As a multi-disciplinary DOE national laboratory, Argonne's activities are diverse, and geospatial science is central to many of our projects. Our geospatial scicence work advances understanding and decision making in many areas. Examples include climate research, cultural resources, biofuels, emergency planning, environmental science, equity, grid resilience, hydrogeology, laboratory operations, land management and planning, remote sensing, transportation electrification, weather observation and analysis, web-based mapping tools, and wildfire risk.

# **EQUITY IN TRANSPORTATION ELECTRIFICATION**



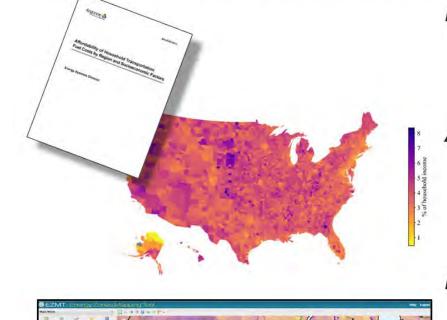
## Justice 40: 40% of the overall benefits of certain Federal investments—including investments in clean transit—must flow to disadvantaged communities.

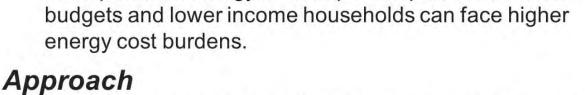
Approach Development of equity datasets, analysis publications, data sharing, and webinars. Web-based portals for mapping and modelin transportation electrification with equity considerations

Stakeholders can rapidly assess certain funding opportunities by location, and learn about available planning data, tools, and methods.

POC: Yan (Joann) Zhou, yzhou@anl.gov

# **MAPPING TRANSPORTATION ENERGY BURDE**





Transportation energy is an important part of household

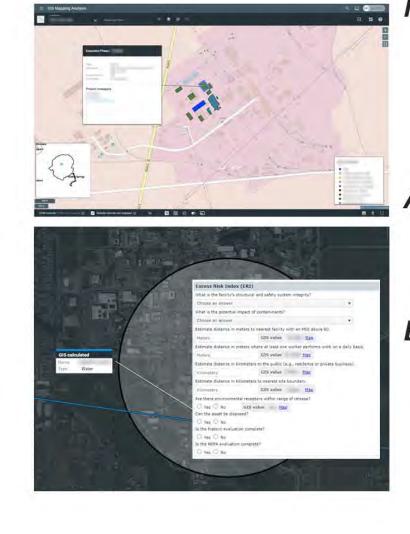
Projected household vehicle miles travelled, vehicle fuel efficiency, and fuel price data were modeled and analyzed to estimate household transportation energy burden (HTEB) at a census tract level.

## Benefits

HTEB data can be used to assess the spatially distributed impacts of additional transportation energy component costs, vehicle efficiency, or transportation policies on household transportation affordability. The results have also been used as an equity consideration in modeling potential locations for electrical vehicle charging stations.

POC: Yan (Joann) Zhou, yzhou@anl.gov

# NATIONAL SECURITY



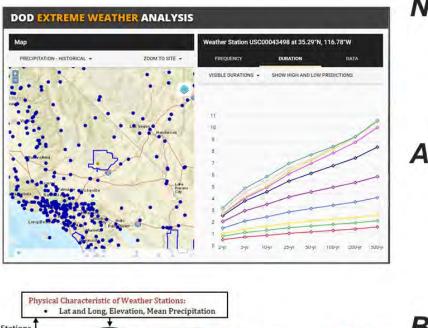
## Provide information on NNSA assets for reporting and planning, leveraging a science-based riskdriven approach to infrastructure management using criteria such as building condition, mission dependency, excess risk, and replacement cost.

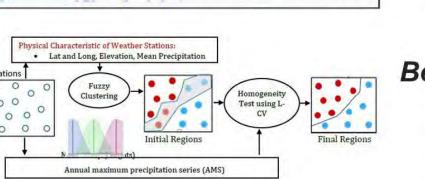
Develop and maintain mapping capabilities within the NNSA Program Management Information System, Generation 2 (G2).

Provides an intuitive interface to navigate and present complex data. Presents users with a GIS calculated value and visual explanation of individual isk factors.

POC: Doug A Johnson, Doug.Johnson@anl.gov

# HISTORICAL AND PROJECTED EXTREME PRECIPITATION ANALYSIS





Department of Defense activities require improved assessment of potential changes in future intensity and frequency of extreme rainfall and snow melt events, and their associated impacts on critical infrastructure and operations.

## Approach

Historical weather data and dynamically downscaled future climate projections were statistically analyzed and geographically interpolated to generate

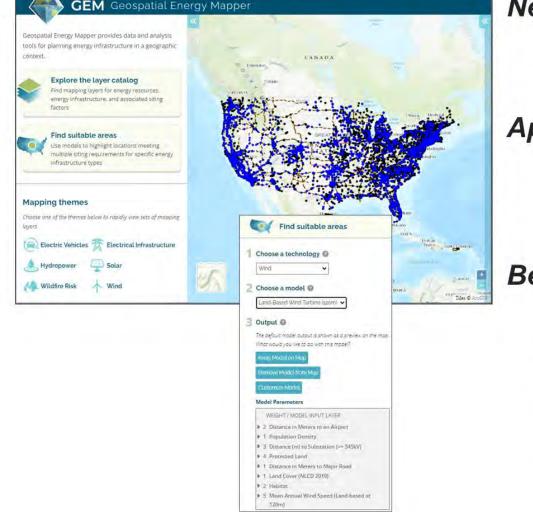
Intensity-Duration-Frequency (IDF) curves. Results were deployed in a web-based portal.

## Benefits

IDF curves are used when designing or upgrading drainage systems and flood-sensitive structures. Projected rainfall and snow melt IDF curves considering historical trends and future climate changes will enable designs today to remain robust in the future.

POC: Eugene Yan, eyan@anl.gov

# **GEOSPATIAL ENERGY MAPPER (GEM)**



Provide a versatile and convenient mapping an modeling capability for energy infrastructure location screening

# Web-based mapping portal coded with open-

source components and populated with energy resource, energy infrastructure, and key siting

# Benefits

GEM provides a large repository of energy frastructure data for mapping, analysis, and nodeling in a convenient web-based interface Models in GEM generate "heat maps" showing locations best meeting an array of user-specified siting factors, allowing for rapid screening-leve identification of potential energy project locat

POC: Jim Kuiper, ikuiper@anl.gc

## E ANALYSIS AND PLANNING TOOL RESILIENCE



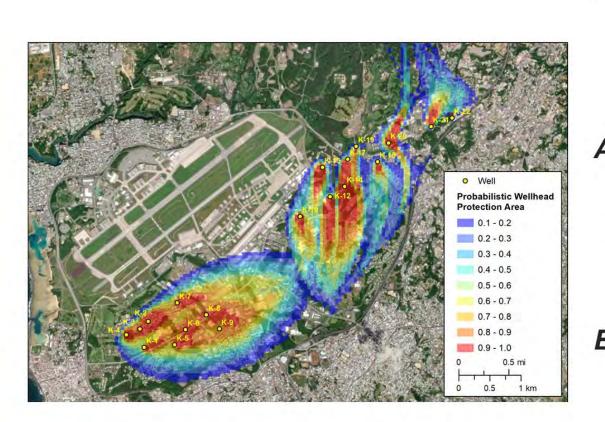
## Emergency managers need easy access to geospatial information to visualize and analyze critical community data in order to improve planning, response and recovery initiatives.

RAPT provides anyone access to powerful data and easy-to-use GIS mapping that can help everyone understand their community. The tool publicly available with no log-in required at www.fema.gov/rap RAPT includes GIS data layers of community characteristics the epresent potential challenges to disaster resilience, important data layers for equity considerations, and community infrastructure locations and characteristic

RAPT allows users to combine data layers to gain a holistic view o challenges to community resilience. RAPT promotes more inclusive nd equitable planning by providing population characteristics, luding language spoken in the home, people with disabilities EMA Community Resilience Index. RAPT also includes hazard d and forecasted future conditions data such as sea level rise

POC: Carmella Burdi, CBurdi@anl.gov

# **GROUNDWATER MODELING**



## Link groundwater modeling results (in this case, probabilistic capture zones determined for a wellhead protection plan) to a detailed GIS.

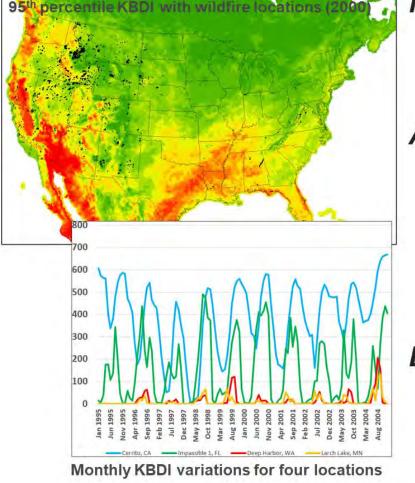
Generate groundwater flow model, determine capture zones using probabilistic approach to address hydrogeological uncertainty, and

## export results to a GIS. Benefits Users can explore the potential

groundwater contamination sources within the capture zones

POC: John Quinn quinnj@anl.gov

# **WILDFIRE RISK**



## Greater understanding of current and projected future wildfire risk will aid in land management and emergency planning

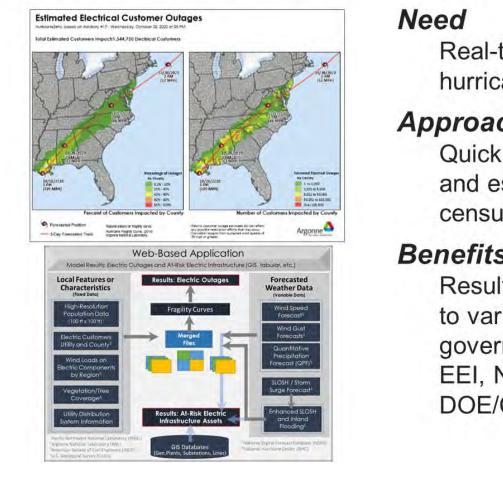
Historical and future climate projections were used to compute the Keetch-Byram Drought Index (KBDI), an index used to describe wildfire potential. Work continues in computing more advanced wildfire risk metrics, including the California Fire Weather Index (CFWI).

# Benetits

These datasets help provide a scientific basis for land management practices, increasing public safety, and improving infrastructure resilience.

POC: Jiali Wang, jialiwang@anl.gov

# HURRICANE ELECTRICAL ASSESSMENT DAMAGE OUTAGE TOOL (HEADOUT)



# Real-time support of DOE response activities during hurricane season.

Approach Quick turn-around tool to identify bulk assets at-risk and estimate customers at-risk of electric outage by census tract, county, and State.

# **Benefits**

Results are disseminated by DOE-CESER/ESF-12 to various stakeholders, including federal and state governments, and electric industry partners (APPA, EEI, NRECA, mutual aid networks). Also provided to DOE/CESER EAGLE-I emergency response tool.

POC: Leah Talaber, Italaber@anl.gov

# LABORATORY OPERATIONS

Current, precise, geographically referenced data of Argonne's facilities, infrastructure, and systems

Enterprise GIS, mobile data collection devices, web-based mapping portals and dashboards, integration of laboratory procedures and information

Supports laboratory-wide system integration and spatial data analytics

POC: Joseph Tauer, jtauer@anl.gov



# Geospatial Science Powers a Broad Array of Projects at Argonne National Laboratory

# **ARGONNE'S TELCOFAST TOOL**



r of days with maximum temperatu

an Free Mar Ann May Jun Jul Ann Snei Ors Nev Dec

tuational awareness for system operators on the impacts of various ubsequent loss of communication and control capabilities for other critical infrastructures

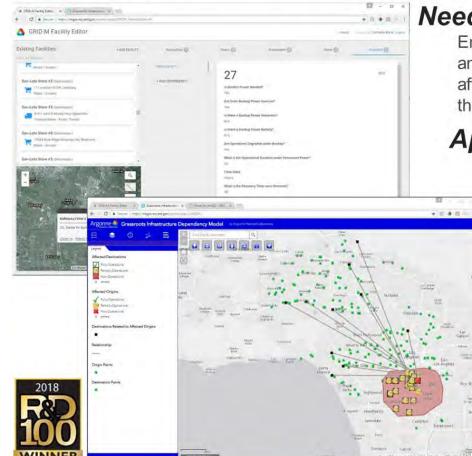
## Approach TelcoFast' has a network module with information on ~30,000 wire an

- wireless centers and ~345,000 cellular-microwave towers in North Methodology determines wire center (central office) and mobile
- ving a given site or region. switching center (MSC) ser agility curves used to predict how loss of cellular-microway
- ower/antennae during storms affects voice and data transfer GIS-based approach to determine what critical infrastructure could
- be adversely affected by disruption of these wireline and wireless

A web-based tool to quickly determine at-risk wireline and wireles ommunication assets serving a given critical infrastructure site or regior Jsers can identify assets whose disruption would lead to loss of mmunications.

POC: Steve Folga, sfolga@anl.gov

# S INFRASTRUCTURE DEPENDENCY MODEL – GRID-M



## Emergency managers need to be informed about supply chain secur and resilience. SLTTs need assistance in understanding how they can affect change to increase the resilience posture of the supply chains that are most critical to their community

GRID-M provides SLTTs with a simple supply chain question s that can be mapped to provide operational status of each supply nd demand node (operational, partially operational, or not outage or disruption data from utility providers with predetermined pecific coping strategies (e.g. backup power) based on a pre-incident limited infrastructure survey.

GRID-M displays all outputs within a Geographic Information Systems environment with additional prepopulated layers such as real-time traffic and demographics information of the affected communities. This information can also be paired wi limited damage survey (e.g. a windshield damage sessment) to further provide situational awareness for eac node within supply chains of interest.

POC: Carmella Burdi, CBurdi@anl.ge

# GEOGRAPHIC ANALYSIS TOOL KIT FOR REGIONAL CLIMATE ANALYSIS (GATOR) Historic, 1995 to 2004 RCP 8.5 Scenario, 2085 - 209

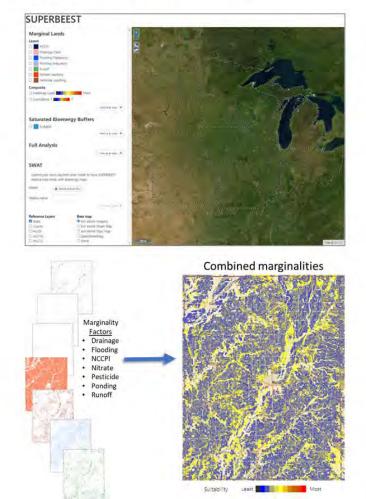
Facilitate generating analytical climate statistics from raw climate data for planning and analysis. Approach

Condensed data repository of historical and projected future climate metrics (e.g., precipitation wind, temperature) for North America, paired with open-source python code designed to compute statistics and output results as GIS files.

Benefits GATOR facilitates computing historical and projected future climate statistics (e.g., heat waves, percentiles, annual/monthly averages) useful for infrastructure planning and studies of the potential effects of climate change.

POC: Jim Kuiper, jkuiper@anl.gov

# **SUPERBEEST**



## A decision support tool is needed for analyzing perennial bioenergy crop adoption in marginal farmland. The goal is to grow the bioeconomy while minimizing land use change and improvir agriculture's impact on the environment.

Approach

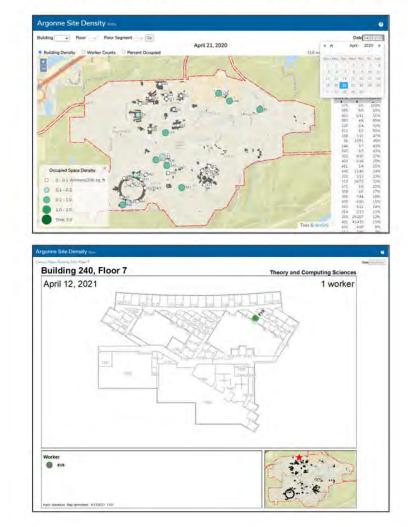
The Scaling Up Perennial Bioenergy Economics and Ecosystem Services Tool is under development. Marginal land delineation is based on USDA and USGS data. Ecosystem services and economic aspects are being determined.

# Benefits

Reduced greenhouse gases and biomass cost. Improved carbon sequestration and water quality

POC: John Quinn quinnj@anl.gov

# LABORATORY COVID-19 REDUCED OPERATIONS



# Need

Timely awareness of laboratory-wide and within-building worker numbers and densities accessible in web-based portal

# Approach

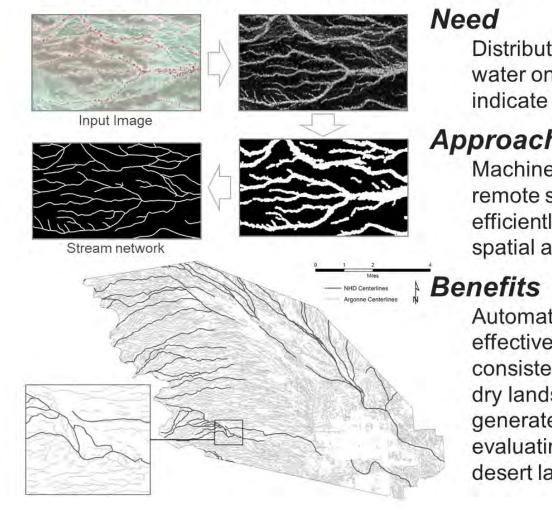
Teamwork between laboratory operations, and science and technology geospatial staff

Benefits GIS helped to safely restart operations during

COVID

POC: Michael Dunn, mdunn@anl.gov

# MAPPING EPHEMERAL STREAM NETWORKS ON DESERT LANDS



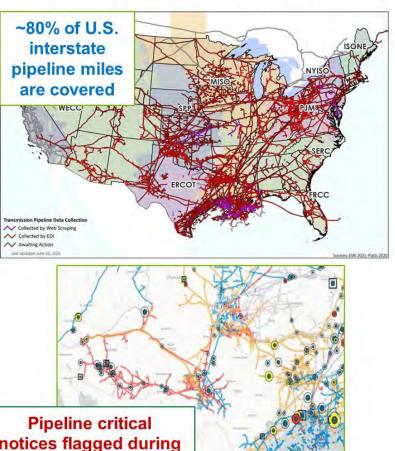
Distributions and dynamics of dry streams, which convey water only after heavy rain, impact desert ecosystems and indicate potential hazards for energy infrastructure. Approach

Machine vision techniques with high-resolution optical remote sensing provide a snapshot of desert streams efficiently. A series of stream-network maps could show spatial and temporal patterns of change in water flow.

Automatic mapping would improve efficiency and effectiveness of habitat management by providing timely, consistent information about stream-networks across large dry lands. In conjunction with climate data, stream maps generated overtime would help energy developers in evaluating potential weather-related risks to their assets in desert landscape.

POC: Yuki Hamada, yhamada@anl.gov

# **SHT: NEAR-REAL TIME NATURAL GAS DATA COLLECTION, PROCESSING, AND ANALYSIS**



2021 Texas cold snap

Natural gas and power grid system operators need situational awareness of potential constraints in interstate natural gas pipeline

Approach

- *NGinsight* provides national-level, near-real-time natural gas situational awareness by collecting data directly from interstate pipeline operators, including:
- Gas volumes consumed by individual customers (20,000+ points oscribed capacity available for additional available supply cal and non-critical notices; planned service outages. ritical notices are mined using Machine Language to flag potential

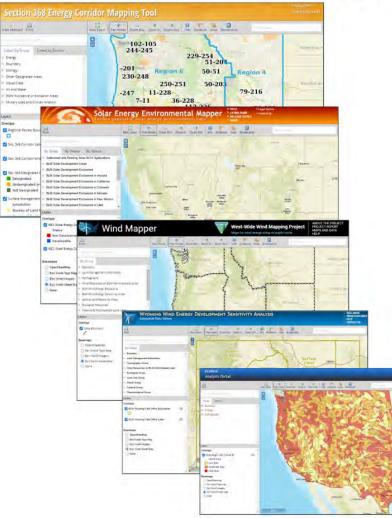
## Benefits

gas delivery constraints

NGinsight makes public pipeline information more accessible reliable, and useable - improving responsiveness to gas disruptions and changing market demands. The NGinsight dashboard couples ctric generation and gas fuel adequacy data, facilitating near-real-time natural gas and electric power modeling and analysi

POC: Steve Folga, sfolga@anl.go

# **RAPIDLY-CONFIGURABLE WEB-BASED PORTALS**



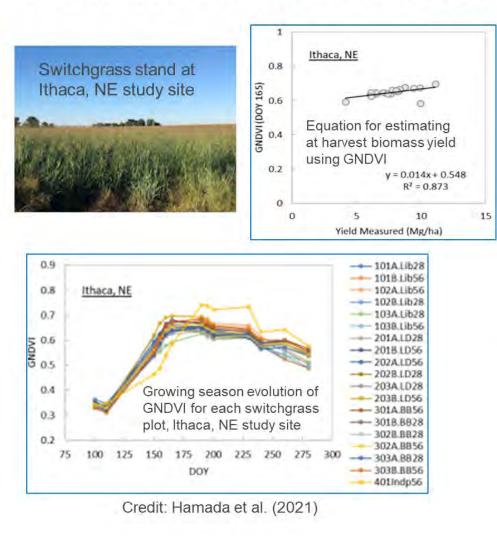
Rapid-deployment of project-specific web-based mapping portals to provide all stakeholders w decision-making data

The "basic online GIS" (bogi) framework was created using open-source software. Form-based idministrative tools allow for customization of mo content, and routine data updates and configuration

Shared framework based on open-source onents reduced overall cost and increase flexibility. Form-based administration empower updates to be made rapidly without develope assistance

POC: Andrew Ayers, aavers@anl.g

# **ADVANCED AND SUSTAINABLE ENERGY CROPS**

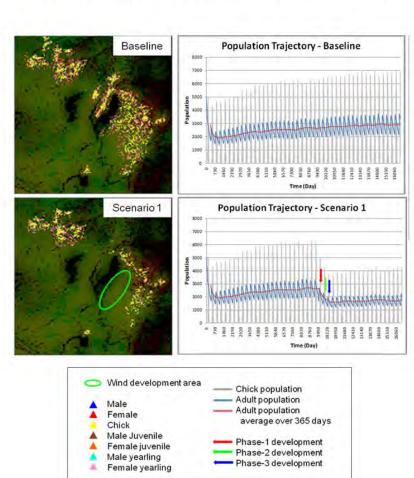


### Sustainable, large-scale production of biomass for bioenergy and bioproducts requires using high-yielding perennial bioenergy crops grown in marginal agricultural lands. Marginal agricultur lands often exist in sub-field scale and are spread as small areas around the agricultural landscapes. A tool is needed to estimate bioenergy crop agronomic attributes (e.g., biomass yield and quality) at harvest time at the sub-field scale.

Explore suitable algorithms that could estimate at harvest agronomic attributes based on the growing season dynamics of elevant biophysical indices (e.g., normalized difference vegetation index (NDVI), green NDVI, etc.) using Sentinel-2 imagery (10 m spatial resolution) validated by field collected data at five study sites across four states.

Remote sensing approaches allow us to estimate sub-field scale biomass yield and quality, which are important biomass metrics or biomass farmers, biofuel refineries, conservationists, etc under the proposed sustainable biomass production system. They could also provide cost-effective means of generating high volume of quality data for ML/AI applications in environmental and agricultural domains.

POC: Jules Cacho, jcacho@anl.gov



How would wildlife respond to energy facilities? What are population-level effects? Exploring these questions at the early siting stage is the key to balancing energy

development with conservation.

Approach

An agent-based model (ABM) indicates population-leve effects that emerge from individua animals' behavior survival, and reproductive success.

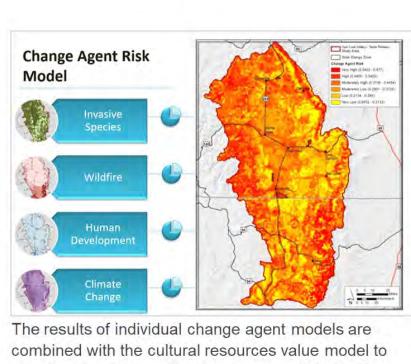
## Benefits

**ENERGY DEVELOPMENT EFFECTS ON GREATER SAGE-GROUSE** 

Wildlife ABM modeling can reduce energy-wildlife conflict and improve benefits for the energy industry through proactive assessment of energy development implication for wildlife species population. Siting managers can compare projected effects across multiple plans, such as different project locations, areas, and configurations, to make ecologically mindful siting decisions.

POC: Yuki Hamada, yhamada@anl.gov

# **CULTURAL HERITAGE VALUES AND RISK ASSESSMENT**



Luis Valley-Taos Plateau from a combination of all

hange agents.

Regional landscape-scale resource management on public lands allows for a responsive posture capable of meeting challenges of

- environmental and social change. Objectives: Document the most important and at-risk cultural resources that have shaped regional history
- Evaluate cultural resource vulnerability to change agents over time (e.g., human development, climate change, wildfire, and invasive species)
- Focus regional mitigation efforts on the most important and atrisk cultural resources

Developed a cultural heritage values and risk assessment strategy to support interagency land use planning in the West

Benefits visualize the risk to cultural resources within the Sa

This approach allows for a responsive posture capable of meeting challenges of environmental and social change. Comprehensive landscape assessments afford better long-term planning and adaptive management across economic, administrative, and jurisdictional

POC: Konnie Wescott, Wescott@anl.gov

