USGS
science for a changing world

South Dakota

The U.S. Geological Survey (USGS) provides information needed to manage the Nation's earth resources, mitigate natural hazards, and understand the environment. In South Dakota, the USGS works cooperatively with local, State, and Federal agencies to study earth-science issues.

Earth Surface Mapping and Imagery

The USGS works with numerous cooperators to produce map products and digital cartographic data, which are used with geographic information systems (GIS). Among the most popular maps are 1:24,000-scale topographic maps that depict natural and cultural features such as lakes, streams, highways, railroads, and political boundaries. Among the most popular digital products are digital orthophoto quadrangles (DOQ's), which are digital versions of aerial photographs. These digital images provide snapshots of the Earth's surface that are well suited as base maps on which other information can be overlaid. Production of DOQ's has been supported by numerous State and Federal agencies. The South Dakota Department of Environment and Natural Resources (DENR) has cooperated in the production of other map products, which include digital elevation models (DEM's). A DEM is a set of gridded elevation values. DEM's are useful for illustrating surface or topographic views of the Earth, and for deriving characteristics, such as slope, from elevation data.

The USGS Earth Resources Observation System (EROS) Data Center near Sioux Falls is the world's largest nonmilitary repository of remotely sensed data. The EROS archives house worldwide imagery from satellite-borne sensors and more than 7 million aerial photographs of the Nation. Much research within the USGS is based on this ever-expanding collection of image data. Digital and photographic products are made available to government agencies, commercial users, and the public. The USGS also has developed partnerships with several agencies to provide unclassified imagery for hazard management and emergency-response needs.

Figure 1 shows South Dakota as recorded by the thematic mapper sensor aboard a Landsat satellite. This cloud-free image is a compilation of 18 images acquired during September and October from 1986 to 1993. In this false-color image, healthy vegetation appears red. Examples of vegetation patterns include intense red tones of forests in the Black Hills (left edge of mosaic) and cultivated fields dispersed throughout the State. The light area in the lower left represents the Badlands region. Many other light-colored areas are harvested fields. The smallest features that can be seen in this image are about 250 feet in size. Noticeable features include the City of Sioux Falls in the lower right, prairie lakes in the upper right, and Oahe Dam in the center of the mosaic.

The USGS is a partner in the South Dakota Space Grant Consortium, which is dedicated to improving research capabilities within the State, and also hosts university researchers who work in areas of mutual interest. The USGS also participates in an educational partnership with the Flandreau Indian School. This

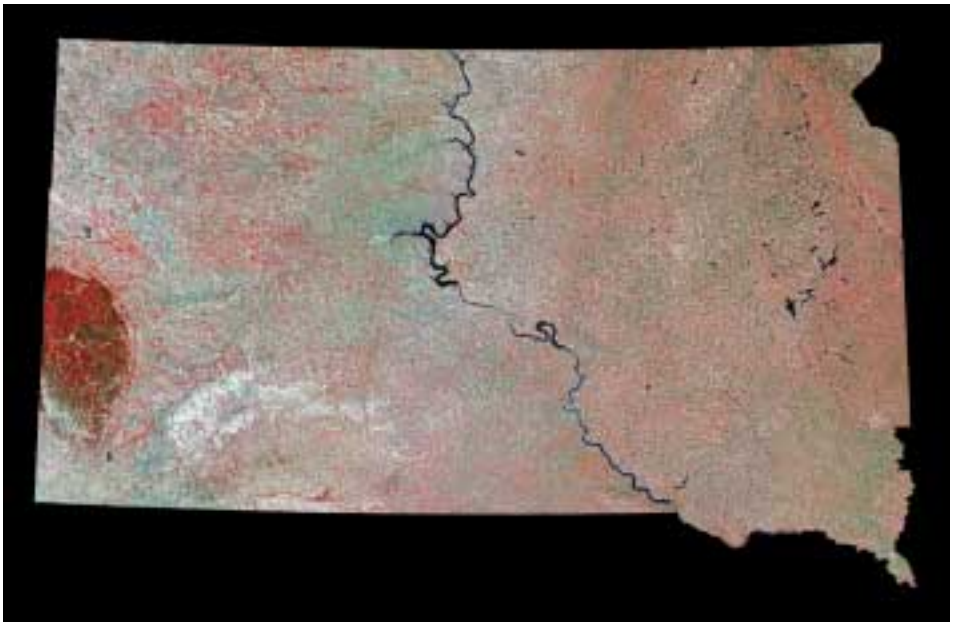


Figure 1. False-color image of South Dakota.

partnership provides the school with resources and improves the quality of math and science education.

The USGS Earth Science Information Centers (ESIC's) provide information about programs, products, and technical developments. In cooperation with the South Dakota Geological Survey (SDGS), the USGS operates ESIC's in Sioux Falls and Vermillion. As part of the national ESIC network, information is provided on cartography, geography, digital data, remote sensing, geology, geophysics, geochemistry, hydrology, geohydrology, aerial photography, and land use.

Water and Climate Issues

Northeastern South Dakota has been severely impacted by rising lake and wetland water levels during much of the 1990's. Some lakes in the Waubay Lakes Chain, which is within a closed basin that lacks streams to drain it, have risen as much as 18 feet since 1992, impacting residences, farmsteads, and roads (fig. 2). The Federal Emergency Management Agency has requested that the USGS lead a multiagency study of flooding conditions around Day County. This study focuses on estimating the frequency and duration of flooding conditions in the closed basin. Specific tasks include summarizing climatic conditions and the resulting extent of inundation during 1992–98; modeling hypothetical future water-level changes; preparing long-term (decades to millennia) estimates of lake-level chronologies; and conducting water-balance and frequency analyses for the Waubay Lakes Chain. Other participating agencies are the U.S. Department of Agriculture–Natural Resources Conservation Service, the U.S. Army Corps of Engineers (USACE), the DENR, the South Dakota Division of Emergency Management, and South Dakota State University.

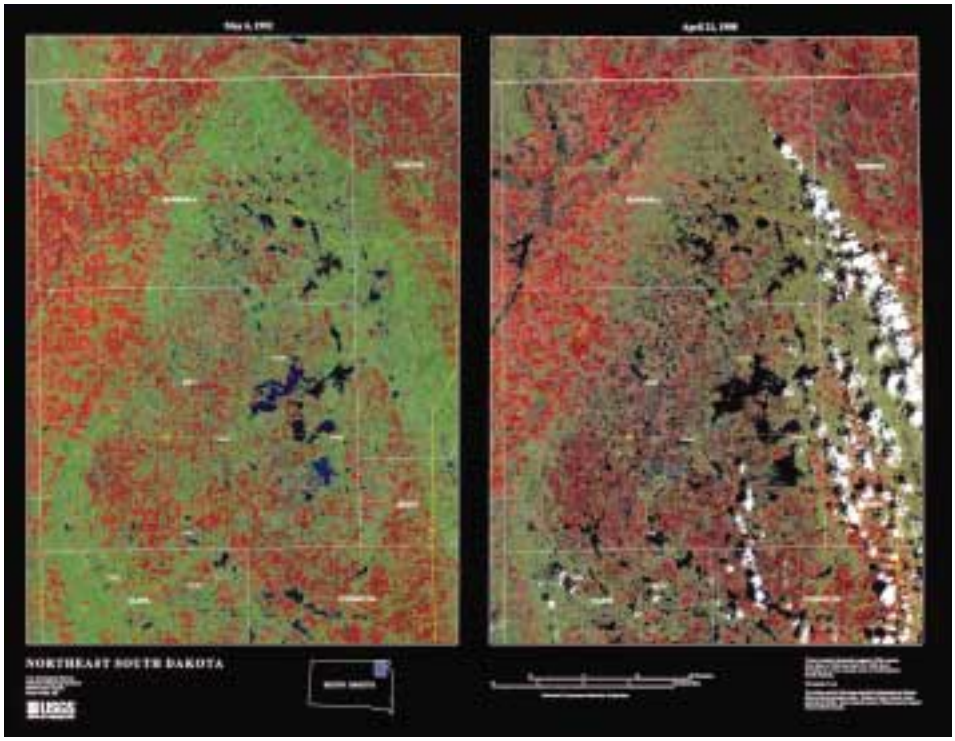


Figure 2. Landsat images of Day County showing normal conditions in May 1992 (left) and flooded conditions in April 1998 (right).

A regional study of lake sediments may provide insights into long-term climatic conditions in northeastern South Dakota. Lake sediments can provide records of climatic change over time periods that range from years to millennia. Cores of lake sediments provide a time series for documenting the last 10,000 years of climatic and environmental changes through investigations of biology, sedimentation, and chemistry. Sediments from Pickerel Lake provide a continuous record of climatic and environmental change for the last 12,000 years. Preliminary data on carbon and oxygen isotopes from sediments, fossil assemblages, magnetic susceptibility, and organic carbon and carbonate, indicate that the climate and environment changed dramatically during this period.

Rapid City and other towns near the Black Hills are prone to flash flooding because of steep stream gradients and intense thunderstorms. An extreme flood in 1972 on Rapid Creek and in adjacent drainages caused 237 deaths. In response to needs for enhanced flood-warning capabilities, the USGS is cooperating in the operation of a network of 17 stream gages and 19 precipitation gages in the Black Hills area. All gages transmit real-time data to computer systems in USGS, National Weather Service, and Pennington County Emergency Management offices. Other cooperators include the Bureau of Reclamation, USACE, and local agencies.

The USGS recently initiated a study with the South Dakota Department of Transportation (DOT) to evaluate factors affecting ice forces at bridges in response to damage to a bridge across the Missouri River. The study will involve measuring ice thickness and crushing strength and developing methods to predict these factors. Two other studies with the DOT recently were completed—a determination of channel-scour characteristics at 31 bridge sites, and a statewide flood-

frequency analysis that provides techniques for estimating peak-flow magnitudes and frequencies.

Wetland, Fish, and Wildlife Studies

The USGS is cooperating with the City of Sioux Falls to evaluate the artificial ground-water recharge potential and habitat benefits of a constructed wetland near Lyons. The results may be useful for evaluating benefits of other potential wetland replacement efforts. The objective of the hydrologic component of this study is to develop a water budget for estimating the volume and efficiency of recharge from the wetland to the Skunk Creek aquifer, which is a source of municipal water supply for Sioux Falls. The objective of the study's biologic component is to monitor aquatic and terrestrial wildlife and vegetation in the created wetlands.

The USGS South Dakota Cooperative Fish and Wildlife Research Unit has developed maps showing the locations of 947,652 wetlands that cover about 10 percent of the total landscape in eastern South Dakota. These maps are used to plan developments such as highway construction and municipal expansions that will allow conservation of wetlands along with development. In cooperation with the DOT, USGS scientists also are studying wetlands created from highway construction borrow pits. This study began with an inventory of biological diversity in natural wetlands that was used to evaluate factors that could be incorporated into wetland designs. Several wetlands have been created by the DOT near Mitchell and the results are being evaluated.

USGS scientists at the South Dakota Cooperative Fish and Wildlife Research Unit have been surveying fish communities in South Dakota rivers and obtaining information on walleye and catfish. This information has been useful to anglers, and State agencies, such as the South Dakota Department of Game, Fish and Parks (GF&P) and the DENR. The data include habitat measurements intended to help management agencies plan conservation measures, such as improving in-stream habitat conditions or identifying areas to establish conservation easements.

Fifty species of fish live in the South Dakota part of the Missouri River. New information on their abundance, age, and growth help the USACE assess the quality of the riverine habitat. Emphasis is on the fish community and the commercial and recreational anglers that depend on a healthy fishery, while also considering other uses of the river such as electrical production, shipping, and flood control.

The status of reptilian and amphibian populations is uncertain in much of the northern Great Plains. Studies are underway in South Dakota by the USGS to determine the presence, numbers, and habitats of reptiles, frogs, toads, and salamanders at Wind Cave National Park and, in cooperation with the U.S. Forest Service, at Buffalo Gap National Grasslands. In addition, the USGS, the GF&P, and the Natural Heritage Program are preparing an "Atlas of South Dakota Herpetology" for the World Wide Web.

Several National Parks have management concerns regarding native hoofed animals. Efforts are being made to restore bighorn sheep populations in Badlands National Park. The USGS is providing census techniques, evaluating restoration practices, testing habitat models, and developing a model to guide restoration plans. A separate USGS and National Park Service (NPS) study in Wind Cave National Park is examining the effects of fire and elk grazing on the establishment and growth of declining shrub communities.

Geologic Mapping

Geologic mapping may help identify undiscovered cave passages in Jewel Cave and Wind Cave, which are the fourth and seventh longest known caves in the world, respectively. Based on calculations of air flow and atmospheric pressure differences, it is estimated that only 5 percent of the cave passages have been discovered. The NPS is concerned about preserving undiscovered passages from potential contaminants seeping down from the cave-bearing Madison Limestone.

A new 1:100,000-scale geologic map of the central Black Hills is being completed in collaboration with SDGS, mining companies, and the South Dakota School of Mines and Technology. This map will provide improvements to the knowledge of igneous rocks that host most of the economic mineral deposits in the area. Sedimentary rocks and their structures also are highlighted to show ground-water movement off the flanks of the Black Hills. Geophysical maps, including gravity and aeromagnetics, are incorporated to show the extent of subsurface units.

Areal Water-Resource Appraisals

The USGS, in cooperation with the SDGS, counties, and Indian tribes has been appraising water resources in South Dakota since 1958. Studies for most counties in eastern South Dakota have been completed (fig. 3), and studies have been initiated in western South Dakota. These studies typically use test-hole drilling, observation-well installation, and water-quality sampling to determine

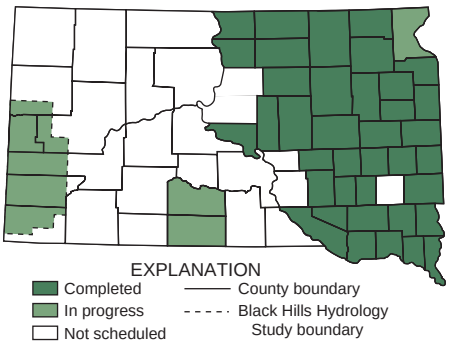


Figure 3. Status of county and multicounty water-resources appraisals in South Dakota.

the availability, movement, recharge, discharge, and quality of water in glacial and bedrock aquifers. The studies usually result in a detailed water-resources report published by the USGS and three reports published by the SDGS—a detailed geology report, a major aquifers report, and a sand and gravel report. The reports are a foundation for water-resource planning by State and local agencies.

Water-resources information is critical for planning and management by the nine Indian tribes in South Dakota. Hydrogeologic studies with six tribes (fig. 4) were completed by the USGS during 1970–80. To meet the tribes' changing needs, more recent studies of the Lower Brule and Rosebud Reservations were completed during the 1990's. In addition, studies are in progress with four tribes. An extensive appraisal of surface- and ground-water resources is underway with the Sisseton-Wahpeton Tribe. Ongoing work includes streamflow gaging, test-hole drilling, observation-well installation, and water-quality sampling. Studies of the Pine Ridge, Cheyenne River, and Standing Rock Reservations are intended to meet a variety of needs. Information related to surface- and ground-water quality is of particular importance in light of Federal programs associated with the Clean Water Action Plan. Development of accurate hydrogeologic data bases for GIS applications is another priority.

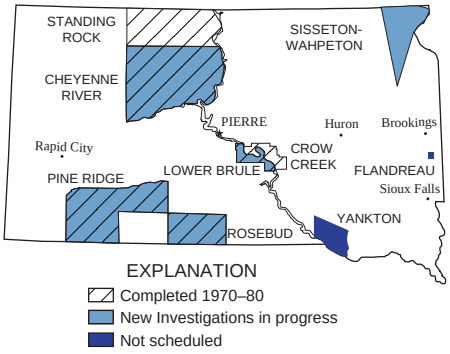


Figure 4. Status of hydrogeologic investigations of Indian Tribal lands in South Dakota.

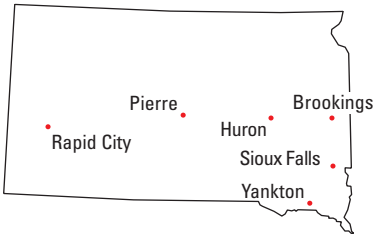
Bedrock Aquifer Studies

A series of bedrock aquifers that underlies much of the State is recharged in outcrop areas of the Black Hills. Population growth and associated development in this area are increasing the demand for water from (and the potential for contamination of) these aquifers. Several studies are addressing these issues. The Black Hills Hydrology Study (fig. 3) is a hydrogeologic study in a six-county area that began during 1990 in cooperation with DENR and local cooperators. Preliminary efforts focused on extensive data-collection activities that included precipitation and streamflow gaging, water-quality sampling, and ground-water-level monitoring. Currently, efforts focus on interpretive activities including hydrogeologic mapping, determination of hydrologic budgets, characterization of aquifer properties, geochemical modeling, and analysis of interactions between surface water and ground water.

The Madison and Minnelusa aquifers are particularly important in the Black Hills area because of potentially large well yields and important interactions with surface water. The objectives of ongoing studies in cooperation with Rapid City and Spearfish include determination of aquifer characteristics, geochemical analyses, and modeling of ground-water flow and solute transport. Solute transport is of particular concern because of the fractured nature of many aquifers in this area. To address this issue, mapping of aquifer sensitivity to contamination in Lawrence County also was initiated. This study uses extensive hydrologic information and geologic maps.

USGS office locations

The USGS has 147 employees in South Dakota



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