

Prepared in cooperation with the Environmental Protection Agency, Desert Research Institute, and Tahoe Regional Planning Agency

Geographic Research at Lake Tahoe

Lake Tahoe is a natural resource famous for its alpine setting and deep, clear waters (fig. 1). During the last half century, however, human activity in the Lake Tahoe Basin has increased, and significant environmental impacts have been observed and documented, including a loss in lake clarity of about 1 foot per year. The U.S. Geological Survey's (USGS) Western Geographic Science Center is responding to some of these concerns with two interdisciplinary research projects in the Lake Tahoe Basin, and the USGS is also implementing a Partnership Project for The National Map in the Lake Tahoe area.

Land Use Change, Water Quality, and Ecosystem Health in the Lake Tahoe Basin

In spite of past and ongoing efforts to understand how Lake Tahoe functions and to what extent humans have affected its landscape and ecosystem processes, data and analysis are lacking regarding historical land cover change for the Lake Tahoe Basin (fig. 2). USGS Geography and Water Resources are conducting a research project to (1) map the current and historical state of the land surface, (2) analyze patterns, rates, and trends in urbanization and land use change using geographic information systems (GIS) and other tools, and (3) assess the causes and consequences of land use change. We hypothesize that changes in the extent of urban growth, the corresponding increase in impervious surfaces, and the decrease in natural vegetation have had severe impacts on stream environment zones, water quality, and ecosystem health over time.

Current research is focused on two watersheds in the southern Lake Tahoe Basin: the Upper Truckee River and Trout Creek watersheds. Since no large-scale temporal land cover data exist for any part of the Lake Tahoe Basin, an extensive data collection effort was necessary. Historical digital orthophoto quadrangles for the years

1940, 1969, and 1987 were produced and then combined with precision-corrected IKONOS satellite imagery acquired in August 2002 to derive four eras of land cover data, including estimations of impervious surface area (ISA) (fig. 3).

The increase in ISA, which is any land cover that prevents the infiltration of precipitation runoff directly into the soil (for example, buildings, paved roads, driveways, and rooftops), is directly related to human activity and habitation and is a key indicator of watershed ecosystem health.

Impervious surfaces change the flow dynamics, sediment load (the amount of sediment carried in water), and pollution content of stormwater runoff. As precipitation is unable to infiltrate the soil, the unfiltered runoff flows over the impervious surfaces, which causes significant increases in water runoff. The subsequent surge in water flow reaches the receiving streams, where it significantly increases erosion of the stream channels and banks and consequently affects surrounding wetlands. Additionally, the water that flows into Lake Tahoe is likely to contain increased amounts of sediments, pollutants, and nutrients that decrease water quality and clarity.

Tahoe Decision Support System

Resource managers at Lake Tahoe need tools that can help them keep abreast of changes in environmental conditions and scientific understanding as they work to maintain the vibrant recreational, economic,



Figure 1. Emerald Bay from the west shore of Lake Tahoe.

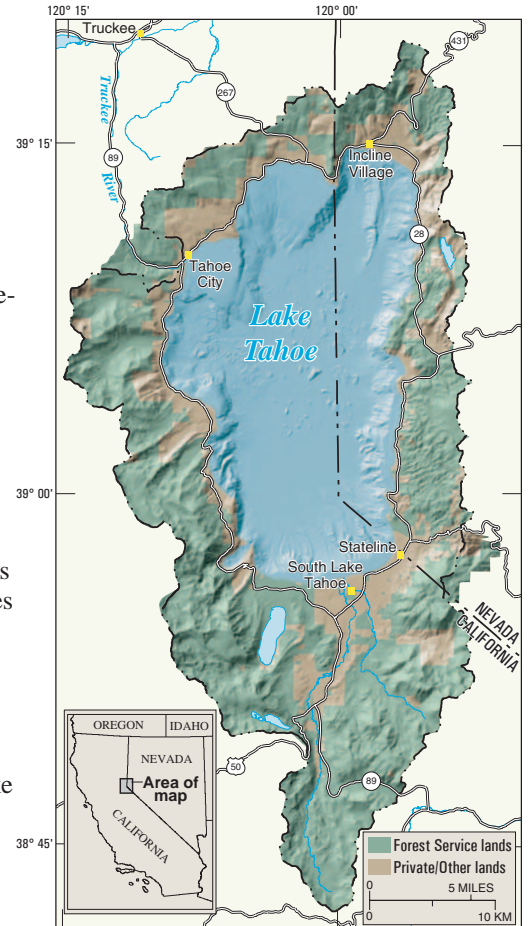


Figure 2. The Lake Tahoe Basin.

and natural attributes of the basin. To support this need, the USGS is developing a decision support tool for the Tahoe Regional Planning Agency (TRPA) that incorporates economic and environmental considerations

typically faced by the agency. A prototype tool, which was completed in 2002, illustrates some of the economic effects of current regulations that restrict urban development in order to control sediment runoff that can cloud the lake. A new phase of work began in 2003 to examine a wider array of socioeconomic and natural resource management issues faced by the TRPA as it plans for the future.

In collaboration with the TRPA, the Environmental Protection Agency,

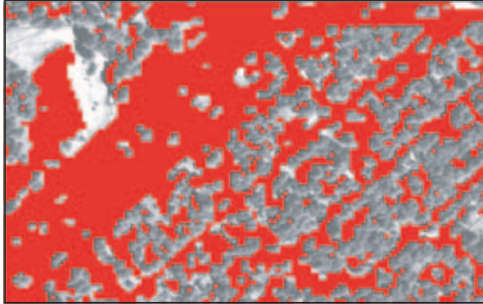
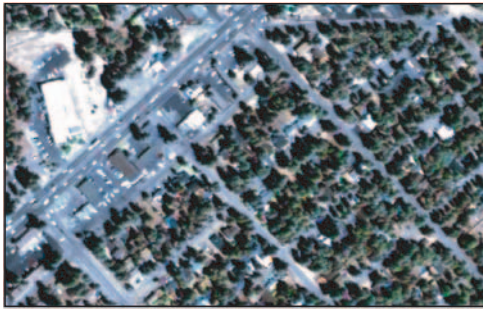


Figure 3. The top image is a natural-color composite section (510-m wide) of satellite imagery from the Lake Tahoe Basin. The bottom image of the same section shows impervious surfaces in red as interpreted from the imagery using remote-sensing techniques.

and the Desert Research Institute, the USGS built a prototype decision support tool called the Tahoe Constrained Optimization Model (TCOM), which was piloted in the Upper Truckee watershed. That model assesses the influence of the TRPA's Individual Parcel Evaluation System (IPES) (a ranking system used in assigning residential building permits and impervious cover allowances) on urban growth patterns, property values, and sediment runoff to Lake Tahoe. Using a linear programming platform, TCOM generates numerical results and detailed maps that enable decisionmakers to envision the outcomes of different management scenarios (fig. 4).

The Tahoe Decision Support System (TDSS) expands beyond a single watershed and incorporates additional environmental criteria and indicators for decisionmaking in the Lake Tahoe Basin. In this second phase of work, socioeconomic indicators besides property values are being explored, and environmental qualities associated with air, biodiversity, and habitat are likely to be included along with water clarity. Since the TDSS will be used to support multiagency, long-term strategic planning at Lake Tahoe, the project will place heavy emphasis on developing a user-friendly interface that allows managers to experiment quickly and easily with hypothetical decisionmaking scenarios.

The National Map Partnership Project

The USGS is developing *The National Map* to be a consistent online framework of high-quality geospatial data and information from multiple partners that is available online to resource managers and the

public. *The National Map* serves as a foundation for integrating, sharing, and using other government and private sector data easily and consistently, as well as providing a geographic framework to underpin scientific research.

Initial development of *The National Map* for the Lake Tahoe area involved the challenges and opportunities of integrating data across two States, eight counties, and several cities, including the urban centers of Reno and Carson City. Technical issues for the implementation included integrating Federal, State, and local data and developing Web viewer services. *The National Map* Partnership Project (fig. 5) continues to build on the Federal coordination and research being conducted under an Executive Order following the 1997 Lake Tahoe Presidential Forum. As the partnership

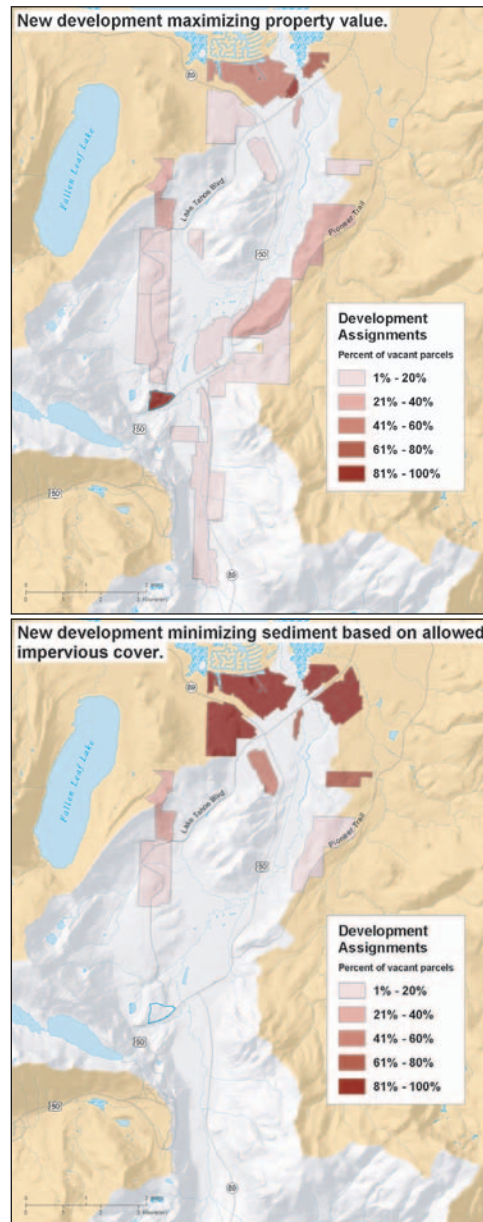


Figure 4. These two scenarios identify parcels in South Lake Tahoe that may be developed while maximizing property values or minimizing sediment load according to allowed impervious cover for newly developed parcels.

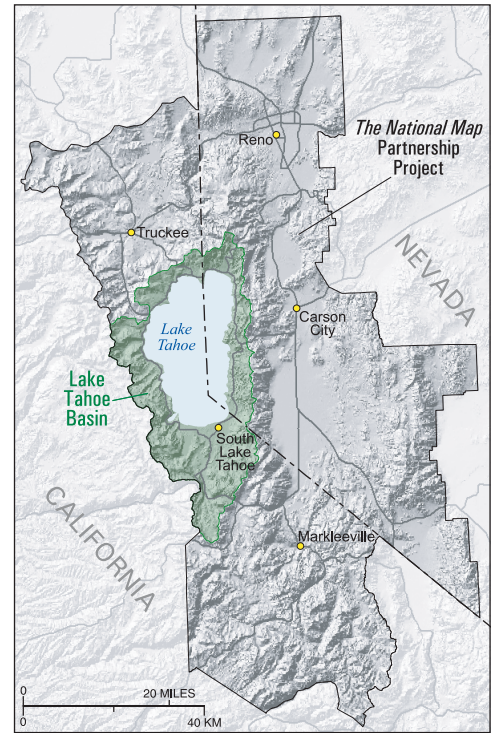


Figure 5. The National Map Partnership Project includes all of the Lake Tahoe Basin and additional lands in Nevada and California.

project evolves, future issues will include identifying volunteers for updating datasets, establishing local data stewards and procedures, integrating high-resolution imagery, distributing real-time data, linking the TDSS capabilities, and collaborating with Nevada and California on statewide visions for framework data development, access, and distribution.

The USGS is working with the TRPA to use *The National Map* as the geographic underpinning to the Tahoe Integrated Information Management System, which will provide public access to environmental information. This project will demonstrate the application of *The National Map* as a foundation for integrating, sharing, and using data easily and consistently.

Christian G. Raumann, Elizabeth Schwerer Duffie,
Carol Ostergren, and William Kaiser

For More Information:
Susan Benjamin
U.S. Geological Survey
Western Geographic Science Center
345 Middlefield Road, MS 531
Menlo Park, CA 94025
E-mail: sbenjamin@usgs.gov

<http://nationalmap.usgs.gov>
<http://seamless.usgs.gov>
<http://tahoe.usgs.gov>