

# MAPS OF SOIL EROSION

## An Aid in Land-Use Planning

TAWNA NICHOLAS • JOHN McCOLL

**R**oad building and other types of construction activities on range and wild lands often involve considerable landscape manipulations and may cause serious soil erosion particularly on steep slopes with shallow soil. Some of these effects are noticeable in The Geysers area of northern California where there are about a dozen geothermal power plants in operation. Removal of vegetation and construction of drill pads, steam transmission lines, power plant sites, roads, parking lots, and electrical transmission rights-of-way mar the landscape and accelerate erosion. Furthermore, widespread concern over diminished energy supplies makes additional development of geothermal resources imminent. Therefore, steps should be taken to minimize erosion by identifying critical areas before site disturbance.

With this objective in mind, a study of erosion potential was conducted in the upper portion of Big Canyon Creek watershed, as part of a class project in the Department of Conservation of Natural Resources in the College of Natural Resources at Berkeley. This watershed, just a few miles northeast of The Geysers, contains many areas newly leased for geothermal exploration and development.

### The study area

The Big Canyon Creek watershed lies in a northwest-oriented canyon approximately 20 miles southeast of Lakeport, California, and is bounded on the northwest by Boggs and Siegler mountains. The drainage area opens on Putah Creek and the Colla-



Geothermal power plants (above and opposite) with the associated site disturbances by drill-pads, steam transmission lines, roads, and electric power at The Geysers, northern California. (Photos by Craig Martz.)

yomi Valley, about 10 miles to the southeast. Topography is often precipitous and the area is geologically young, comprised of Pliocene andesites, and Mesozoic rocks of ultramafic and marine origin. Soils there have developed under "Mediterranean" conditions of hot, dry summers and cool, moist winters; they seldom freeze. Eight soil series cover a major portion of the watershed: Hugo, Aiken, Laughlin, Salminas, Hennecke, Mayman, Los Gatos, and Josephine.

Vegetation distributed in the watershed, while primarily a function of soil type and depth, is also determined by topography. The hotter, drier southeast slopes are generally covered with chaparral, while communities on the northwest slopes are primarily oak woodlands and mixed conifer forests. Vegetation on the north slopes of Boggs Mountain has a marked transition from oak woodland to mixed conifer forest at an elevation of about 2,800 feet.

# POTENTIAL— in Range and Wildlands

Maps of erosion potential were produced for an area in northern California where exploration of geothermal energy sources is in progress. The maps were derived from existing maps and other data on topography, soils, and vegetation. The simple procedure used to make these maps could easily be adapted to other situations where disturbance of range or forest lands is anticipated. Such maps are therefore effective tools for intelligent land-use planning.

## Development of erosion potential maps

The main steps for developing the maps are diagrammed in fig. 1. First, a map with six slope categories was compiled from the U.S. Geological Survey 7½-minute topographic map. Percentage of slope was determined after measuring distances across 40-foot contour lines. The watershed was then divided into the six slope categories: 1 (0 to 3 percent), 2 (3 to 10 percent), 3 (10 to 20 percent), 4 (20 to 30 percent), 5 (30 to 50 percent), 6 (50 percent and over).

A second map was compiled from the State Cooperative Soil-Vegetation Survey Map, Sheet 60 A-3, and from erosion hazard designations by soil series according to six categories set up by the Soil Conservation Service. The erosion hazard rating of each soil series is determined by the vegetation the series supports, the texture of the soil, and a rough field estimate of the slopes on which the series generally occurs. Arbitrary numerical ratings were assigned as follows: 1 (very low erosion hazard), 2 (low), 3 (moderate), 4 (moderate to high), 5 (high), 6 (very high).

A "composite map" (fig. 2) was made from the maps of slope and erosion hazard using transparent overlays. The areas were designated numerically on a scale of 2 to 12, where the numerical values were additions of the overlying numerical values from the original two maps. This composite map should indicate the degree of erosion that is presently occurring and the areas which would be most sensitive to disturbance.

Vegetation reduces erosion substantially, and the sooner an area



can revegetate after disturbance, the less erosion will occur. Therefore, soil fertility was also considered to be an important criterion for the final erosion potential map (fig. 3). A soil fertility map was produced using categories of the Soil Conservation Service, which we designated numerically as: 1 (very high fertility), 2 (moderately high), 3 (moderate), 4 (low), 5 (very low). These numbers were added to the previous ratings of the composite map (fig. 2) and a transparent overlay yielded the final erosion potential map (fig. 3).

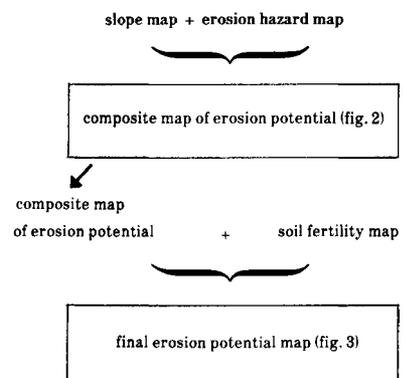


Fig. 1. Steps in the development of maps of potential soil erosion.

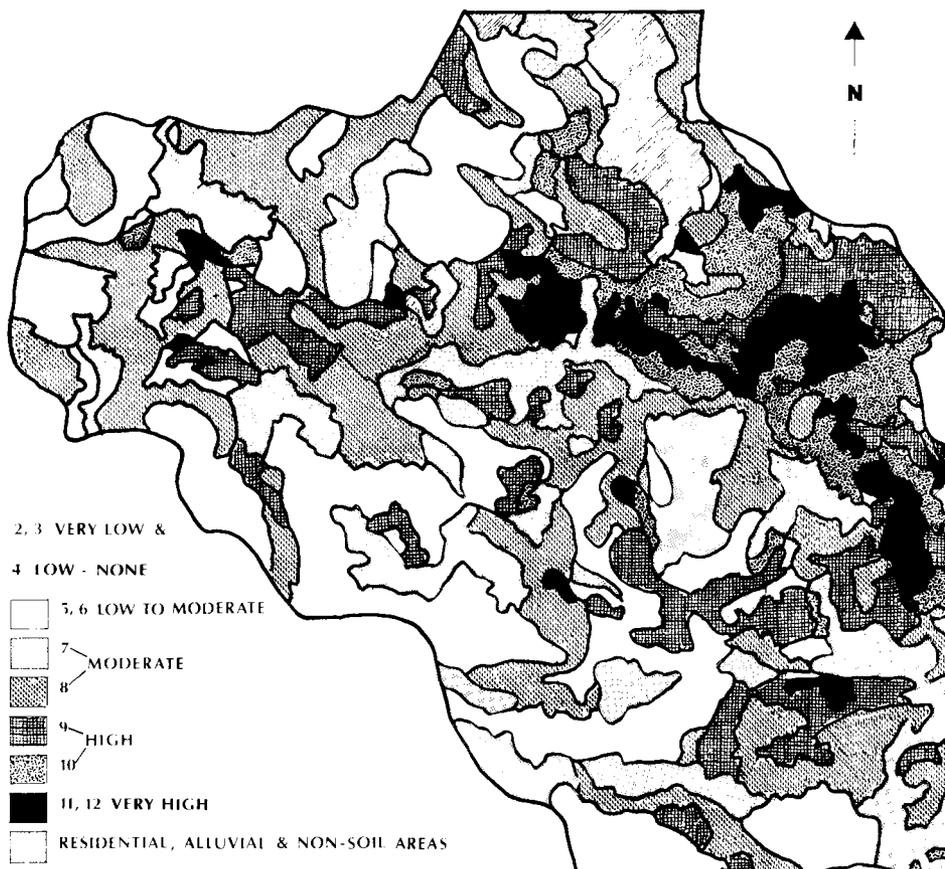


Fig. 2. Map of erosion hazard; a composite of slope and erosion hazard maps.

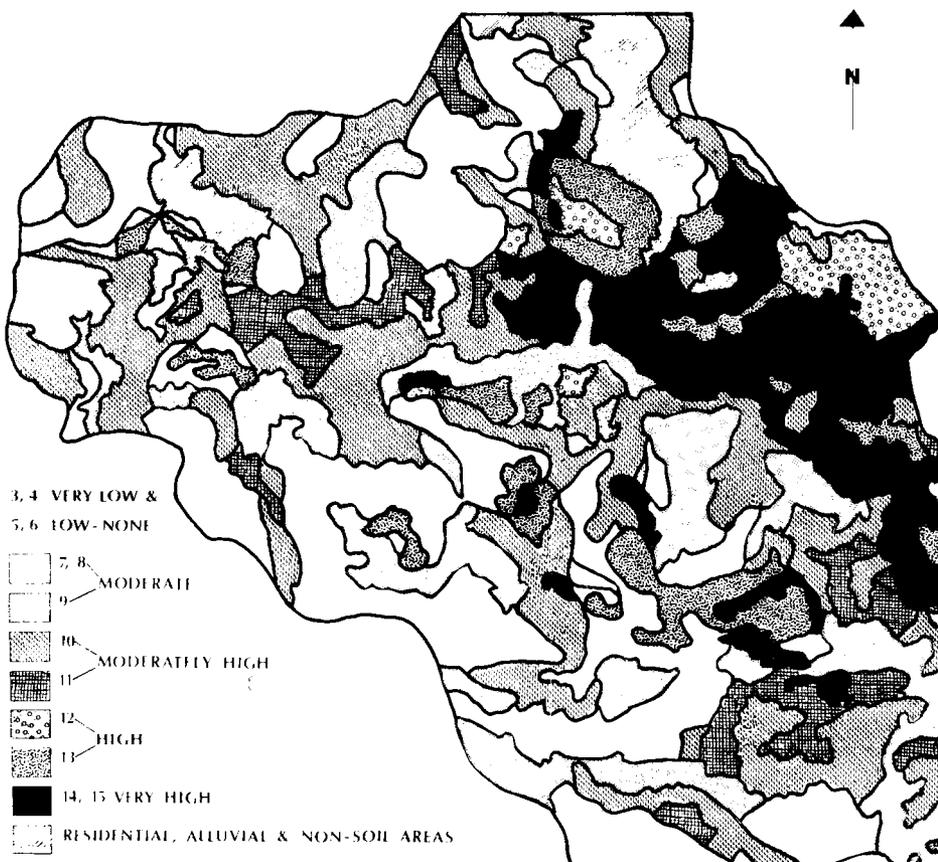


Fig. 3. Final map of erosion potential; a composite of erosion hazard (fig. 2) and soil fertility maps.

Numerical ratings on this final map range from 3 to 15 and were grouped as follows: 3 to 4 (very low erosion potential), 5 to 6 (low), 7 to 9 (moderate), 10 to 11 (moderately high), 12 to 13 (high), 14 to 15 (very high).

#### Use of the maps

Both erosion potential maps (figs. 2 and 3) indicate that the majority of the watershed has high erosion potential, because of unstable soils on steep slopes. For example, soils developed from serpentine on 30 to 35 percent slopes are very critical. Obviously, greater attention to mitigation measures should be applied to areas most likely to erode. Engineering modifications affecting initial location, and construction and maintenance of roads and facilities may be necessary if a site is chosen in a highly sensitive area.

In comparing figs. 2 and 3, the influence of the "soil fertility factor" is clearly shown by the relative size of the darkest areas of "very high" erosion potentials on each map. These areas primarily occur on the northern side of Big Canyon Creek, largely because of the presence there of soils developed on serpentine. These soils (Hennecke and Montana Series) are relatively low in calcium, nitrogen, and molybdenum but are high in magnesium. (This fertility problem is reflected in fig. 3.) Revegetation of such areas following disturbance is extremely difficult—chemical fertilizers (particularly lime) are probably necessary to re-establish vegetation successfully.

The simple, inexpensive procedures used to produce the maps of potential soil erosion could apply to other locations where topographic, vegetation, and soil maps are available. For example, road location, building on range land, and activities related to forest harvesting could be planned to minimize erosion and degradation of the environment.

*Tawna Nicholas is Staff Research Associate and John McColl is Assistant Professor in the Department of Soils and Plant Nutrition, College of Natural Resources, University of California, Berkeley. This article was aided by a gift from Republic Geothermal, Inc. The study was conducted with the approval of the Planning Department, Lake County, California.*