Natural Resource Impact Studies

Programs and projects in the natural resources area address how physical and biological systems are potentially affected by human activities, especially issues associated with air quality, water resources, and ecological systems.

PROBLEM/OPPORTUNITY

Applied and basic research studies in natural resources support nationally important energy-environment and land management issues, often defined by major federal actions or policies.

Federal agencies frequently lack sufficient information regarding characterization of air, water, and ecological resources on land areas that they manage. This information is critical for making informed decisions about operations, construction projects, and land management practices within the framework of environmental compliance and stewardship of natural resources.

Complex spatial dynamics, multiple ownership patterns, perceived winners and losers, and limited data provide fertile ground for developing new approaches for natural resource management studies.

APPROACH

Projects range from single disciplinary problems to large integrated studies involving teams of engineers, physical scientists, and ecologists.

In support of air resource studies, Argonne's Environmental Science Division (EVS) staff have been actively involved in developing, improving, and validating advanced computer models in the areas of pollutant releases over complex terrain, accidental releases of toxic chemicals, chemical hazard and risk assessments, photochemical processes, long-range transport, cooling tower impacts, and community noise impacts. The staff also evaluates technologies for emission control and process changes for emission minimization.

To assist in analyzing and visualizing complex watershed dynamics, EVS staff utilize watershed models coupled to a geographic information system (GIS) to provide the core operational system. Specific model variables and parameters contained within the GIS are photorealistically positioned within a 3-D watershed to provide a quantitative, but visual, interface for model initialization, scenario development, and model output.

Ecological impact studies include ecological risk assessments (ERAs) that are conducted to evaluate the likelihood that adverse ecological effects could result from the exposure to one or more chemical and/or radiological contaminants in the environment. ERAs also provide needed information to adequately develop and evaluate remedial alternatives that best balance cost with environmental objectives that are protective of human health and ecological concerns.

EVS provides support to the U.S. Department of Energy (DOE), the Department of Defense (DOD), and other federal agencies in all aspects of ERA, including the design and conduct of site-specific ERAs, technical reviews, policy and guidance development, and training.

Ecosystem evaluations for developing and modifying installation management practices can also take the form of biodiversity studies to determine the relative abundance and habitats of rare, threatened, and endangered species.

RESULTS

The following are illustrative examples of completed or ongoing projects in natural resource impact studies.

Riparian habitat studies by EVS ecologists have been assisting federal agencies in developing flow recommendations for hydropower production on the Upper Colorado River. Protection of warm water habitats

used by native fishes has been a key component of the flow analysis studies. As part of the habitat analysis, EVS staff used aerial videography to delineate backwater habitats and riparian vegetation along a 60-mile segment of the Green River below Flaming Gorge Dam.

Individual-based models have been used for evaluation of possible impacts on threatened and endangered species of energy-related facilities. The models can be used to predict population- or community-level responses by aggregating individual responses. Example applications are the evaluation of impacts on the sage grouse from oil and gas development in Wyoming and the balancing of hydropower production and the protection of downstream fish populations in Utah and Colorado.

In the fishery studies, trout production was simulated as a function of daily flow fluctuation, which affected factors such as water depth, velocity, and temperature; fish movement and feeding behavior; and availability of drifting food. Strategies for dam operations to minimize impacts on fisheries can be derived from these studies.

River basin studies are used by EVS to evaluate the relationship of water resource availability and quality to the economic and demographic developments within a basin. An example is the EVS assessment of the Nakdong River Basin, the second largest river basin in Korea. EVS staff worked with the Research Institute of Industrial Science and Technology (RIST) in Pohang, Korea, to develop a Hydrological Simulation Program-FORTRAN (HSPF) model that analyzed three scenarios for future basin development for the years 2001, 2006, and 2011.

Results of the assessment showed that additional water quality improvements in the Kumho River probably require flow augmentation as well as increased wastewater treatment. High levels of biological oxygen demand, nitrogen, and phosphorus appear driven in part by non-point sources of pollution. Reductions in these pollutant levels will thus require both controls of non-point sources and tertiary treatment facilities for point sources.

Integrated regional air quality studies can be used to assist agencies in developing environmentally sound strategies for management of federal lands. The potential usefulness of these studies is illustrated by the results of an EVS project modeling future cumulative impacts on urban regional air quality from land development and urban growth in the Las Vegas Area. The land development was projected from congressionally mandated sales of land managed by the federal Bureau of Land Management. In the analysis, EVS utilized innovative GIS-based software tools linked to advanced models for computation and visualization of results. Field experiments were also conducted to characterize parameters for wind blown dust.

Data for use in climate models is being made available through an EVS program to develop a uniform set of software tools that can be used with the data being collected at Atmospheric Radiation Measurement Program Climate Research Facility (ACRF) sites. The objective is to satisfy the need for a single method that can be used with the data being collected at the spatial scale of the ACRF or specific AmeriFlux sites to derive suitable grid average values or column mean values of measured variables for model evaluation and data assimilation in climate models. The software products couple the latest statistical modeling tools with knowledge of relevant physical and chemical processes to develop a "climatologically aware" method for processing ACRF and other spatially sparse data sets.

The North Slope Science Initiative (NSSI) was established in 2003 by several agencies with the objective of integrating inventory, monitoring, and research activities to support a science-based decision-making process for resource-management decisions on the North Slope of Alaska. Argonne's EVS Division was called upon to develop and help facilitate three public workshops that brought together industry, government, nongovernmental organizations, interested citizens, and Alaska Native representatives to discuss the scope and issues that should be addressed by the NSSI. EVS staff produced a report on the results of the workshop, plus a draft strategy document that outlined key elements considered to be essential for a successful program and implementation plan.

FUTURE

EVS will continue single-investigator projects in core areas of ecology, air quality, data collection and modeling, and spatial data analysis and visualization. The Division will (1) expand work on large integrated science and assessment programs that address energy-environment issues; (2) assist agencies with developing new natural resource programs, such as the North Aleutian Basin Science Program for the Mineral Management Service; and (3) build on the strengths of Argonne to develop advanced capabilities for studying the responses and feedback of the terrestrial ecosystem to climate change.