



# U.S. Geological Survey Programs in Hawaii and the Pacific

U.S. Department of the Interior ■ U.S. Geological Survey



The U.S. Geological Survey (USGS) is known for its impartial data collection and research. The data that the USGS gathers, interprets, and presents enable resource planners and others to make informed decisions on the basis of objective information. Today's issues related to earth resources and natural hazards are more pressing than ever, and the USGS continues to address these issues in cooperation with State, local, and Federal agencies, universities, and other public organizations.

The State of Hawaii consists of 132 islands, shoals, and reefs. The major Hawaiian islands are the volcanically derived mountain ranges of Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai.

Elsewhere in the Pacific, the USGS works in the Territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, and the Republics of the Marshall Islands and of Palau (the last three named are all in compact of free association with the United States).

## Hydrologic Data Collection

The USGS, in cooperation with local, State, and Federal agencies collects streamflow, ground-water level, water-quality, water-use, and rainfall data at sites throughout the State of Hawaii and on all Pacific islands where the United States has an interest (fig. 1). Data provided by these networks are fundamental to the quantification, management, and protection of the islands' fragile and finite water resources. Hydrologic data are used to determine the extent and severity of droughts, to identify flood-prone areas and potential hydrologic hazards, to quantify available freshwater resources, to monitor the effects of human activities on water resources, and to resolve complex legal issues associated with water rights. Data collected from these island networks throughout the vast Pacific Ocean have global significance by providing a significant part of a worldwide data base for

climate-change investigations and the study of the Pacific El Niño phenomena.

## Volcanic and Seismic Hazards

Residents of the island of Hawaii, and, to a lesser degree those of the island of Maui, face the unique hazards that go along with living on the slopes of an active volcano. These hazards include lava flows, volcanic gases, and earthquakes. Two volcanoes on the island of Hawaii, Kilauea and Mauna Loa, have erupted repeatedly in this century. The current eruption of Kilauea started January 3, 1983 and has since destroyed more than 180 houses and buried 8 miles of highway and utility lines. A third volcano, Hualalai, which last erupted in 1801, and Haleakala Volcano on Maui, which last erupted in 1790, have the potential to erupt again within our lifetime.

The youngest volcano in the Hawaiian chain is Loihi Seamount, which lies 23 miles off the southern coast of the island of Hawaii below 3,300 feet of water. Loihi probably has erupted recently, judging from its frequent earthquake swarms (the

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largest ever was recorded in the summer of 1996) and the fresh lava samples dredged from its surface.

To help prevent loss of life and property from eruptions and earthquakes, USGS scientists are working to increase our ability to predict these natural events and to educate the public about the hazards in their area.

The USGS maintains the Hawaiian Volcano Observatory (HVO), which is responsible for monitoring the activity of

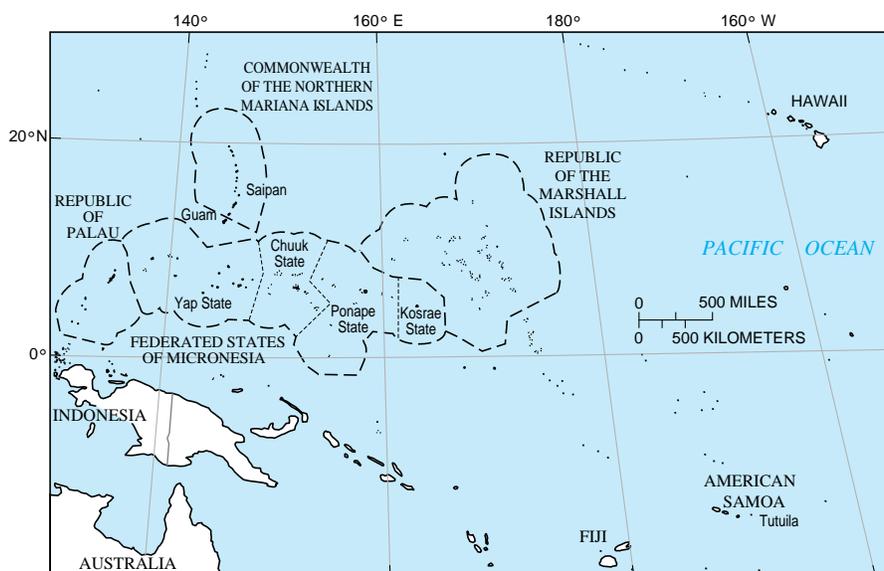


Figure 1. The Pacific Ocean area includes areas in which the U.S. Geological Survey collects data and conducts investigations. (Dashed lines approximate, but do not necessarily represent actual, political boundaries.)

Hawaiian volcanoes and issuing warnings of impending eruptions. To assess long-term volcanic hazards, HVO scientists study prehistoric lava flows to determine the size, frequency, and type of past eruptions. This information forms the basis for hazard-zone maps that guide land-use planning decisions.

The HVO operates a dense seismic network that records thousands of earthquakes each year. Most of these are too small to feel, but about once a decade, a large earthquake causes widespread damage across the island of Hawaii. These earthquakes cause significant economic losses and sometimes claim human lives. HVO scientists are working with county and State officials by providing seismic data and information to set building codes that accurately reflect the seismic hazards on each island. The HVO takes an active role in educating the public on how to prepare for an earthquake.

## Water Supply for Native Hawaiian Homesteads

The State Department of Hawaiian Home Lands (DHHL) has responded to a desire on the part of Native Hawaiians to resettle and restore the land at Kahikinui on the island of Maui (fig. 2). The traditional Native Hawaiian approach to land use and management was to subdivide the land into *ahupua'a*, which is an area that extends from the ocean to a mountain summit. Those living in an *ahupua'a* could acquire everything needed for basic survival within that land division. Kahikinui is the only intact *ahupua'a* on the DHHL

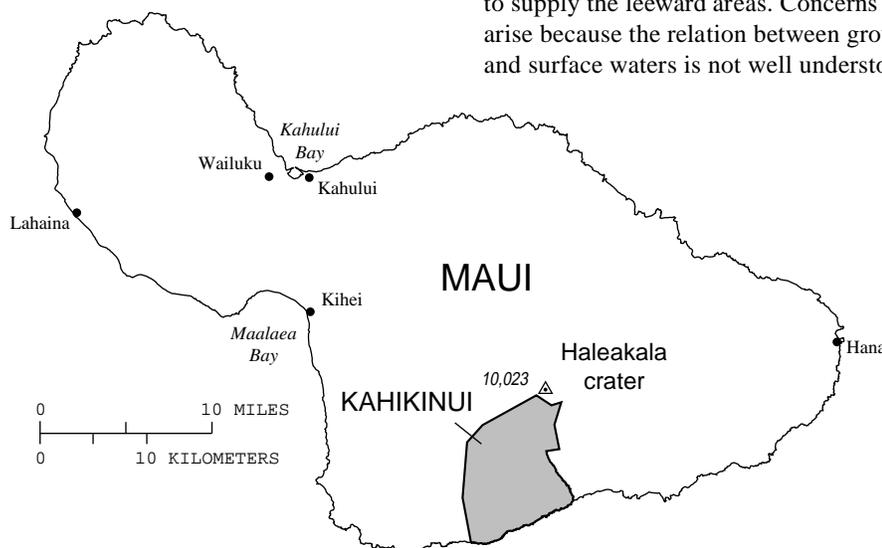


Figure 2. Studies are underway at Kahikinui, island of Maui, Hawaii, in preparation for resettlement of Native Hawaiians.

land inventory. The land was made part of the DHHL's holding by the Hawaiian Homes Commission Act in 1920; when the lease to ranch the land expired in 1994, the DHHL proceeded with resettlement plans. Kahikinui covers about 23,000 acres of arid land and sustained a population of about 8,000 Hawaiians in the 1700's. For the past 100 years, the area has been leased out to ranching interests. Logging and grazing have affected much of the land's original native forests and habitat, and over time, Native Hawaiians were compelled to abandon the area.

The Kahikinui area is remote and lacking in readily available water and other infrastructure. The USGS is doing a geophysical survey to help define the ground water of the area. As part of providing climatological data for the planned restoration of Native Hawaiian forest on the upper slopes of Kahikinui, the USGS is installing and maintaining climatological stations. The data collected are helping determine the effect of reforestation on the area's hydrology through analysis of precipitation, cloud water, canopy throughfall, soil moisture, and evaporation. Climatological data also are helping determine the potential for fog catchment as a potable water supply.

## Effects of Ground-Water Development on Streamflow

Most of the known ground-water resources in many of the dry, leeward areas of the Hawaiian islands have been developed. Pressure has increased to develop ground-water resources in the wet, windward areas where perennial streams exist to supply the leeward areas. Concerns arise because the relation between ground and surface waters is not well understood;

thus, the effect of ground-water development on nearby streams cannot be accurately predicted.

The USGS, in cooperation with the State Commission on Water Resource Management and the Maui County Board of Water Supply, is studying the relation between ground and surface waters on the windward side of eastern Maui. Results of the study are helping determine if future water needs for Maui can be met through development of ground water in northeastern Maui and have implications for the development of ground-water sources of water on the islands of Kauai, Oahu, Hawaii, and Molokai.

## Topographic Mapping

Among the most popular and versatile products of the USGS are its 1:24,000-scale topographic maps (1 inch on the map represents 2,000 feet on the ground). These maps depict natural and cultural features of the landscape, such as lakes and streams, highways and railroads, boundaries, and geographic names. The state of Hawaii is covered by 124 maps at this scale. These maps have long been favorites with the general public for outdoor uses and with scientists and engineers for conventional technical applications.

Today, scientists and engineers depend on digital (computerized) base maps for their research and analyses. Without the geographic context provided by digital base maps, it would be impossible to understand the spatial patterns and changes of natural and human distributions. The USGS is working with the State of Hawaii to ensure and improve digital base data availability for the State so that studies in landslides, ground water, earthquakes, tsunamis, and human impacts on the environment can be conducted as effectively as possible.

The USGS, the State of Hawaii Office of State Planning, and a private consultant are working to prepare digital elevation model (DEM) data for the islands of Oahu, Maui, and Lanai. Cooperative activities include data collection, data-base development, technical assistance, and user training. This type of public/private partnership can provide essential standardized data in a cost-effective manner. The new DEM's will allow the State to perform important watershed modeling projects that were impossible with existing data. The elevation data are also useful to State, local, and

private organizations for environmental management and planning purposes. Because of the need for comprehensive statewide data coverage, the USGS is also preparing DEM's and digital contour files derived from the 1:24,000-scale USGS topographic maps for the islands of Hawaii and Kauai.

Other digital base data being produced as part of the National Mapping Program include the digital raster graphics (DRG's) for the entire State of Hawaii. With DRG's, the USGS brings the images of traditional 1:24,000-scale topographic maps to the computer screen in raster form. These data sets are useful as a base overlaying other information themes, updating map features, and for other land and resource management applications.

### Hydrologic Studies at Kilauea Volcano

Recent USGS hydrologic studies at Kilauea Volcano on the island of Hawaii have increased knowledge of the ground-water flow system of Kilauea, which is one of the world's most active volcanoes. Many volcanic islands have highly permeable rock and scarce surface water, so residents must rely on ground water and rain catchments for water supply. Because of the high flow rates through volcanic rock, the potential for ground-water contamination problems is high. In addition, hydrologic hazards are present in an active volcanic area. The results of the Kilauea studies also are increasing understanding of ground-water sources and flow patterns on all Hawaiian islands.

Stable isotope ratios in water are useful in interpretation of ground-water recharge areas, and tritium content can be used to determine ground-water age. Isotope ratios in ground-water samples at Kilauea were compared with isotope ratios in rainfall to determine the approximate elevation at which the water entered the system as recharge. The relation between elevation and isotope ratios in rainfall obtained for the island of Hawaii may be similar to those on other Hawaiian islands because the temperature and climate patterns are the same. If so, then isotopes can be used to interpret ground-water recharge areas on other Hawaiian islands with minimal collection of precipitation data. This idea is being tested by the USGS with a smaller scale precipitation isotope study on the eastern side of Maui.

### Hydrology of Endangered Species Habitat

Hawaii has more rare and endangered plants and animals than any State in the Nation. The survival of endangered species often depends on an understanding of the water resources of their habitat. The USGS, in cooperation with the U.S. Fish and Wildlife Service (USFWS), is investigating the water system associated with wetlands at the James Campbell National Wildlife Refuge (fig. 3). This natural wetland is home to at least four endangered species of birds, which include the Hawaiian stilt and the coot. Water-quality problems exist because the refuge lacks a sufficient supply of surface water during extended dry periods. In addition, water in the refuge is susceptible to contamination from numerous sources. The project goals are to identify and monitor the quantity and quality of all sources of water that enters the wetlands by using gaging stations for measurements of stream and ditch flow, rainfall, and well water levels. The information obtained from the investigation will be used by the USFWS to maintain a viable habitat for migratory waterfowl.

### Evaluation of Flood Hazards

Flooding on streams in Hawaii is a persistent and often life-threatening hazard. Because intense rainfall of short duration is common, floods can happen at any time, usually with little or no warning. Daily rainfall in excess of 10 inches is expected at least once a year somewhere in the State. The intense rainfall generates extreme flood peaks, which combined with steep, short streams, come with little or no warning.

Peak streamflow data collected by the USGS are used to estimate the magnitudes and frequencies of floods, to identify flood-hazard areas, and to design hydraulic structures, such as bridges, culverts, and flood-control channels. The USGS publishes summaries of the magnitudes of the floods, the factors that cause them, and the extent of the damage and the areas affected. Ongoing evaluations of flood hazards in Hawaii by the USGS may help save lives and minimize flood damage.

### Beach Loss in the Hawaiian Islands

Coastal erosion is a widespread, chronic, and locally severe problem in the Hawaiian islands. The beaches of Hawaii derive most of their sediment from the surrounding reefs. Factors that affect the growth and health of living reefs, such as deterioration in water quality or severe storms, can have an adverse effect on beach sediment supply. Island beach systems are important because the people of Hawaii have a very strong cultural attachment to the beaches and because tourism in Hawaii is a multibillion dollar industry that is inextricably linked to the health of the beaches. Loss of beaches through erosion can have an adverse effect on the economy of the State.

The USGS, in cooperation with the University of Hawaii, is documenting the magnitude and extent of beach loss and is studying the causes of erosion unique to the Hawaii environment. Recent activities include profiling of eroding beaches on Oahu and Maui, establishment of a historical shoreline position data base, and comparison

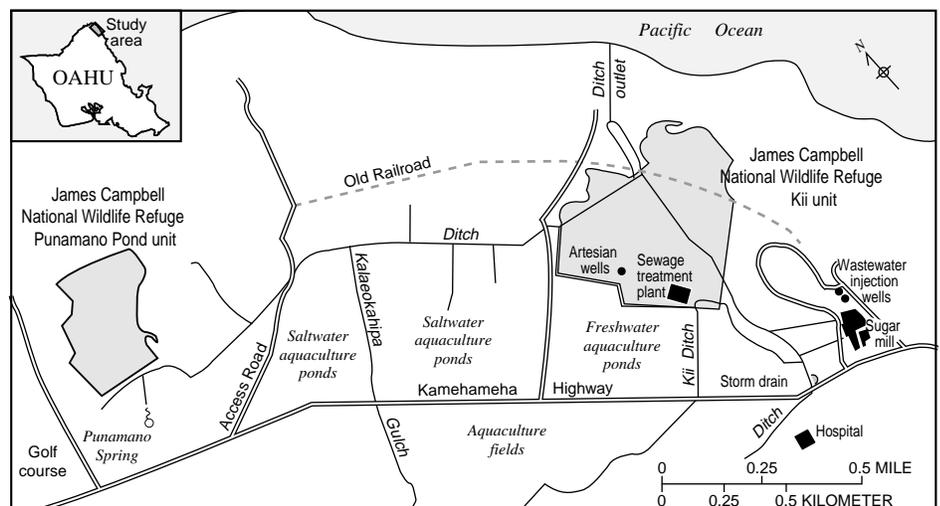


Figure 3. The U.S. Geological Survey is studying the effects of various land uses on the ground- and surface-water systems in the vicinity of the James Campbell National Wildlife Refuge.

of beach profiles and sediment samples with those collected in the 1960's. Results from this program provide information useful to planners, engineers, and resource managers.

## Water Supply for Domestic Needs

A critical issue in the Hawaiian islands is a reliable supply of freshwater. Although rainfall, streamflow, and ground water generally are abundant in Hawaii, most islands are withdrawing water at rates close to the estimated yield of aquifers near the populated areas. In addition, most proposed urban development is in the dry, leeward areas of the islands.

The USGS, in cooperation with State and local agencies, is conducting studies to quantify the availability of ground water in five of the six major islands of Hawaii. As part of these studies, the USGS has undertaken an exploratory drilling program on Hawaii, Oahu, and Kauai.

Studies and test drilling that have led to the discovery and quantification of developable ground-water resources have been completed in the North Kohala and Kona areas of the island of Hawaii, north-central Oahu, and southeastern Kauai. Similar studies are currently underway for western Maui, south-central Oahu, Lanai, and southeastern Kauai.

## Endangered Ecosystems and Nonnative Species Invasions

The USGS's Biological Resources Division (formerly the National Biological Service) conducts studies on rare and endangered species of animals and plants unique to Hawaii and other U.S. holdings in the western Pacific, which include American Samoa, Guam, and the Marianas Islands (fig. 1). About one-third of all listed bird, plant, arthropod, and other species are found in this area, where competitive invasions of nonendemic plants and animals are forcing the collapse of the fragile island ecosystems. For example, scientists are studying the brown tree snake, which is rapidly spreading from Guam to other Pacific Islands and poses a serious threat to the native ground-nesting birds and lizard populations of these ecosystems. The Pacific Island Ecosystems Research Center studies the biology of specific species, such as the Hawaiian crow (Alala), the

crested honeycreeper, the Haleakala silver-sword plant, and many others. This research is supplemented by studies of how introduced diseases and predators take their toll. The Center has a geographic information system and global positioning system node that provides support to its island laboratories for location of endangered species, some of which consist of only a few individuals. It also contracts research for the State, other Department of the Interior agencies, and U.S. military partners through its Cooperative Parks Study Unit. The Hawaii Cooperative Fishery Research Unit is located at the University of Hawaii. The research focus of the Unit is on nearshore fish and aquatic resource communities other than fish.

## Water Resources Studies in the Pacific

The Pacific Ocean area (fig. 1) in which the USGS conducts hydrologic work encompasses one-sixth of the Earth's circumference and includes a wide range of climate, economic development, and local forms of government. The most critical resource problem for these islands is a reliable supply of freshwater. Many of these islands are now near the limit of the known freshwater resources, and demand exceeds the existing supply on many islands. Rapid population growth and expansion of the visitor industry have contributed to water-supply problems. In cooperation with the governments of the territories of Guam and American Samoa, the Republics of the Marshall Islands and Palau, the Commonwealth of the Northern Mariana Islands, and the Federated States of Micronesia, the USGS has undertaken water-resource investigations. These studies are designed to quantify the water resources and to provide a framework for development, management, and protection of these fragile resources.

In cooperation with the U.S. Navy, the U.S. Air Force, and the U.S. Army, the USGS is collecting hydrologic data and conducting investigative studies for U.S. military installations in Hawaii, Guam, Kwajalein, Korea, and Diego Garcia (Indian Ocean). This work includes studies of ground-water availability and contamination, rainfall/runoff, and the collection and analysis of climatologic and hydrologic data.

# For More Information

USGS State representative  
677 Ala Moana Blvd., Suite 415  
Honolulu, HI 96813  
(808) 522-8290  
Fax: (808) 522-8298  
Email: [dc\\_hi@usgs.gov](mailto:dc_hi@usgs.gov)

Additional earth science information can be found by accessing the USGS Home Page on the World Wide Web at [http://www.usgs.gov/](http://www.usgs.gov)

For more information on all USGS reports and products (including maps, images, and computerized data), call **1-800-USA-MAPS**

The **USGS** provides maps, reports, and information to help others meet their needs to manage, develop, and protect America's water, energy, mineral, biological, and land resources. We help find the natural resources needed to build tomorrow, and supply the scientific understanding needed to help minimize or mitigate the effects of natural hazards and environmental damage caused by natural and human activities. The results of our efforts touch the daily life of almost every American.

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