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Developing Renewable Energy Resources and Associated Infrastructure: Location, Location, Location

John Krummel, Jim Kuiper, Robert Sullivan, and Kevin Hlava
Environmental Science Division
Argonne National Laboratory

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Spatial Data and Analysis Leads to More Informed Decision-making

- Provides the context for issues that are fundamentally location based
- Provides stakeholders with the same information used by project decision-makers
- Allows one to visualize a problem
- Critical input/output data for models of physical, social, and biological systems
- Can now be delivered over the web in highly interactive formats

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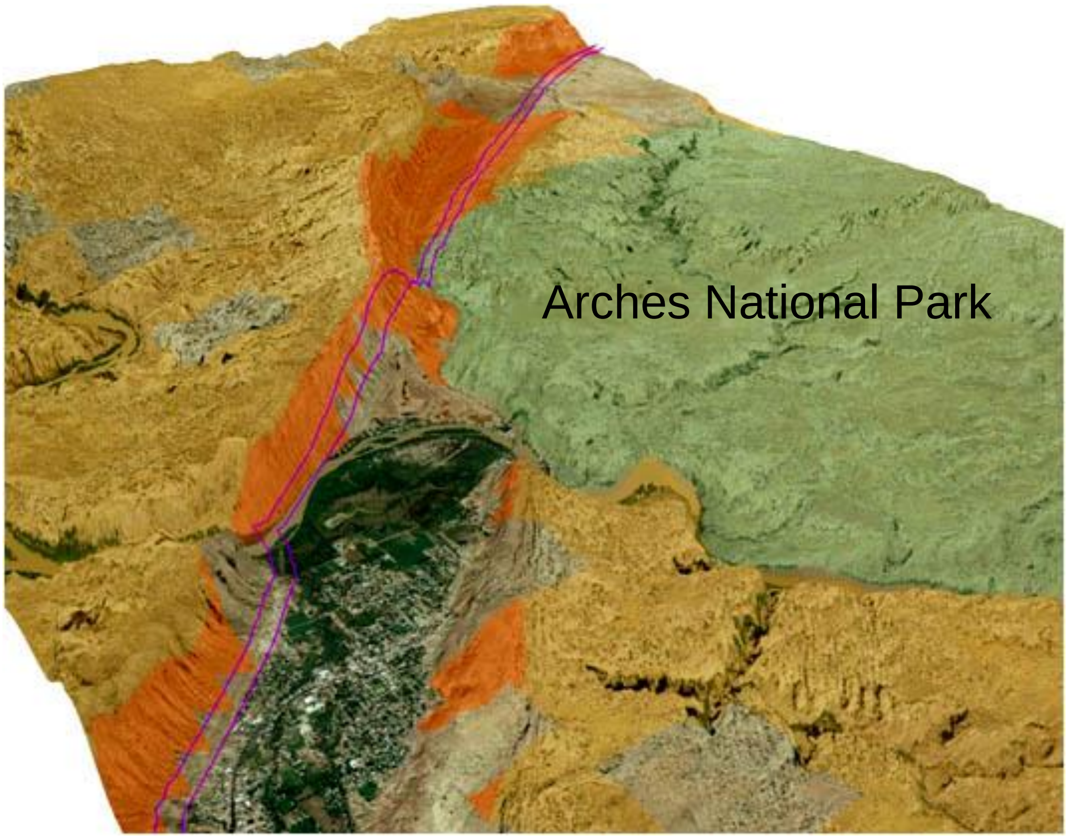
Argonne Develops and Uses Geospatial Technology and Spatial Data Bases in a Variety of Project and Program Areas

- Enhanced visualization of results
- Cumulative analysis
- Watershed-based management
- Constraints analysis
- Spatial modeling
- Spatial statistics
- Map making



Visualization of proposed energy corridor through Moab Canyon

Development of Renewable Energy Resources: Spatial Attributes

- For the most part, renewable energy must be used at, or very near, the location of the source (unlike fossil fuels), thus location becomes a condition of development
- Renewable energy resources are “embedded” in a spatial matrix of other landscape conditions (e.g., animal habitat, existing land uses, sensitive visual conditions)
- Location of the electrical grid and ability to access the grid are important spatial variables in the development of renewables, especially solar and wind
- Large-scale development equals use of large areas of land equals possible changes in landscape patterns

Several Major Renewable Energy and Infrastructure Projects Highlight the Importance of Geospatial Data and Analysis

- Assisting a multi-agency effort in the location of long-distance energy corridors on federal land, especially for new electricity transmission, in the West
- Developing programs for wind energy on federal lands: analyzing spatially-dependent attributes that influence siting constraints and opportunities (environmental, social/economic, infrastructure)
- Analyzing and locating suitable areas for large-scale (utility scale) solar energy projects on public lands in the Southwestern United States, regional to site-specific analyses
- Presenting complex spatial information in an easily used format allows the public and stakeholders to more effectively collaborate during a decision-making process

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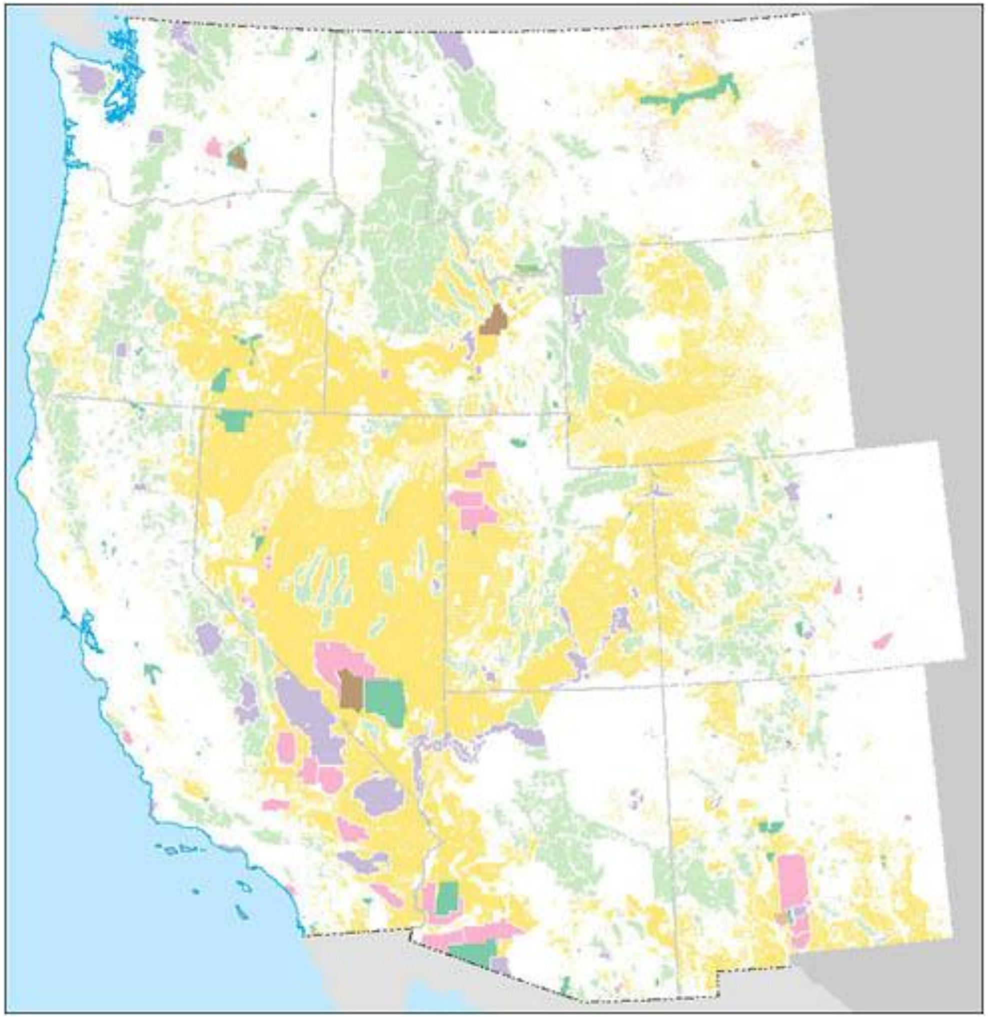
West-wide Energy Transportation Corridor Project

- Develop a systematic approach to locate energy corridors with a specified width, centerline and designated use in 11 Western States (1,185,000 square miles with 48.4% of the land federally managed)
- Manage information received from over 400 local, state, and national-level federal agency offices
- Communicate methods and results to utilities, state and local governments, environmental organizations, and citizens
- Reconcile conflicting policy and management issues among the Departments of Energy, Agriculture, Interior, and Defense



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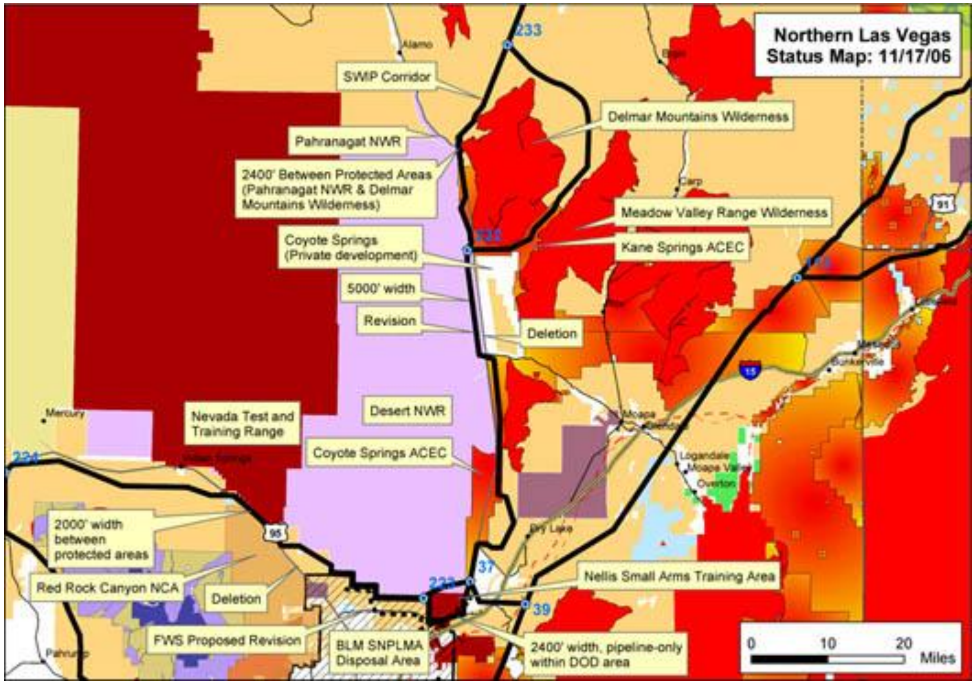
Spatial Database Provided Critical Information for Locating Corridors on Federal Land

- GIS managed over 100 unique layers: Local detail at a West-wide scale
- Numerous siting constraints, including:
  - Physical barriers, such as, mountain ranges, canyons and rivers, and other pinch points
  - Land use restrictions and protected natural resources, such as,
    - National Parks and Monuments,
    - National Wildlife Refuges,
    - Wildernesses and Wilderness Study Areas, and
    - Areas of Critical Environmental Concern
- Stakeholders required visual presentation of the process and the proposed locations
- **A GIS data and analysis approach was the only practical means to locate draft corridors**



Geographic Information System Managed over 100 Unique Layers: Local Detail at a West-wide Scale

Current Energy Transportation Infrastructure Databases Anchored a Conceptual Corridor Network on Federal Land

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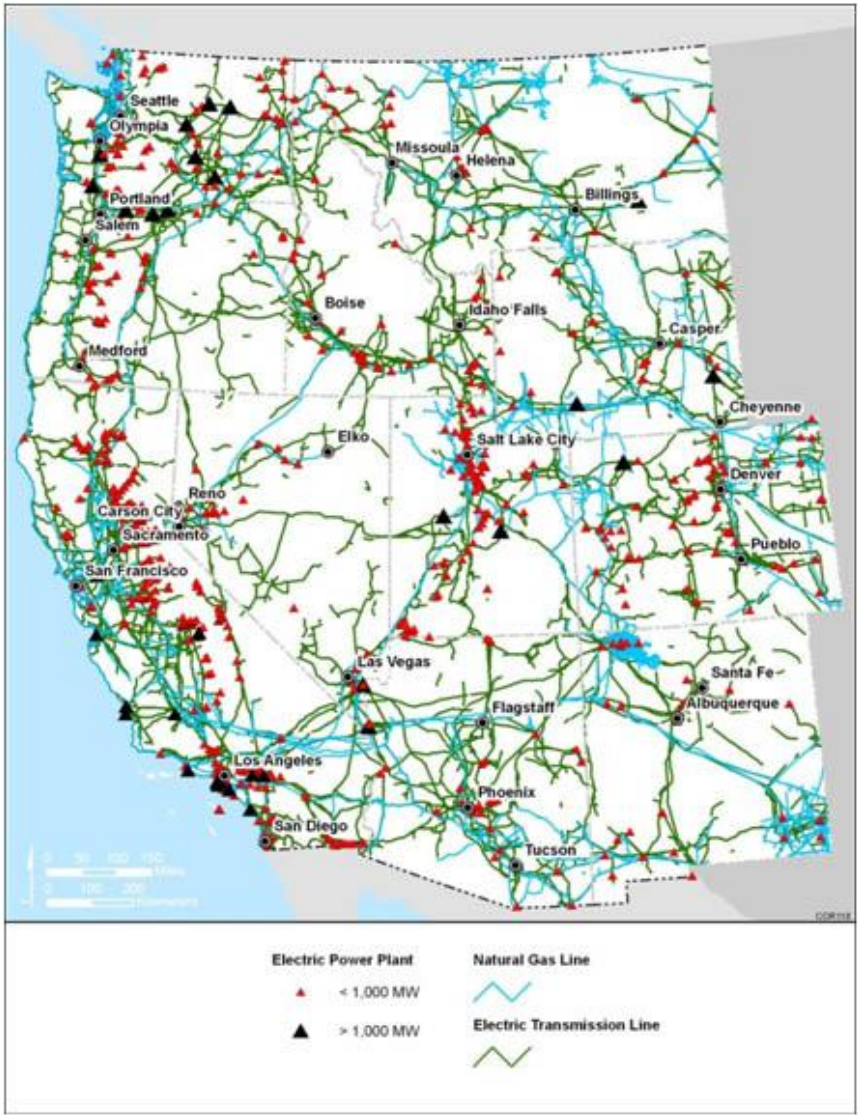
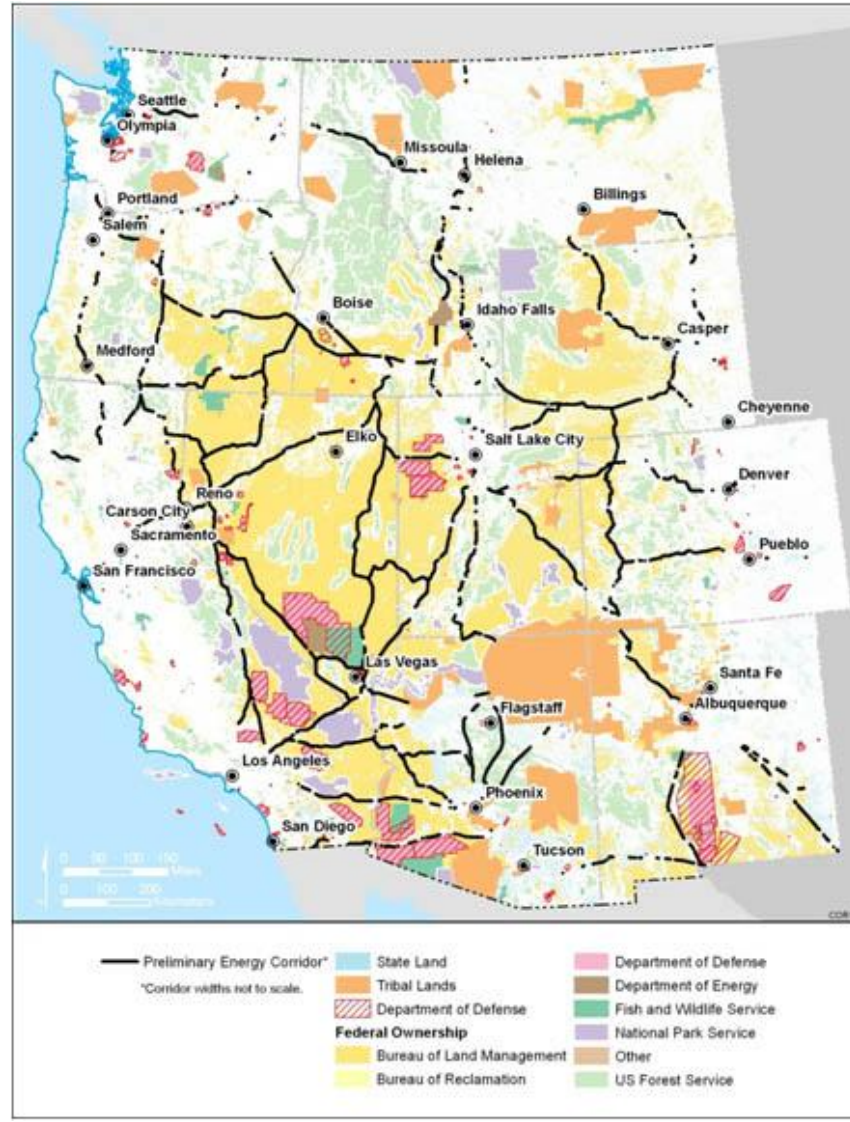
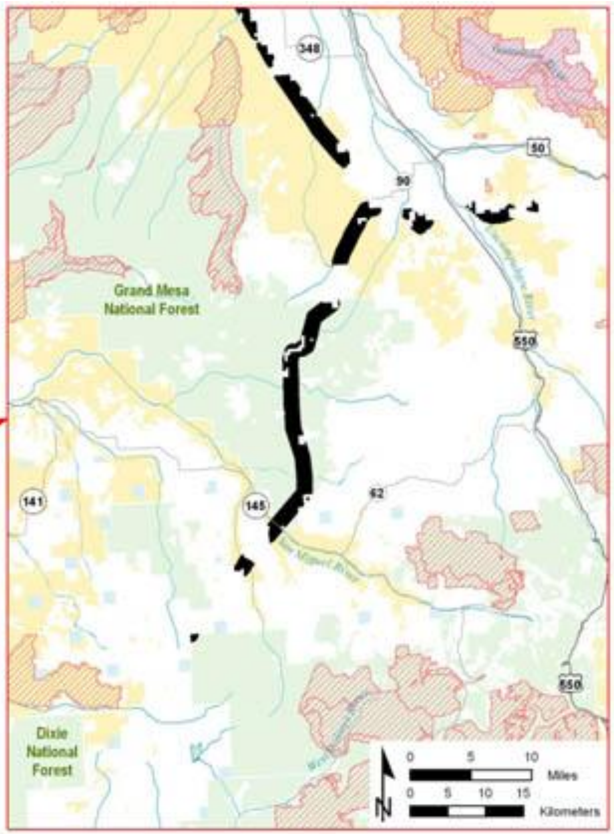




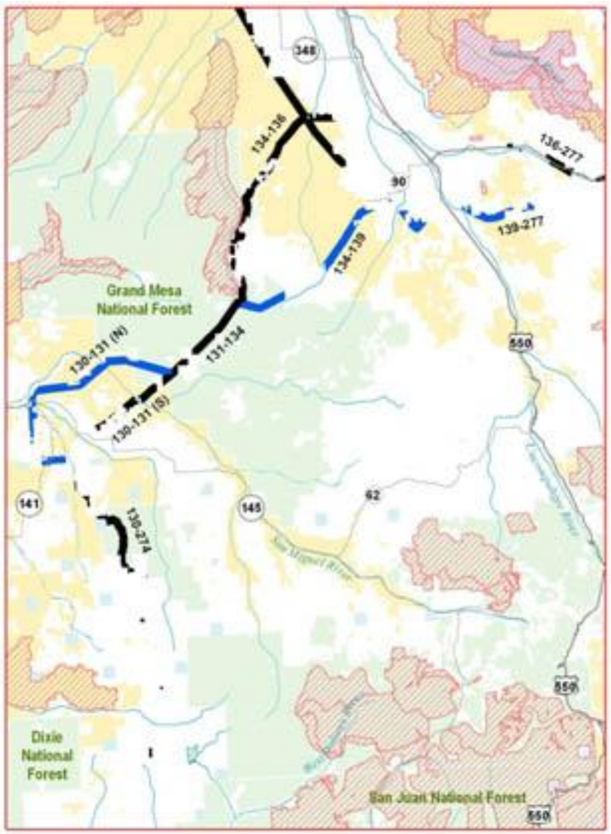
Example of Corridor Development in the First Three Phases (SW Colorado)

Conceptual network

Preliminary refinement



Local refinement



GIS data and analyses were used in public meetings to demonstrate the planning process

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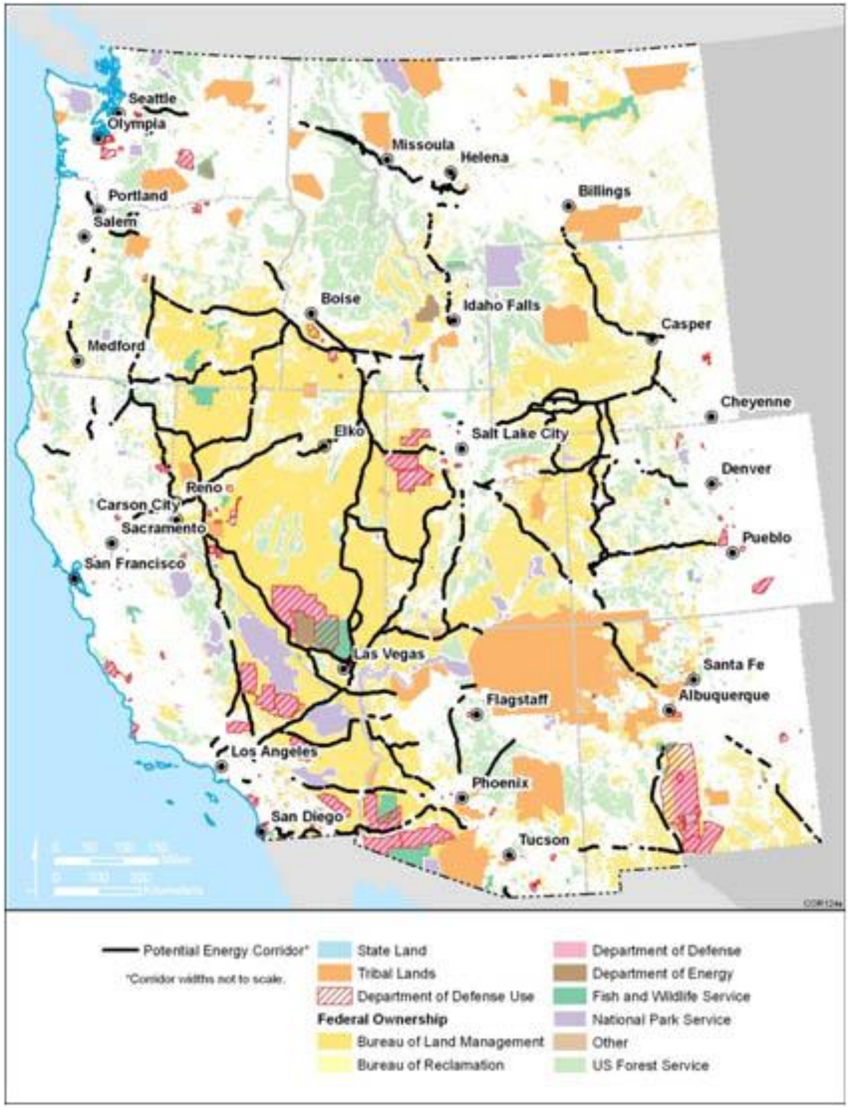
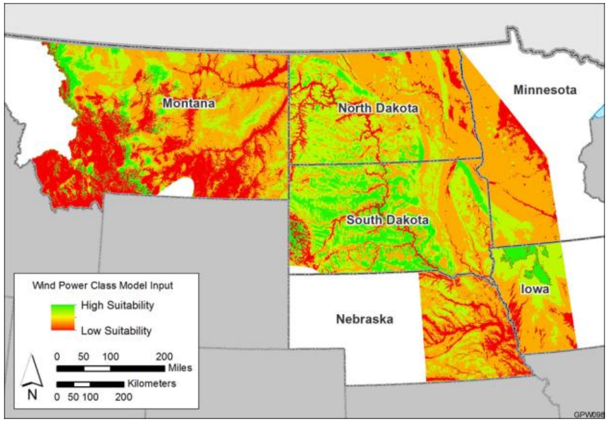
Result of the Corridor Siting Process

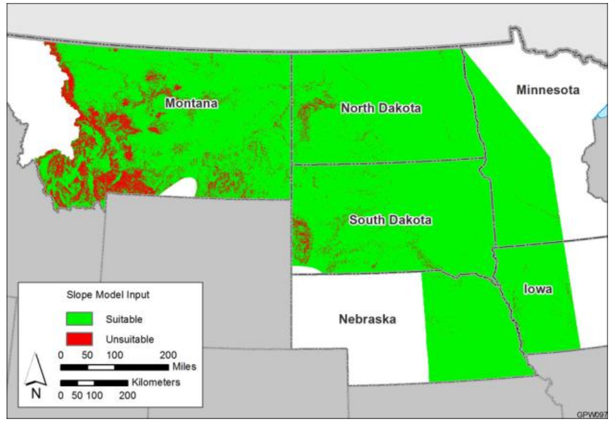
- 6,112 miles of energy corridors that cross multiple agency jurisdictions
- Avoidance of most environmentally and culturally sensitive lands
- 144 land use plans amended
- All the agencies are still on friendly terms with each other
- Corridors are being used for siting projects today



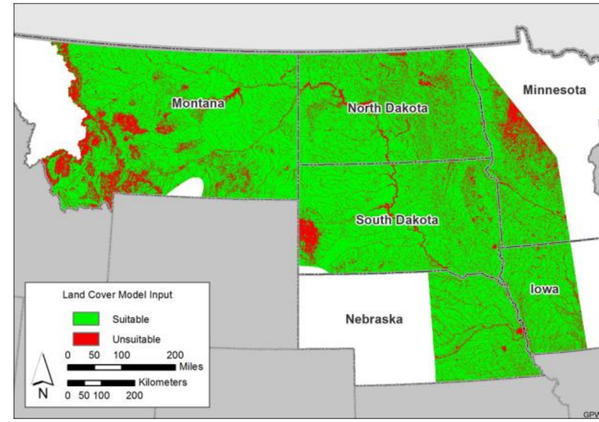
Siting Wind Energy Projects: Geospatial Attributes and Parameters



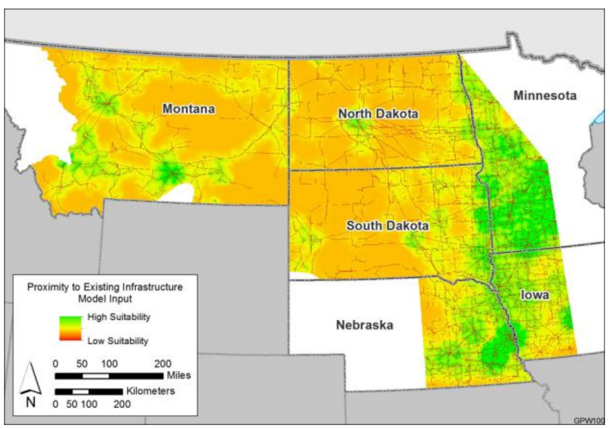
Wind power class



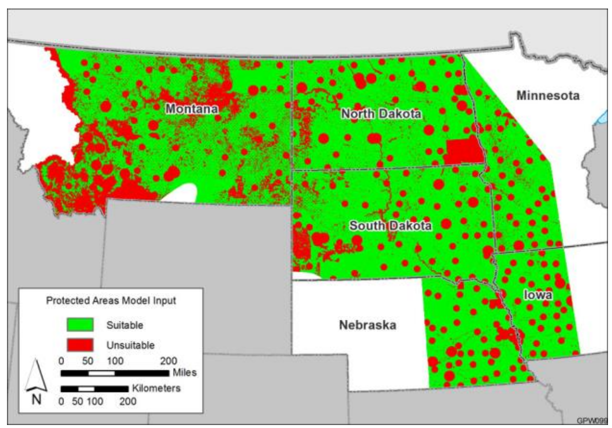
Slope



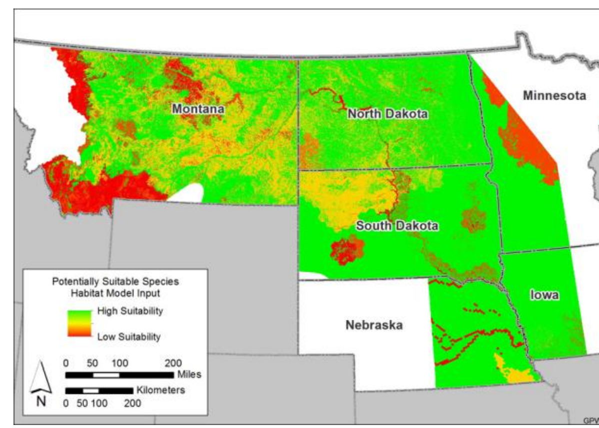
Land cover



Proximity to existing transmission infrastructure

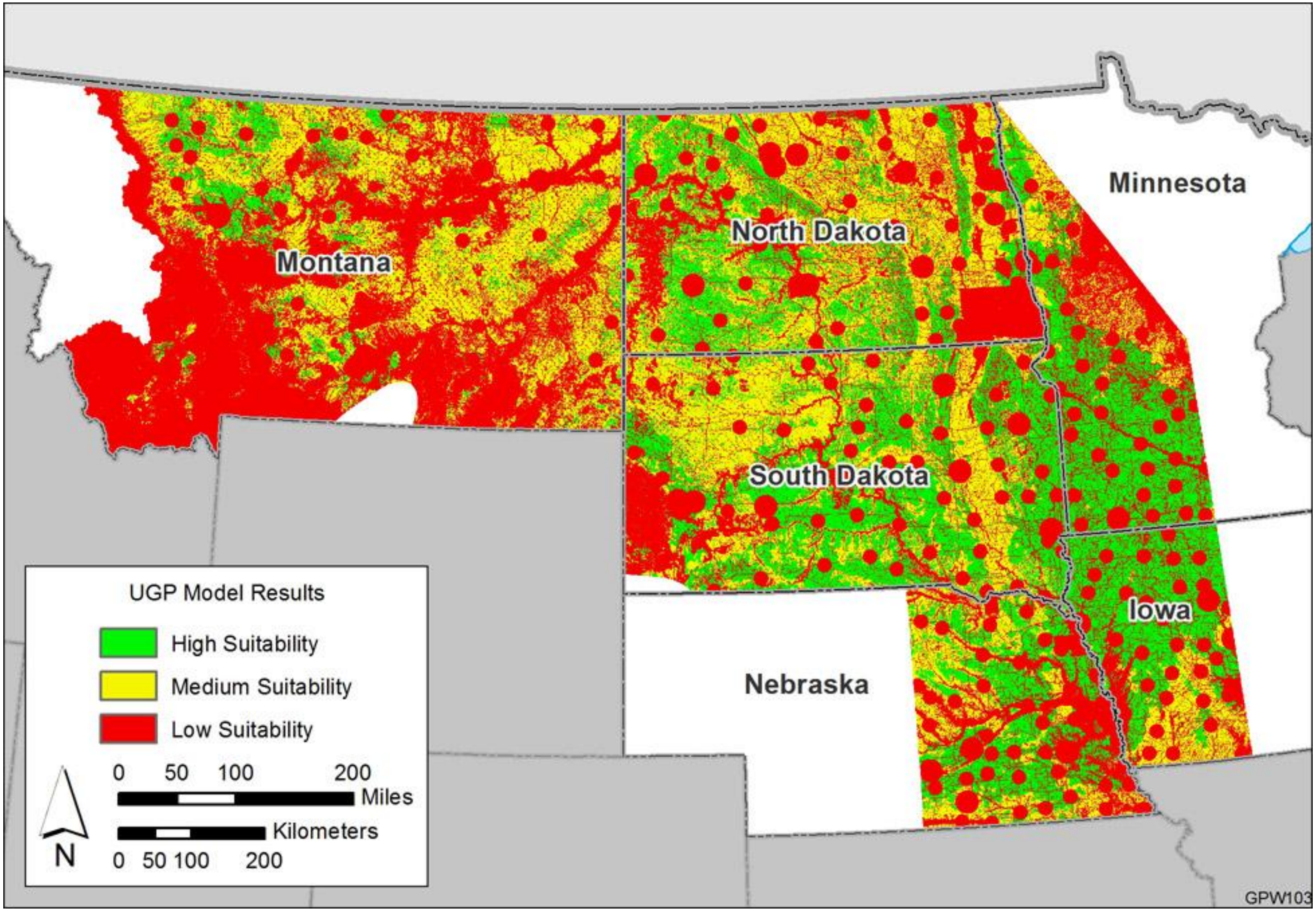


Protected areas



Sensitive species habitat

Siting Wind Energy Projects: Combined Suitability Modeling Results



Visual Impact Risk Assessment and Mitigation Mapping System (VIRAMMS)

Prototype GIS-based System

- Predict relative risk of potential public opposition to utility-scale wind development based on visual impacts

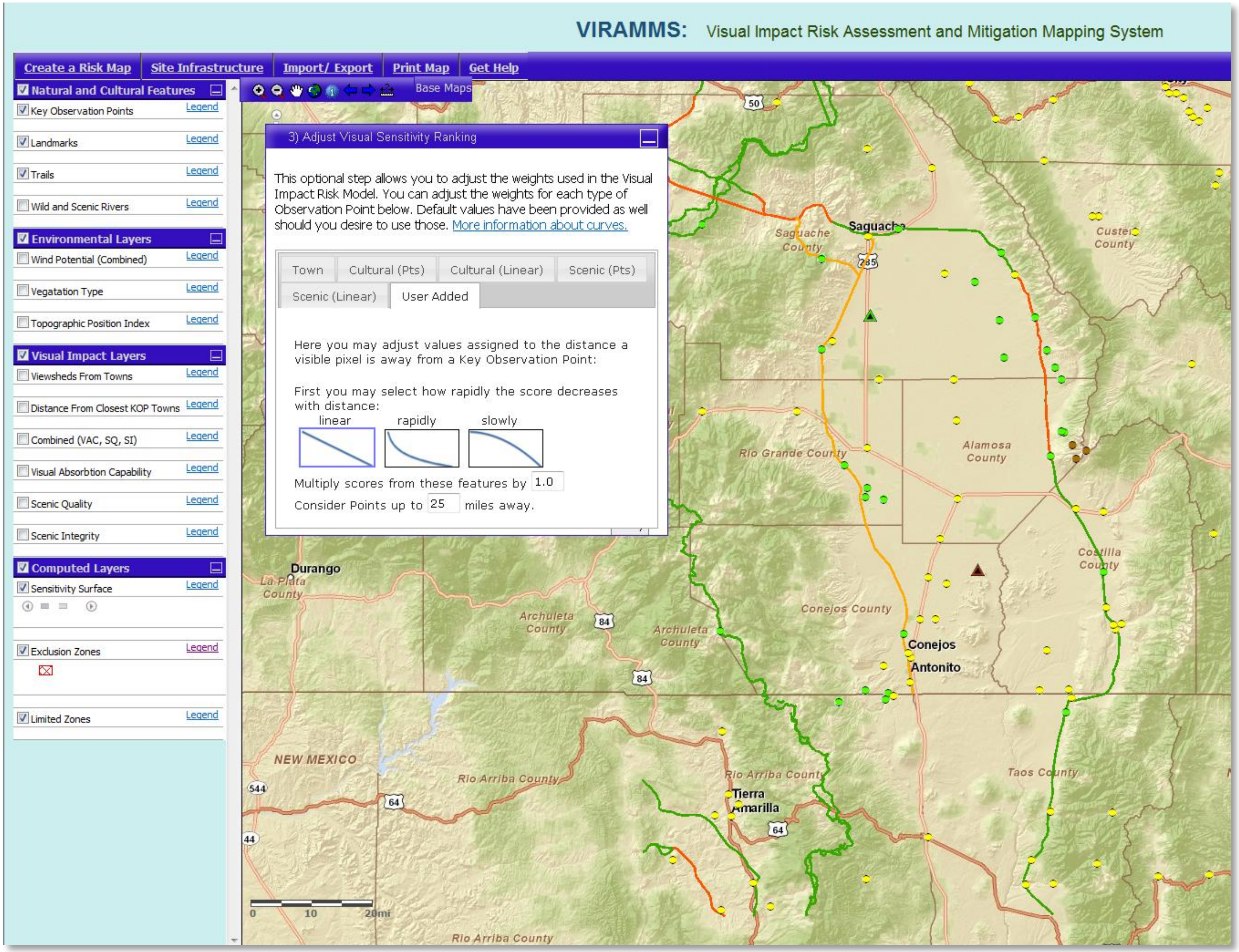
- Identify location-specific visual impact mitigation measures

- Collaborating with the University of Arkansas Center for Advanced Spatial Technologies (CAST)

VIRAMMS Has Two Main Components

- **Risk Map Creation**
  - Base spatial data layers are developed for area of interest, including known key observation points (KOPs), their sensitivity and view-sheds
  - User defines exclusion areas, e.g. urban areas, airports, etc.
  - User defines additional KOPs and their sensitivity
  - View-shed analyses (visible/not visible) are run from KOPs, adjusted for sensitivity
  - View-sheds combined to generate composite distance-weighted sensitivity map
- **Mitigation Mapping and Build Height Calculation**
  - User places facility components, e.g. turbines, transmission lines
  - Runs report to display location-specific mitigation measures
  - User specifies points or segments for view-shed generation
  - Analysis is run to define visible areas, and concealment height for non-visible areas

Adding KOPs and Adjusting KOP Sensitivity



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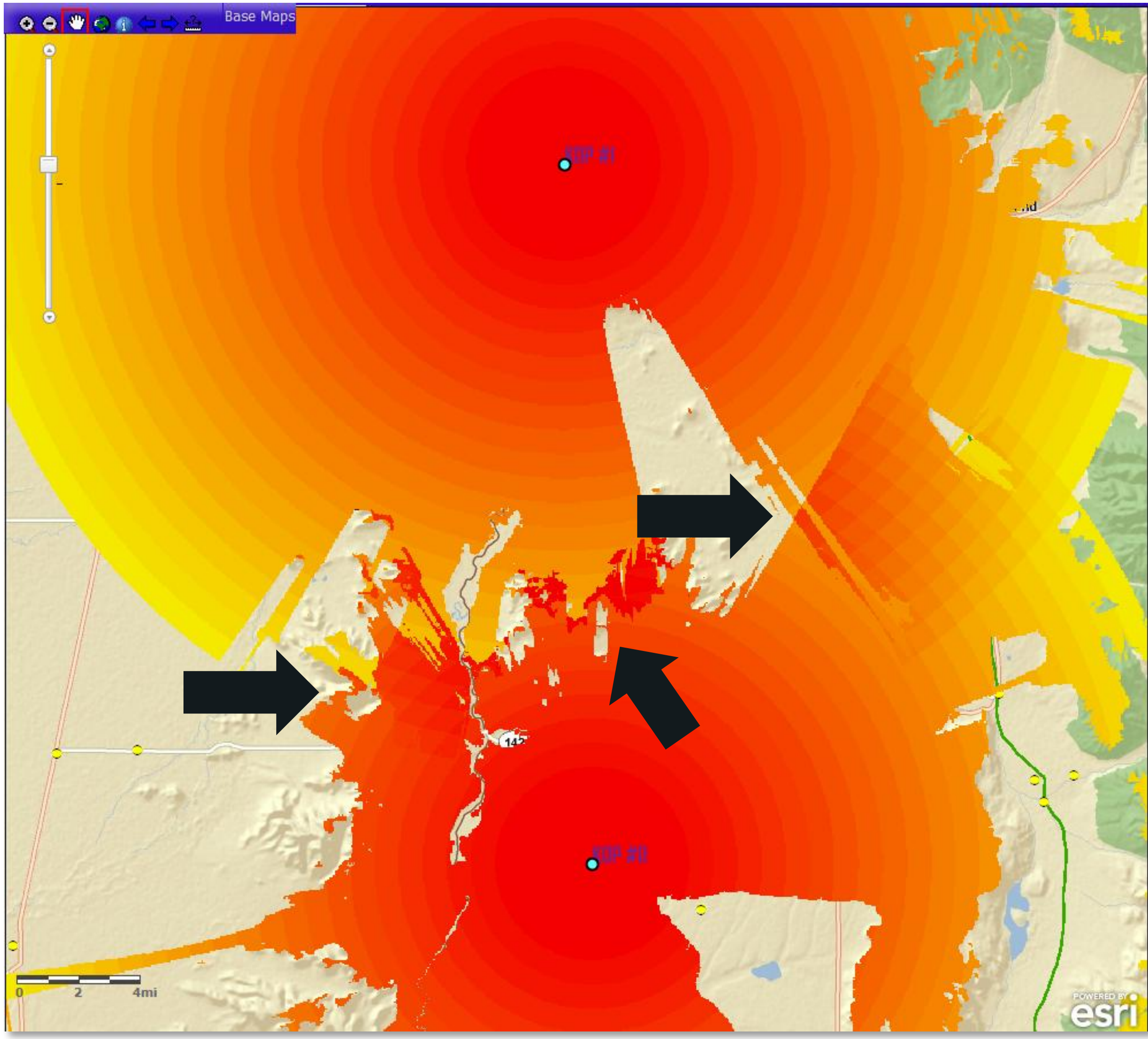
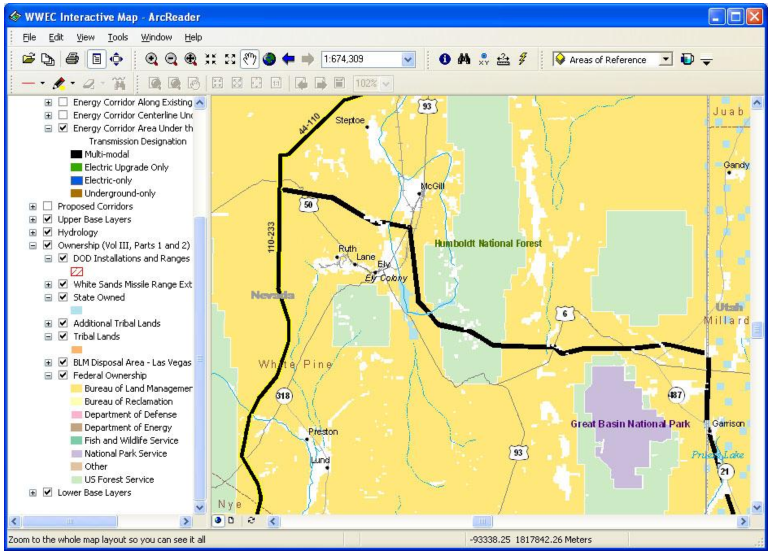
Distance-Weighted Sensitivity Analysis Example

- View-shed analyses show what is visible from KOPs
- Color shows sensitivity (red more sensitive)
- Overlap areas are visible from both KOPs, and therefore less desirable for wind energy development

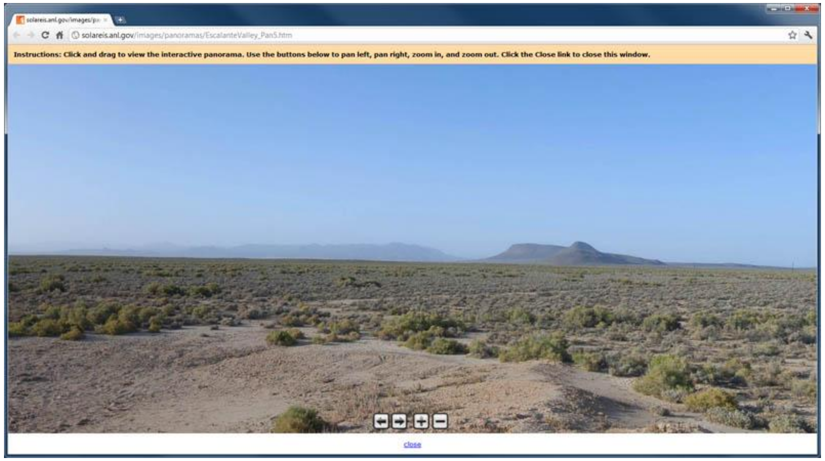


Delivering Complex Spatial Information to the Public and Decision Makers

- Webcast meetings with live GIS
- Downloadable:
  - Maps, such as map atlases, and large format maps
  - GIS files
  - GIS databases with interactive mapping projects
  - KML/KMZ files compatible with Google Earth
- Interactive panoramic photography
- Web-based applications

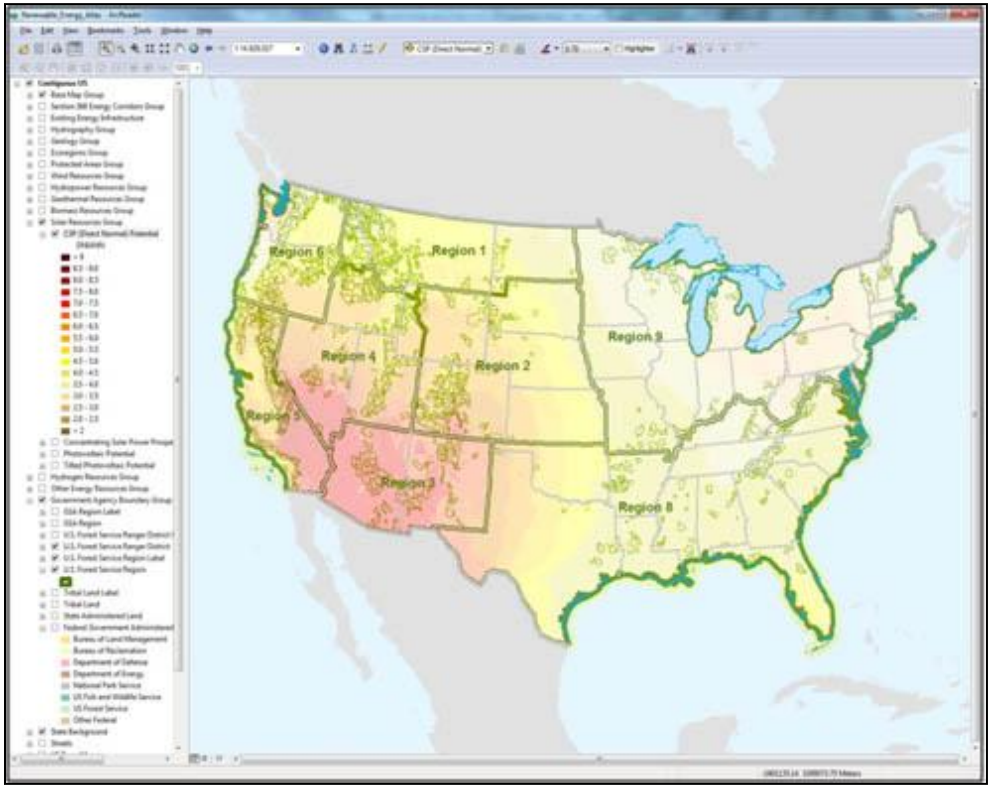


Publicly released ArcReader project with GIS database



Renewable Energy Atlas of the U.S.

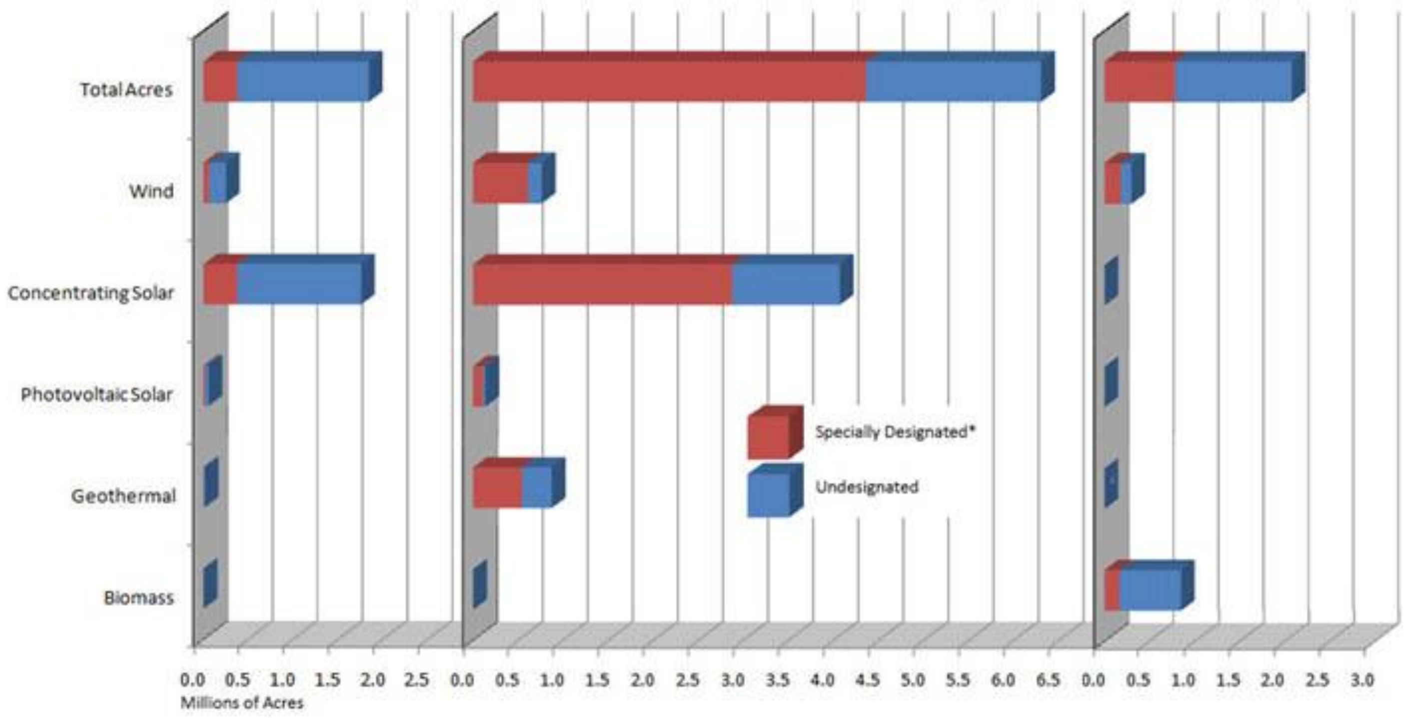
- An extensive GIS database focused on renewable energy is actively maintained to support our projects
- National coverage
- Over 17 GB of content
  - 203 layers for the Contiguous U.S.
  - 94 layers for Alaska
  - 72 layers for Hawaii
- Most layers include additional tabular data



View of the renewable energy atlas in ArcReader with concentrating solar potential and USFS forests and regions.

Renewable Energy Atlas of the U.S.
Analysis Spreadsheet

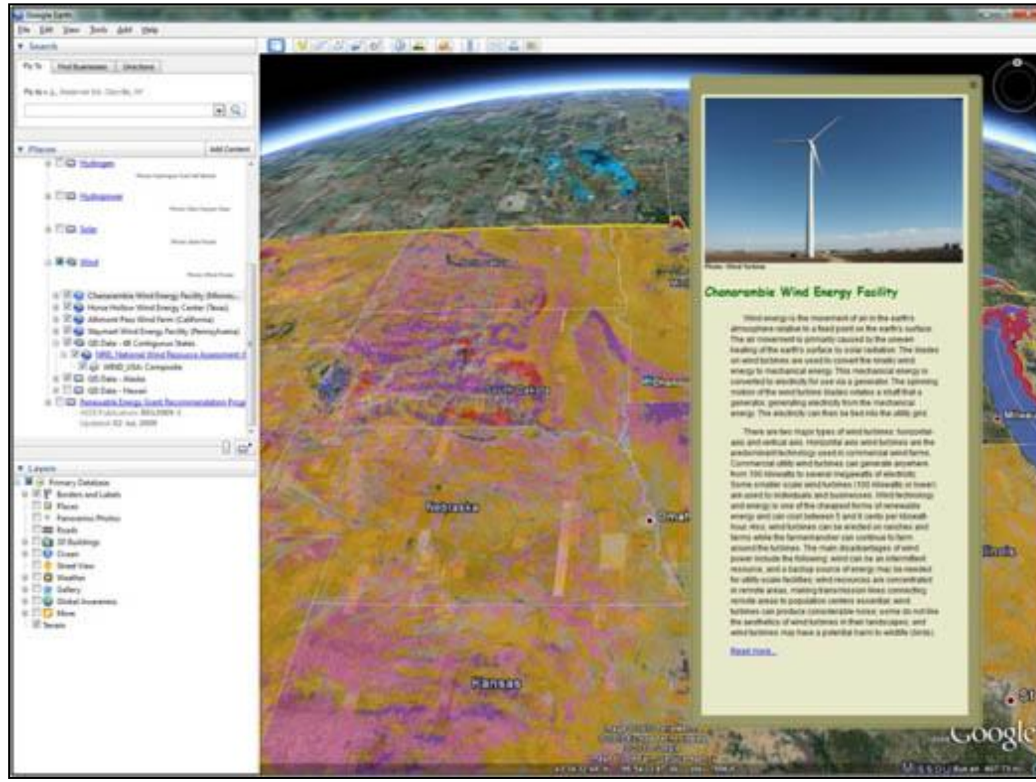
- A cross tabulation of federal land jurisdictions, protected lands, and renewable energy resources
- Contains federal land acreage and potential high quality resource acreage



Comparison of total vs. specially designated acreages and high quality renewable resource categories for Cibola, Humboldt-Toiyabe, and Shasta-Trinity National Forests.

Renewable Energy Atlas of the U.S.
KML/KMZ File Project

- Compatible with Google Earth, NASA World Wind, and other software
- Google Earth and NASA World Wind provide detailed, current imagery base maps and other overlays
- Contains renewable energy resource layers, existing project locations, and factsheets



Google Earth view of wind resource data, and a fact sheet about the Chanarambie Wind Energy Facility in Minnesota.

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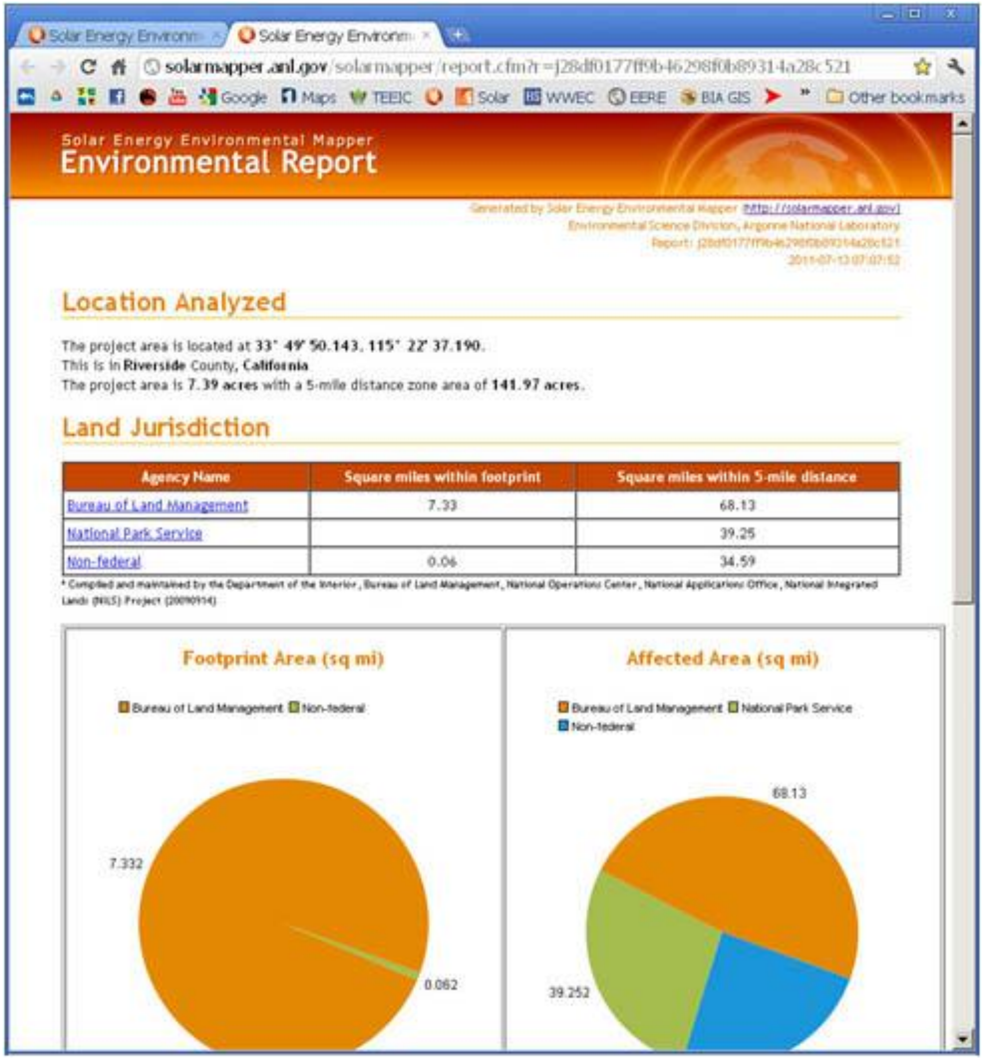
Solar Energy Environmental Mapper

- Interactive web-based mapping application
- Designed to provide access to key spatial information for the Solar Energy Development PEIS
- Analytical tools provide access to tabular information and site-specific reports

- Development of data content and analysis capabilities continues
- Collaborating with National Renewable Energy Laboratory to provide environmental content and analytical services to Solar Prospector
- Design can be easily adapted to other applications and projects

Solar Energy Environmental Mapper
Analytical Siting Report



Report tool:

- Current report focuses on land jurisdictions and protections
- Calls geo-processing service with asynchronous service
- Returns HTML report; PDF option
- Callable from other applications
- Many enhancements in progress

Conclusion

- Geo-Spatial science is an essential element in Argonne's support to the DOE
- GIS and Remote Sensing (RS) are the enabling technologies to manage, visualize, present, share, analyze, and model spatial data
- The rapidly advancing technologies allows researchers to efficiently and cost-effectively understand and analyze complex issues in a spatial context
- Visualizing data in a "mapped context" is an intuitive and effective way to share concepts and collaborate with federal, state, tribal, NGO, and public stakeholders

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