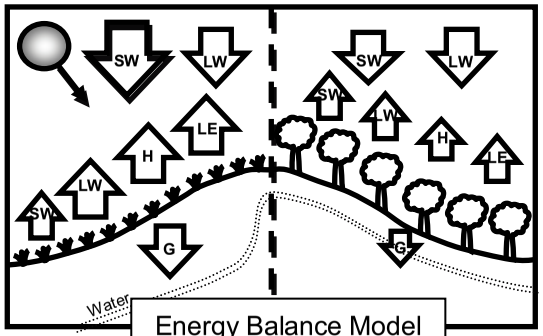
Benefits

Advanced technology for remote monitoring (reconnaissance, tracking chemical plumes, real-time remote sensing, etc.).

POC: Mary Greene, mgreene@lanl.gov

Microclimate





Need

GIS-based microclimate and energy balance models to characterize surface climate variability.

Approach

Formulate spatiotemporal theory of microclimate.

Develop GIS-based tools to model solar radiation and energy balance.

Apply tools for precision agriculture.

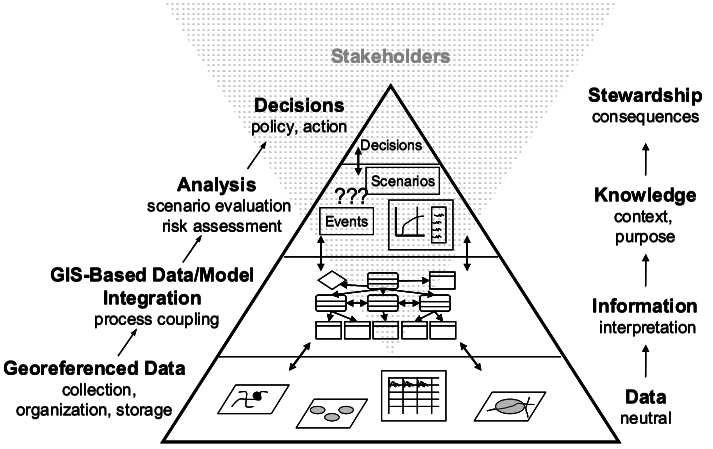
Benefits

Applications for land management, agriculture, climatology, ecology, and hydrology.

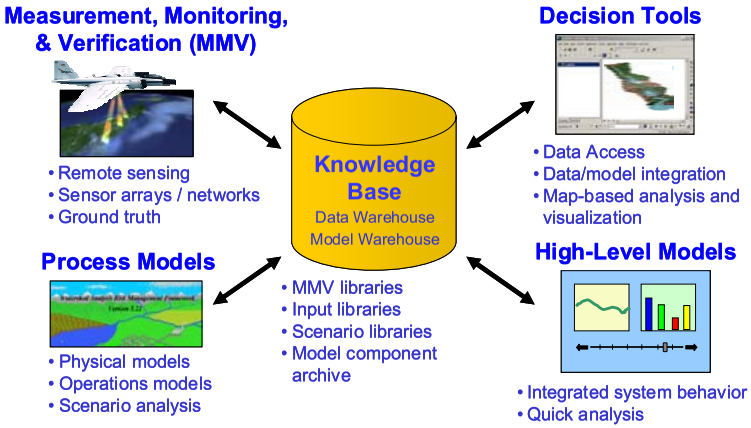
POC: Paul Rich, pmr@lanl.gov

Spatial Decision Support System Design

Geospatial Science Program



SDSS Conceptual Framework



Knowledge Base Approach

Need

Spatial decision support system (SDSS) conceptual framework applicable for diverse projects.

Approach

SDSS conceptual framework integrates data/models and provides decision tools to visualize alternative scenarios.

Knowledge base approach links diverse project elements (decision tools, MMV, process models, high-level models) via data libraries.

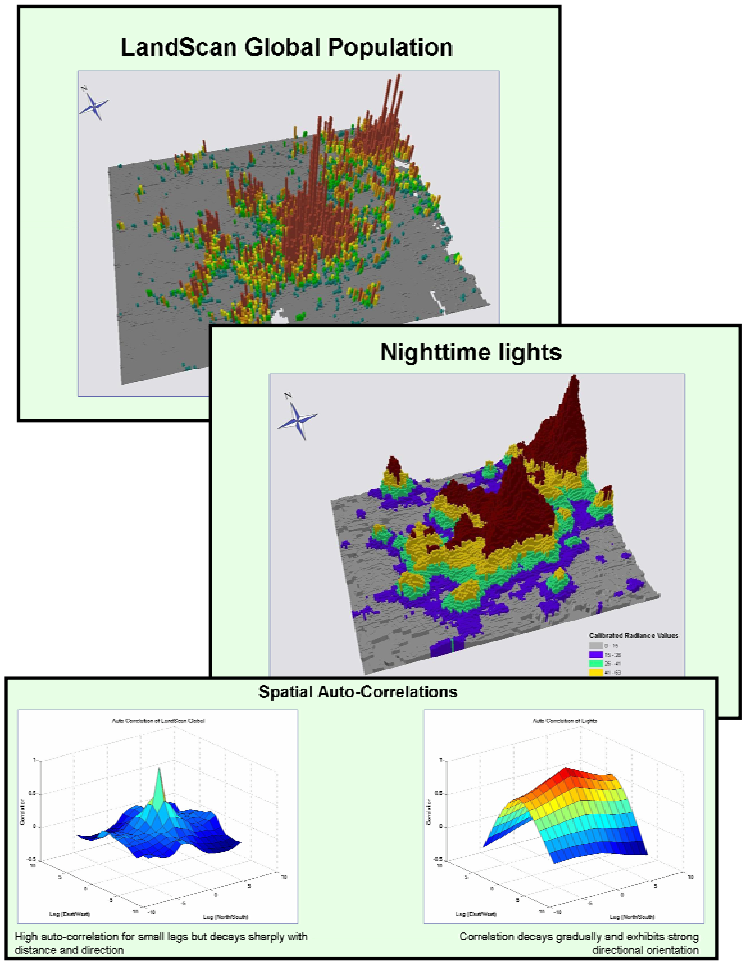
Benefits

Better informed decisions.

POC: Gordon Keating, gkea@lanl.gov

Disaster Utility Metrics and Spatial Correlations for Hi-Res Population

Geospatial Science Program



Need

Hi-res population vs. ancillary variables, metrics to evaluate utility of population for disaster management, and disaster risk management.

Approach

Spatial auto- and cross-correlations, new skill measures combine “equitable threat scores” from meteorological predictions and “ROC curves” from signal processing, and enhanced risk analyses and threat contours.

Benefit

Patterns in correlation with regional variance, utility for disaster management critically depends on modeling methods and the use of available information, and risk analysis benefits decisions and policy.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Educational and Community Outreach

Summer 2005 Participant	Academic Institution
Karen McNeany	MS, University of California – Santa Barbara
Anil Cheriyadat	PhD, Rensselaer Poly Tech
Aaron Myers	MS, University of South Carolina
David Potere	PhD, Princeton University
Lauren Patterson	MS, University of North Carolina

Need

To develop a world-class pool of qualified scientists and researchers for the geospatial sciences.

Approach

Oak Ridge National Laboratory GIST group routinely offers a wide selection of summer and one-year internship appointments. In addition, GIS staff are actively engaged locally via active participation in a community college GIT steering committee, local high school speaking engagements for geospatial sciences, and even elementary school world geography assistance through visual aids.

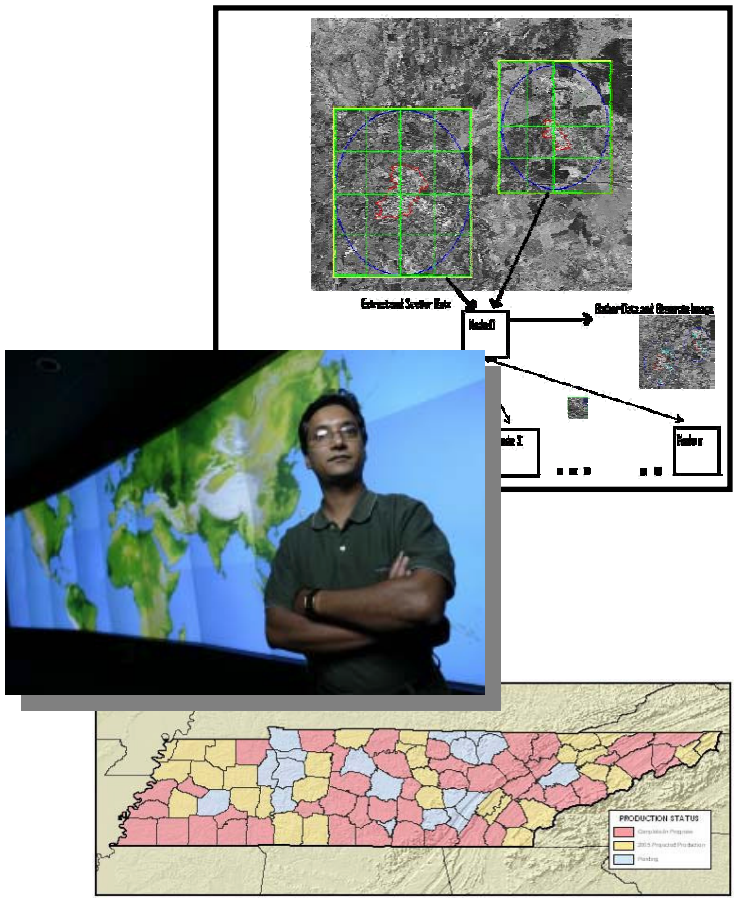
Benefit

Education and community outreach increases general awareness of the criticality of geospatial sciences and facilitates the successful development of a future geospatial workforce for the nation.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

HPC In Terascale Spatial Data Integration and Visualization

Geospatial Science Program



Need

Increasing dimension (3D), resolution, and availability of spatial data requires efficient processing and visualization beyond current desktop capabilities.

Approach

Development of high-performance, cluster computing techniques for data processing. Implementation of GRASS GIS in a cluster computing and 35 megapixel visualization environment.

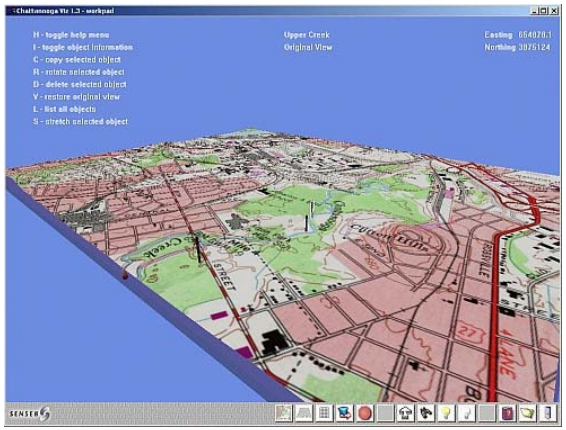
Benefit

Fast and efficient processing of spatial data including high-resolution imagery for information extraction, fusion, and query. High-performance visualization allows enhanced understanding of the quality characteristics of data, model and simulation results.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Immersive Visualization

Geospatial Science Program



Need

Provide access to GIS information in an immersive fashion to facilitate on-site operations.

Approach

Explore the use of COTS hardware and open source software solutions to provide the user with a wearable, untethered, immersive experience.

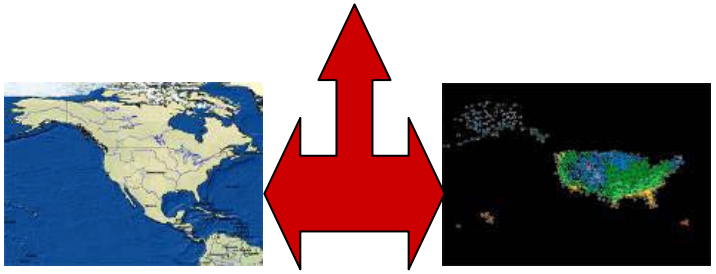
Benefit

Prototype systems have been developed and demonstrated. The system is custom designed for an application and extensible by the end-user.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Integrating Disparate Spatial Data

Geospatial Science Program



Local Data Source

External Data Source

Need

Provide access to display, analyze, and interact with both locally stored and internet-accessible GIS data to users in multiple locations using a variety of operating systems.

Approach

Using off-the-shelf technology and custom development, a thin-client browser application was created to pass XML requests to a server where processing of spatial data was performed.

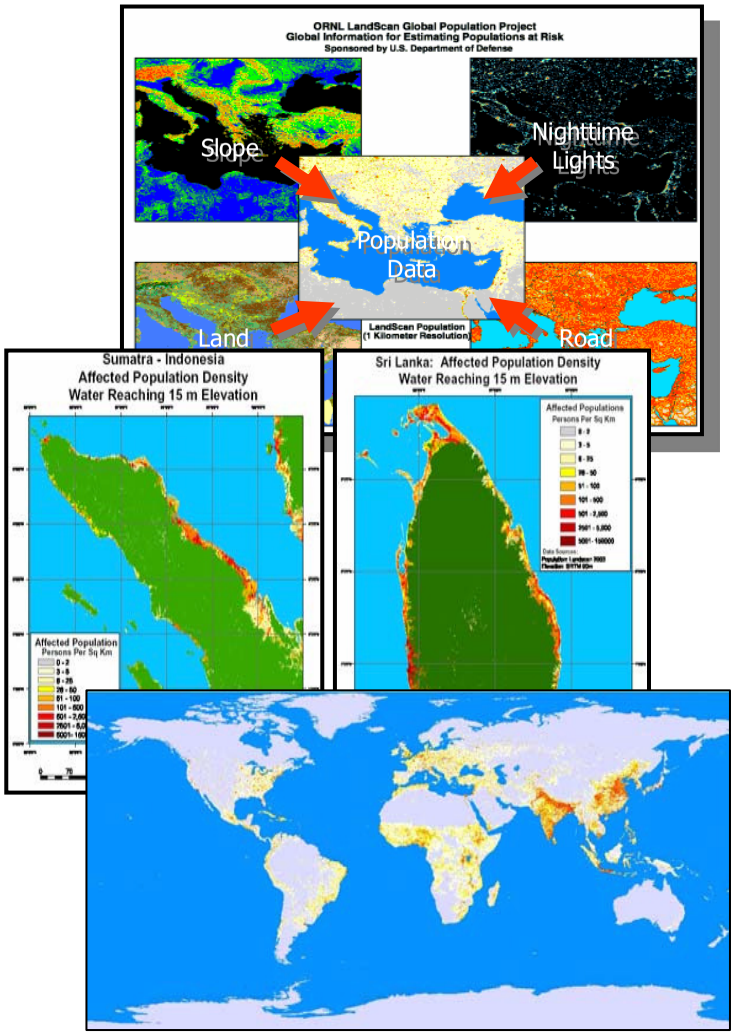
Benefit

A client application that runs within most internet browsers was developed to provide access to multiple maps from different data providers simultaneously. These data can be leveraged against each other in a single, web accessible interface.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

LandScan Global Population

Geospatial Science Program



LandScan Global Population

Need

Accurate depictions of global population distribution are critical for a wide variety of research needs including resource management, policy analysis, and emergency preparedness and response. Catastrophic events such as natural disasters, terrorist incidents, and other threats place vast populations at risk.

Approach

LandScan utilizes GIS and Remote Sensing data and technologies through a multi-variable, dasymetric modeling approach.

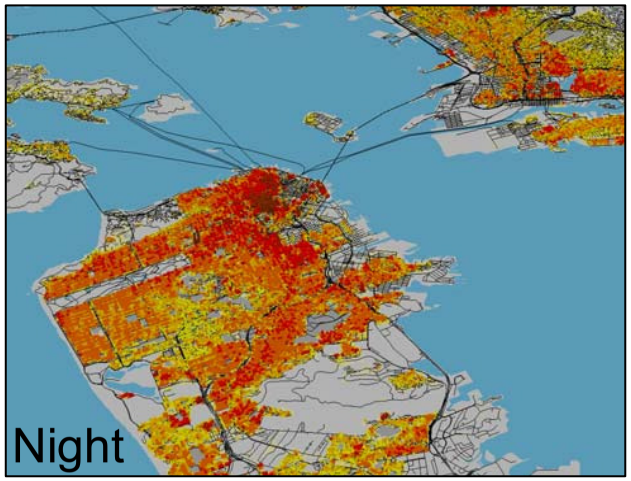
Benefit

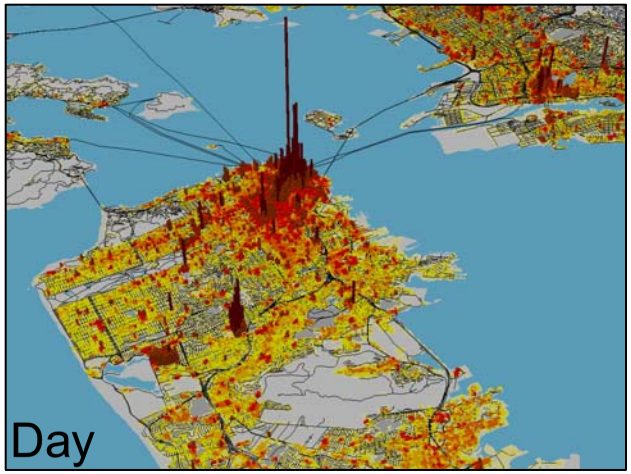
LandScan is an ambient (24-hour average), high-resolution (~1km) population distribution that depicts a more realistic, non-uniform distribution of population. The distribution is updated and modified annually and the finest global population data ever is produced.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

LandScan USA

Geospatial Science Program





Need

Accurate, high-resolution population counts are critical for emergency preparedness and response. Typically, population data are reported by administrative or accounting units and represent “residential” or “nighttime” population.

Approach

LandScan USA utilizes GIS and Remote Sensing data and technologies through a dasymetric modeling approach. Locating daytime populations requires not only census data, but data on places of work, journey to work, and other mobility factors.

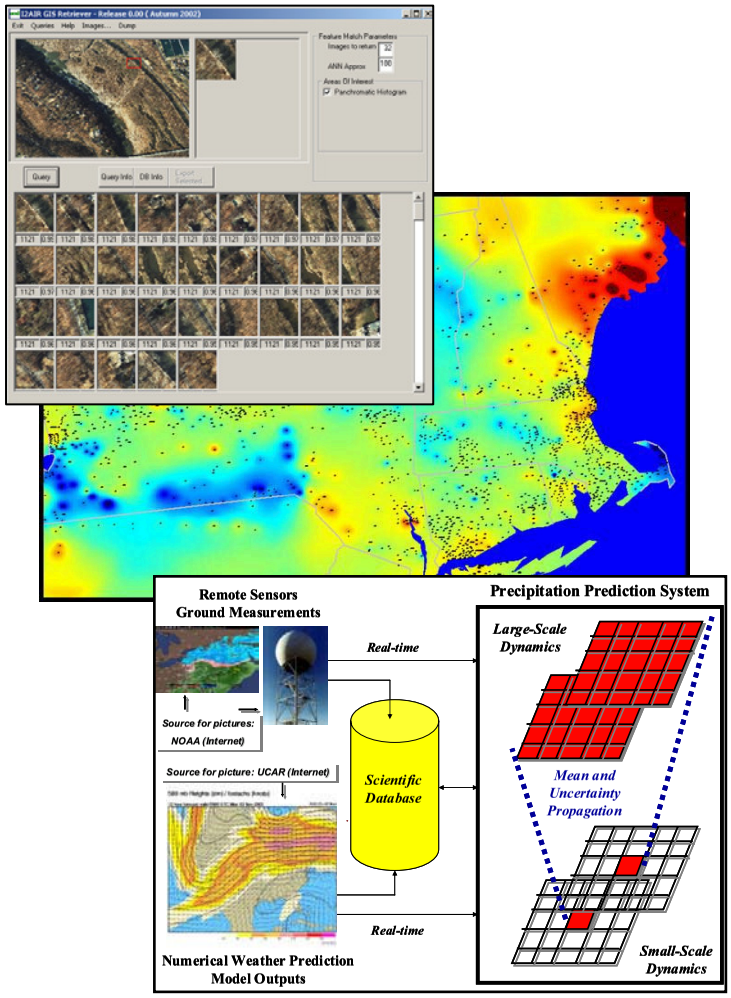
Benefit

The LandScan USA Population is a very high-resolution (90-meter cell) population distribution that depicts a more realistic, non-uniform, time-dependent distribution of population.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Multivariate and Multi-scalar Analysis in Space and Time

Geospatial Science Program



Need

Multivariate and multi-scale dependence analysis in space and time, multivariate predictive models with uncertainty propagation, precursors for rare events, and change from spatio-temporal analysis.

Approach

Spatial correlations and kernel estimates, nonlinear dependence, teleconnections, best fit predictive modeling strategy with linear and nonlinear methods, anomaly detection, process detection, hypothesis generation, and extremal analysis.

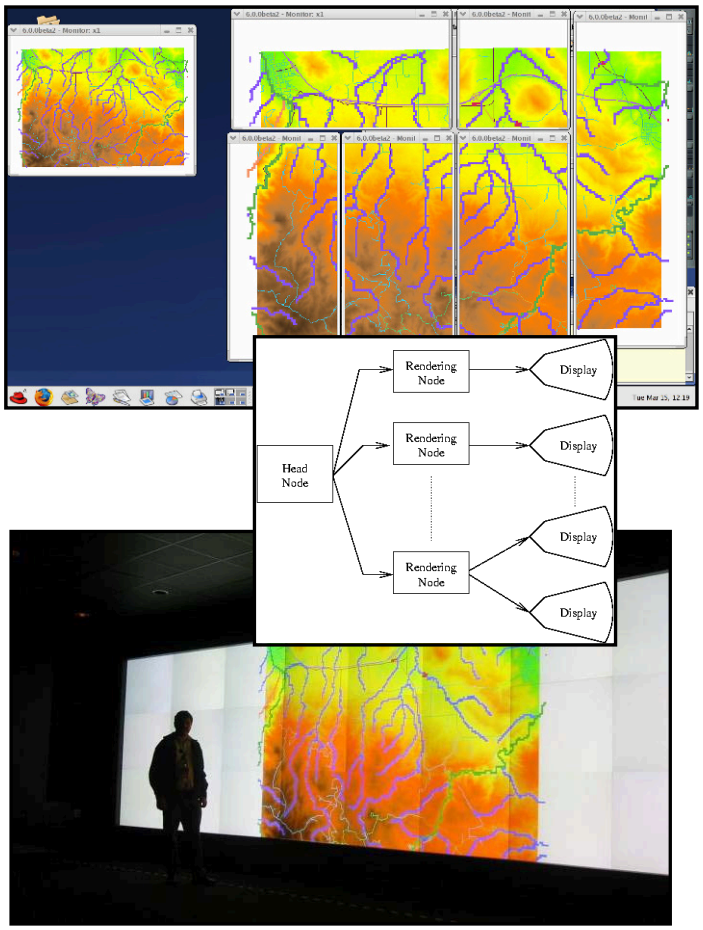
Benefit

Focused methodologies for geospatial-temporal knowledge discovery, application solutions in multiple domains like climate, sensor networks, and national security.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Parallel Visualization for GIS

Geospatial Science Program



Need

Ability to visually comprehend ever-growing geographic datasets is limited by the insufficient resolution of desktop monitors. To address the limitation, displays constituted of many monitors are used. However, software that support such configurations is lacking.

Approach

We have developed a module for a freely available GRASS GIS that can utilize the capabilities of multi-screen display environments driven by Linux-based PC clusters.

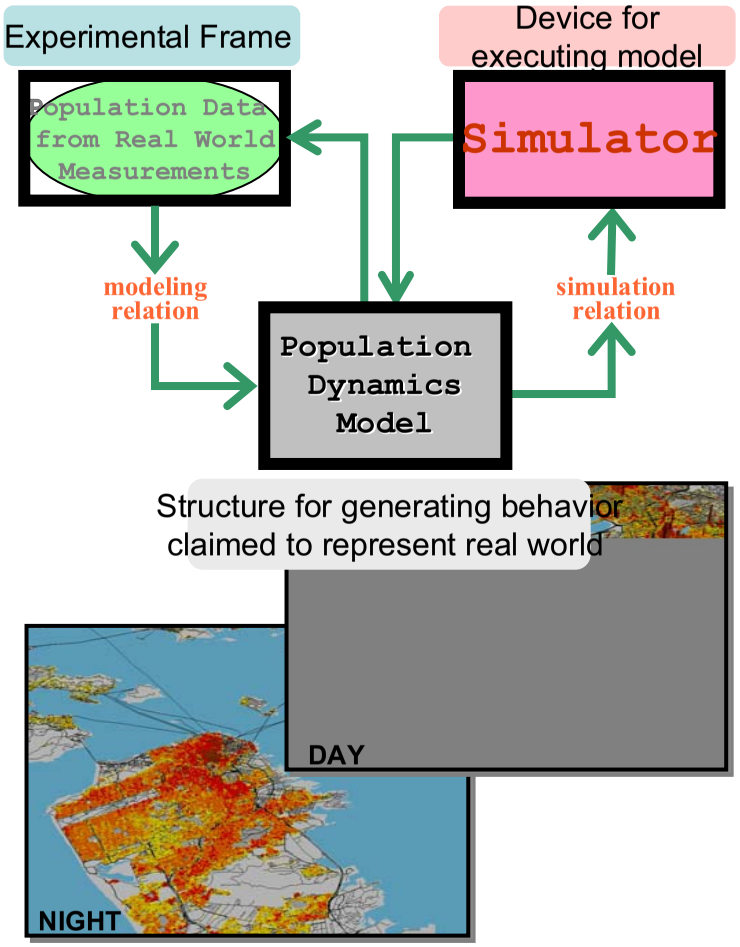
Benefit

The use of a standard GIS in the cluster environment allows us to employ all common GIS capabilities to facilitate visualization of very large geographic datasets on multi-screen displays.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Spatial-Temporal Population Dynamics

Geospatial Science Program



Need

Typically Census data is static and does not represent the dynamic behavior of population over space and time.

Approach

By integrating high-resolution population data with socio-economic and behavioral assumptions and transportation modeling frameworks, mobility and social dynamics of population are being modeled.

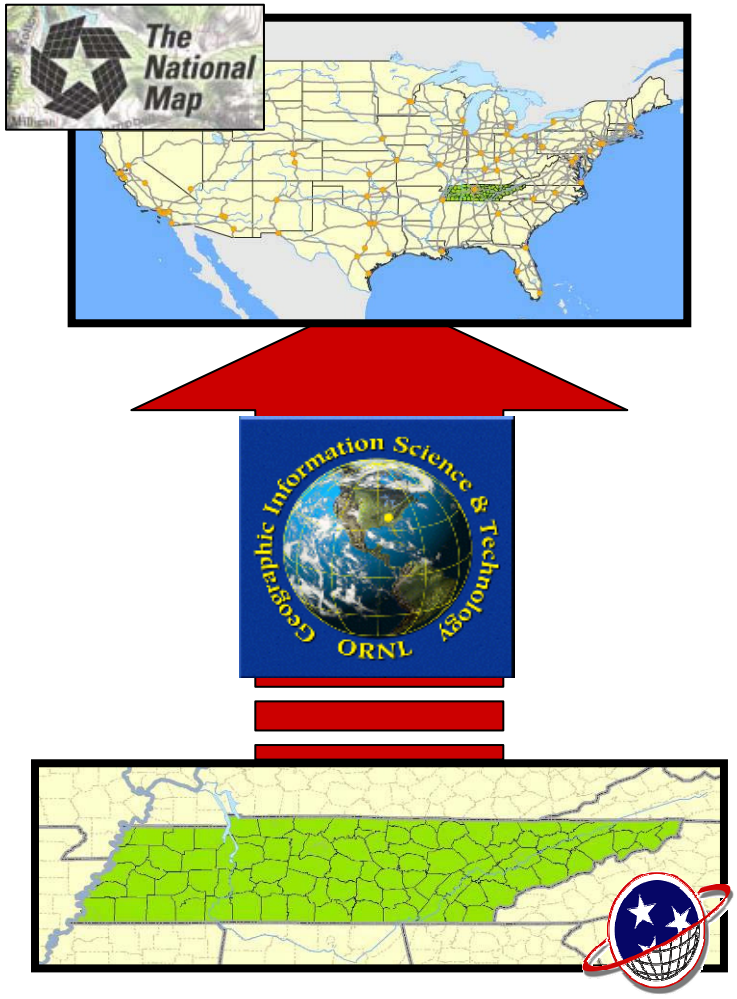
Benefit

Allows a detailed understanding of population movement over space and time, assessment of time specific population distribution, and assessment of social dynamics and interactions among demographic groups to evaluate possible diffusion of diseases and ideas through contact and communication.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov

Tera-Scale Data Integration

Geospatial Science Program



Need

To assist the Tennessee Base Mapping Program (TNBMP) in developing methods of storing, updating, and providing access to large spatial datasets.

Approach

Using off-the-shelf products and custom development, an efficient methodology was outlined to handle large scale data updates and to serve that data through the USGS National Map. Cooperation with the TNBMP team and the USGS ensured the flexibility and functionality required by both organizations.

Benefit

Through cooperation with both organizations, a prototype was developed to be used as a model for the TNBMP team to provide their data to the National Map and assist TNBMP for tracking changes in spatial data records.

POC: Budhendra Bhaduri, bhaduribl@ornl.gov