Recoverability and Vulnerability of Desert Ecosystems

The U.S. Geological Survey (USGS) Recoverability and Vulnerability of Desert Ecosystems (RVDE) project is designed to provide scientific understanding to help conserve and restore threatened desert landscapes. Current research focuses on the Mojave Desert Ecosystem, which is a 125,000-km^2 landscape spread over parts of southern Nevada, western Arizona, southwestern Utah, and southeastern California. It is home to over one million people, including the Nation's fastest growing city, Las Vegas, and is within a day's drive of 40 million people. Many endangered plants and animals depend on the Mojave ecosystem. It contains four national park units, six major military training bases, and a matrix of BLM and privately owned land. Stewards of our public lands are faced with the need to make sound decisions on land use that will allow for economic, recreational, and military use, while still keeping the desert ecosystem healthy and ensuring the survival of threatened species.

USGS scientists are taking an interdisciplinary approach to understanding the physical and biological processes that influence vulnerability of the desert ecosystem to disturbance and its subsequent ability to recover. They are studying historical information, conducting experimental studies on physical and biological processes, and mapping and modeling the existing landscape. These data can be synthesized into maps and predictive models that show how ecosystem components respond to imposed stress, providing valuable tools for desert land managers. Such tools will help land managers make decisions that sustain the desert even as economic, recreation, and military uses continue.

Figure 1. Location of the Mojave Desert Ecosystem (boundary shown in yellow) and the RVDE study area (boundary shown in orange).

Mapping and Modeling Current Conditions

Because vulnerability and recovery times vary across the landscape, RVDE scientists hypothesized that landscape variables such as geology, slope, soil, micro-climate, and botanic habitat must influence how quickly an area bounces back from human impact. Modeling vulnerability and recoverability therefore requires maps of the landscape factors determined to be the most important. Existing geospatial data for the Mojave Desert, such as elevation, roads, hydrography, and Landsat imagery, were collected by the Mojave Desert Ecosystem Program and are available online at www.mojavedata.gov. Starting with these data, RVDE scientists mapped other crucial data sets, such as surficial geology and plant distribution, and modeled various complex landscape characteristics that are spatially and temporally vari-

Figure 2. Land use in the Mojave has included military, mining, grazing, and recreational activities.

able. For example, soil moisture and soil texture are two important physical landscape factors that influence several components of the ecosystem, including vegetation cover and composition, soil compaction and erosion, and biological soil crusts. Hydrologists are working on improved spatial and temporal models of soil moisture and evapotranspiration in the Mojave Desert. Geologists are developing better maps of soil texture by combining maps of surficial geology with soil sample analyses and topography. Maps of evapotranspiration and soil properties can help predict conditions conducive to biological soil crusts, a very fragile and important element of desert ecosystems. Information on current disturbance is also important. For example, RVDE scientists are collecting and analyzing data on recent fire occurrences to better understand fire characteristics in the Mojave Desert. These maps of existing landscape conditions form the base for building vulnerability and recoverability models.

Figure 3. RDVE scientists use wind tunnel experiments to study wind erosion vulnerability.

Understanding the Processes

RVDE scientists are focusing on common impacts and processes that result from a number of different kinds of activities, including disturbance or removal of the vegetation, and disturbances to the soil that result in compaction, destruction of fragile soil crusts, and increased susceptibility to wind erosion. To understand how vegetation recovers, it is necessary to understand

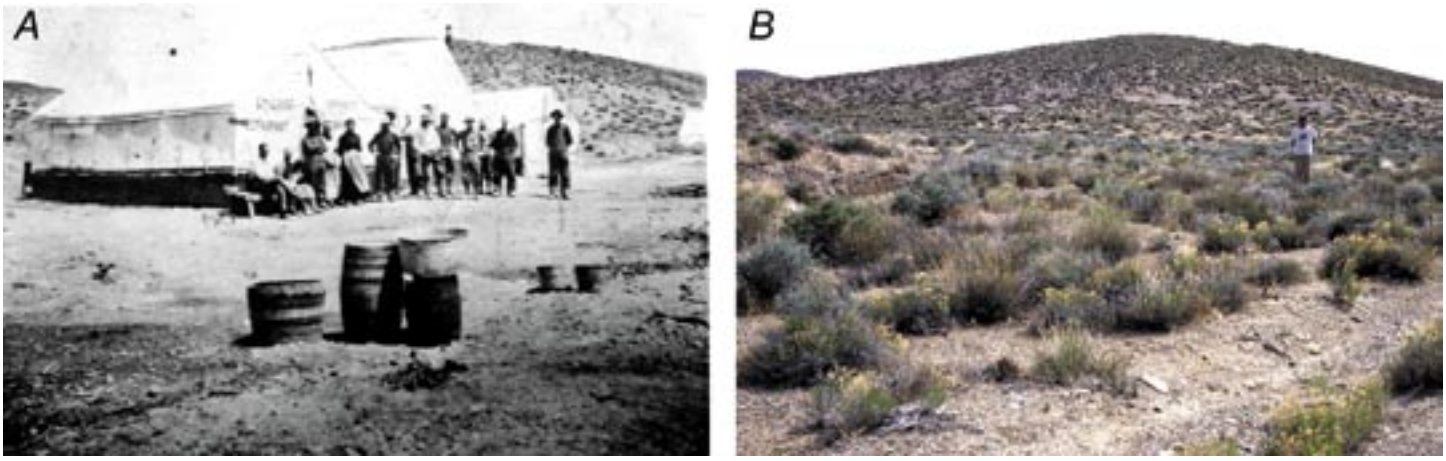

Figure 4. Harrisburg townsite, Panamint Mountains in Death Valley National Park. A, 1908 and B, 1999.

how vegetation changes naturally over time in undisturbed areas of the Mojave. Scientists are also studying vegetation recovery in disturbed areas, both in terms of percent cover and species composition. Vulnerability to soil compaction, recovery from compaction, vulnerability to wind erosion, and time for recovery of soil crusts are all functions of a number of factors, such as soil moisture and soil texture. RVDE scientists use a variety of experimental techniques to determine the functions involved in these processes.

Using the Past to Understand the Present

Some of the once-bustling mining towns that thrived in the Mojave during the early 1900s have vanished with almost complete replacement of vegetation cover, while the sites of other ghost towns are still readily apparent. USGS scientists in the RVDE project are collecting information about conditions in the past to analyze these differences in ecosystem recovery rates and thus better understand how the desert recovers. Analyses of climate history and its influence on vegetation recovery and geomorphic processes, such as overland flow, provide clues as to how vulnerability and recoverability may vary over time. Studies of areas that were disturbed in the past but have since been abandoned, such as military training areas, ghost towns, roads, and utility rights of way, provide useful data on recovery processes and times. Repeat photography is a valuable tool in the analysis of recovery. Data from old maps depicting land use history allow a better understanding of the effect of historical land use patterns on current conditions.

Modeling Vulnerability and Recoverability

To make this research useful to land managers, RVDE scientists are synthesizing this information into spatial models of vulnerability and recoverability. The maps or models of the most relevant landscape factors are combined with knowledge of landscape processes gained from experiments and field studies to derive spatial models of vulnerability and recoverability. Prototype models are being developed for soil compaction (both vulnerability and recoverability), wind erosion vulnerability, soil crust predictions, and vegetation recovery for a part of the Mojave Desert. As these

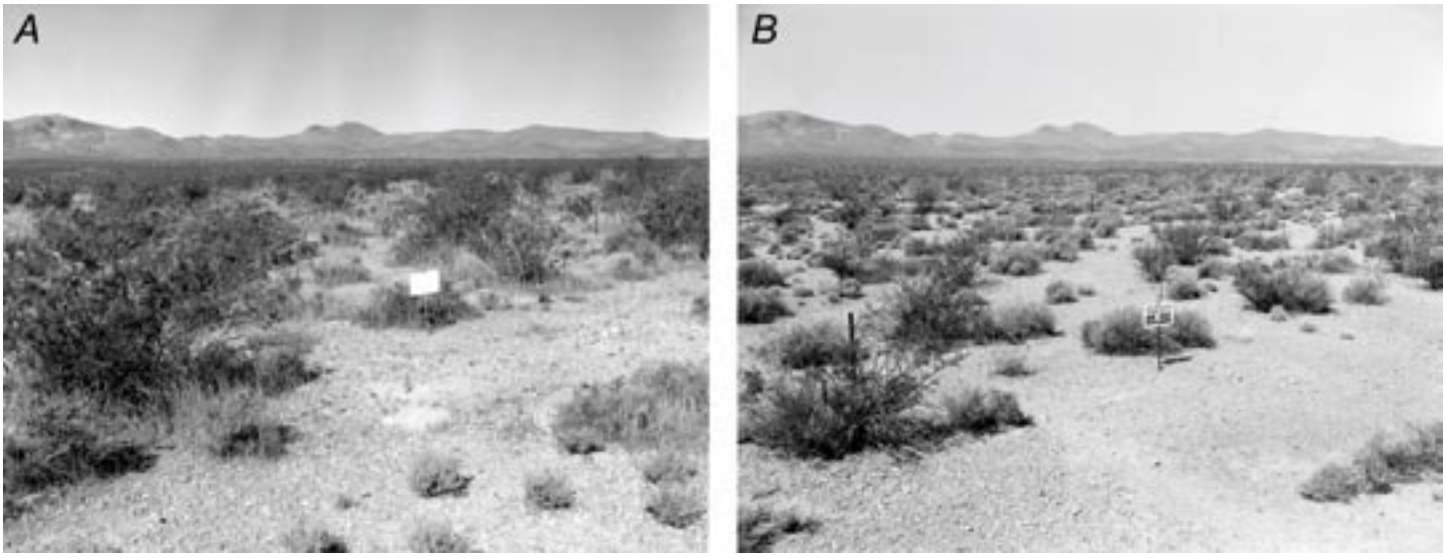

Figure 5. Vegetation plots established in the Nevada Test Site by Dr. Janice Beatley in the 1960s were remeasured by RVDE scientists to study natural vegetation change over time, such as this plot shown in *A*, 1964 and *B*, 2000.

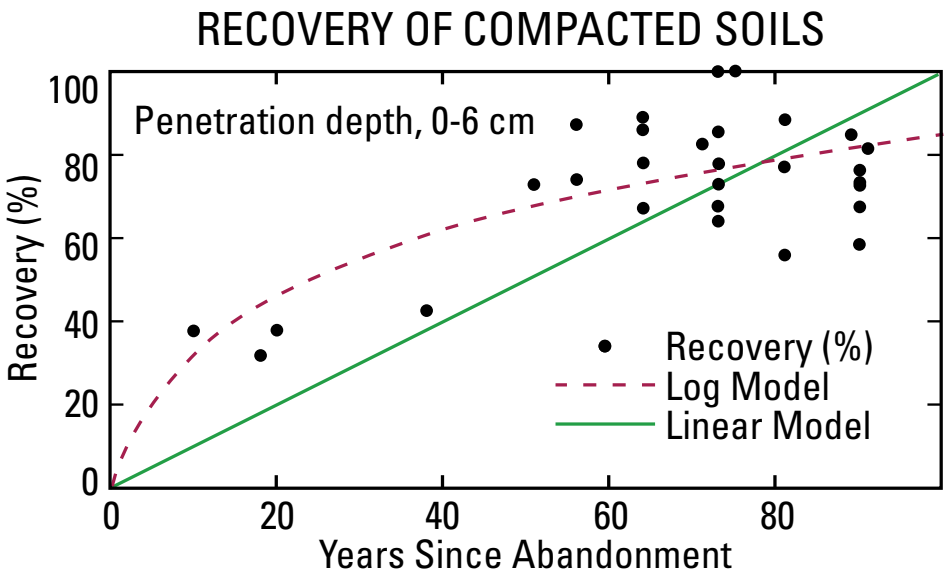

Figure 6. Experimental results showing recovery time from soil compaction.

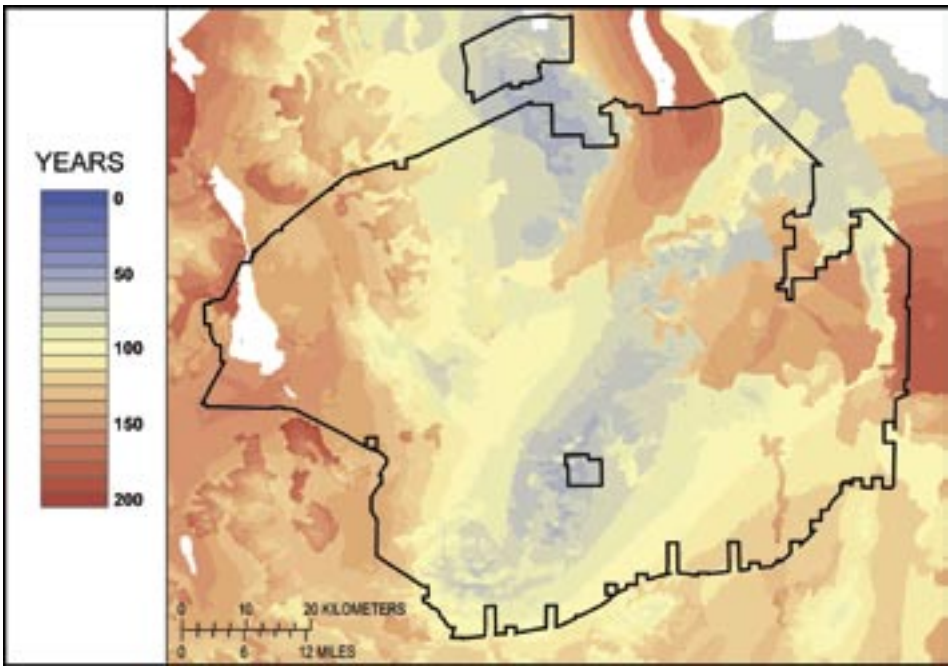

Figure 7. Experimental results such as those shown in the preceding figure on recovery time are translated into geospatial maps showing time to recover from soil compaction.

models are refined and additional models developed, they will be combined into a suite of tools that can be used by land managers to provide input for decision-making. For example, assessing the relative vulnerability of several sites could help in choosing the location and best timing for off-road vehicle use or military activities. Analyzing recovery times in various areas could determine where road closures will be most effective in restoring habitat. Building tools that are based on understanding and modeling the processes rather than developing static maps allows land managers to apply these tools using data of various resolutions in their specific areas of interest.

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Additional information on this project is available at: http://wrg.wr.usgs.gov/mojave/rvde/

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