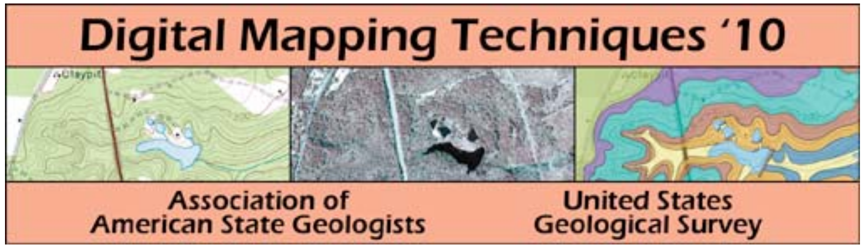

The following was presented at DMT'10
(May 16-19, 2010).

The contents are provisional and will be superseded by a paper in the DMT'10 Proceedings.

See also earlier Proceedings (1997-2009)
http://ngmdb.usgs.gov/info/dmt/

Assessing Erosion Potential and *Coccidioides immitis* Probability Using Existing Geologic and Soils Data

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Introduction

One of the primary benefits of a geographic information system (GIS) is its ability to analyze multiple overlapping layers of spatial data and create new derivative products that provide needed information or answer questions of interest. This new information can then be presented in a clearly understandable way for use by decision makers as well as the general public.

Septate hyphae of Coccidioides immitis. Photo credit: CDC/ Dr. Hardin, 1965.

An example of this type of process is an assessment conducted by the California Geological Survey (CGS) in 2006 on a property in the Bakersfield area that was being considered by the California State Parks Off-Highway Motor Vehicle Recreation Division as a possible State Vehicle Recreation Area (SVRA).

The study area is comprised of soils derived from granitic bedrock and Tertiary sedimentary units.

The property is located within a region that has an elevated incidence rate of coccidioidomycosis, or valley fever. Valley fever is caused by inhalation of spores of the pathogenic fungus Coccidioides immitis. The spores exist in soils in certain parts of the southwestern United States, northern Mexico, and a few other areas in the Western Hemisphere. Valley fever contracted by mammals typically produces flu-like symptoms and in some cases causes chronic pulmonary infection and/or disseminated infections in soft tissue and bones (CDC, 2005; NIH, 2006).

The purpose of this study was to utilize existing geologic, soils, hydrologic, vegetation, and topographic data layers and a GIS modeling approach based on a published erosion hazard rating system to assess both the erosion hazard potential of soils found within the site, and the relative likelihood that spores of the Coccidioides immitis fungus exist in the soils. The findings would then need to be conveyed in a simple and effective manner to resource managers, political representatives, and the general public.

Methods

Erosion Hazard Potential

Erosion hazard potential was assessed using the Erosion Hazard Rating (EHR) System presented in the Soil Conservation Guidelines/Standards Off-Highway Vehicle Recreation Management (see Division, 1991) and preliminary soil survey data provided by from the Natural Resources Conservation Service (see NRCS, not dated). The method utilizes information on soil type, vegetation cover, slope, and precipitation to derive an EHR. The assessment for the site was conducted in accordance with the Division (1991) method, utilizing a model developed in ArcGIS (Figure 1).

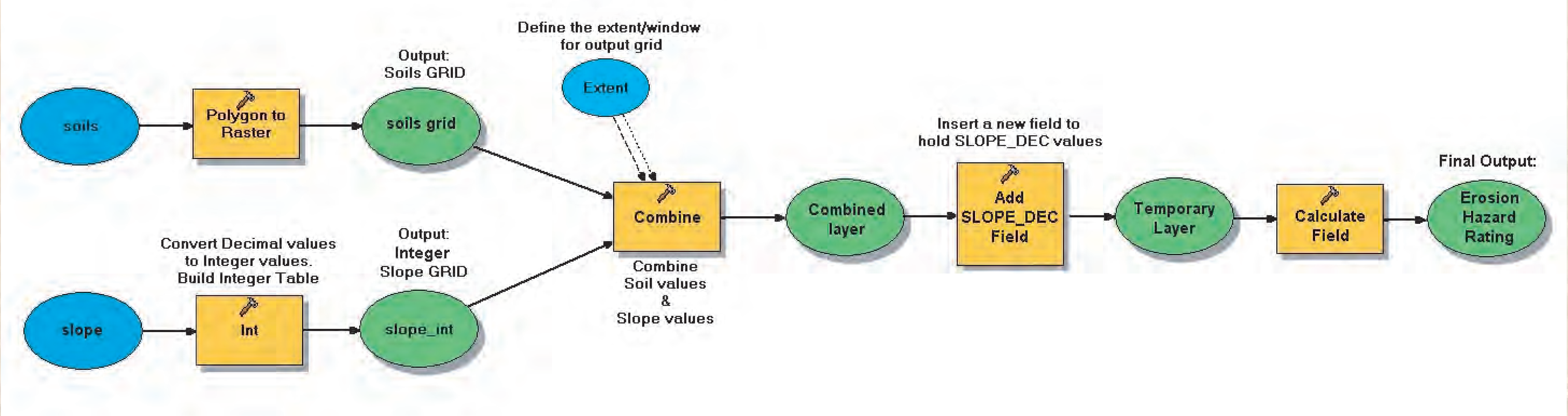

Figure 1. ArcGIS model used to calcualte Erosion Hazard Rating (EHR).

The EHR method determines the relative risk of surficial erosion from runoff drainage on an existing soil covered surface. It provides a first measure of erosion risk, enabling land managers to assess baseline soil erosion conditions, as well as to evaluate, design, and plan soil-disturbing activities so that erosion hazard risk is minimized.

To calculate EHR, soil textures are assigned values which depend on the slope steepness. Other NRCS factors used in the EHR calculation include infiltration and permeability ratings and depth to restrictive layer (e.g., bedrock). Soil vegetative cover was assumed constant throughout the site. The assigned cover value was based on a mix of groundcover vegetation, exposed soil, and shrub and tree canopy.

The results of the EHR assessment for the site are illustrated in Figure 2.

Assessment of Coccidioides immitis Spore Presence

The soils in the southern San Joaquin Valley, particularly uncultivated native soils on the valley flanks, are known to contain *Coccidioides immitis* spores (Fisher, 2006; NIH, 2006). Research conducted by others indicates that within a region known to have the spores, there are variables which increase or decrease the likelihood that the spores may be present in any one area of the region (Bultman, Fisher, and Pappagianis, 2005; Fisher, 2006).

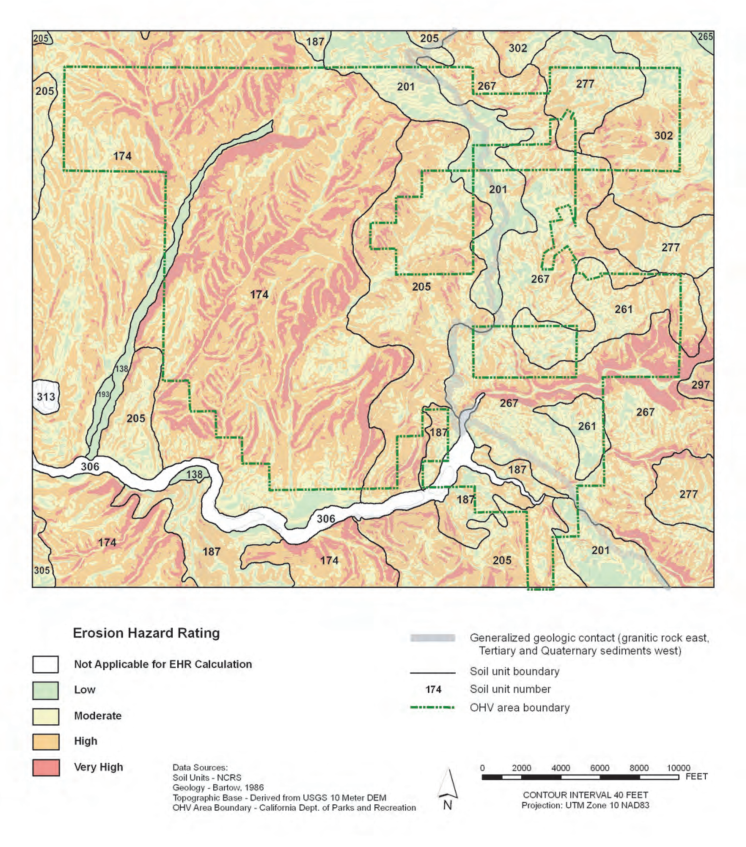

Figure 2. Erosion Hazard Rating map.

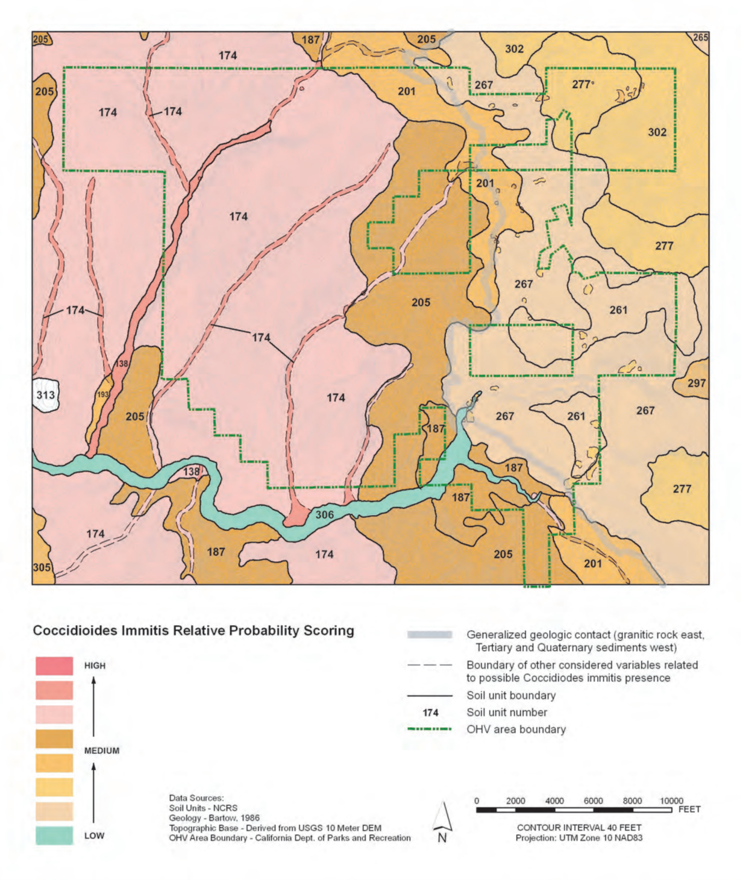

Figure 3. *Coccidoides immitis* relative probability map.

A general ArcGIS-based assessment was made of the site using several of these variables to rate the relative likelihood that *Coccidioides immitis* spores are present in the different soils on the site. To do this, a simplified scoring system was used. Variables were weighted with points ranging from one to three. Generally, each variable represents a characteristic of the soil type (e.g., soil texture) or the physiography of the area (e.g., seasonal drainage along a canyon bottom). These variables were given values of one or two. If the variable corresponds with a percent content, such as clay content, or a range, such as pH, the value given ranged from one to three, depending on percent content or range. This methodology is derived from work presented by Bultman, Fisher, and Pappagianis, 2005, and based on discussions with Fisher, 2006.

The results of the *Coccidioides immitis* spore presence assessment are illustrated in Figure 3.

Findings

Erosion Hazard Potential

Soils derived from Tertiary sediments, especially soil unit 174, appear to be the most susceptible to erosion as measured by the applied EHR method (Figure 2). These soils cover approximately the western two-thirds of the site, with soil unit 174 covering most of that area. An analysis of EHR values assigned to pixels within soil unit 174 shows that the EHR for this soil is Very High when it drapes a slope of 25 degrees (50 percent) or more. Correspondingly, this area, which consists of rolling hills and incised drainages, is mostly shaded orange and red, indicating an EHR risk of High and Very High (Figure 2).

Soils derived from the granitic bedrock on the east, which is mostly soil unit 267, appear to be comparatively less susceptible to erosion. This is due to the less varied topography of the granitic terrain; steep slopes are generally limited to the flanks of Poso Creek. Elsewhere, slopes in the terrain are rarely steeper than 25 degrees. An analysis of EHR values calculated for soil unit 267 shows that the EHR for this soil is Very High when it is on slopes of 30 degrees (57 percent) or more—only five degrees steeper than the soil unit 174 discussed above.

Assessment of Coccidioides immitis Spore Presence

As illustrated in Figure 3, soils west of the granitic bedrock have a greater likelihood of having spores of the fungus *Coccidioides immitis*. These soils are mostly derived from Tertiary sediments. Again, soil unit 174 figures prominently. This soil stands out because its silt and fine sand content, salinity, and favorable clay content and a corresponding water holding capacity are favorable for the growth of the fungus. Additionally, four prominent seasonal drainages run through the terrain covered by soil unit 174. Because these drainages provide a seasonal routine of wetting and drying the underlying soil, the likelihood that *Coccidioides immitis* fungus is in the soil is increased (Fisher, 2006).

The likelihood that the *Coccidioides immitis* fungus is present in the fluvial sediments of Poso Creek (soil unit 306) is considered relatively low because this area is densely vegetated and the creek typically flows year-round, both of which inhibit the establishment and propagation of the fungus (Fisher, 2006).

Discussion and Conclusions

The Tertiary sediments that underlie the soils in the western two-thirds of the site consist of fine sandstones, siltstones, and claystones (CGS, 2006), are generally soft, and are susceptible to erosion from concentrated runoff if exposed. Short of prohibiting OHV travel on the slopes in this area, reducing the erosion hazard risk to an acceptable level would be a significant mitigation effort. The soils in the western two-thirds of the site also have the highest relative likelihood of containing the *Coccidioides immitis* fungal spores (Figure 3).

It is unclear how to mitigate against the inhalation hazard of *Coccidioides immitis* spores when considering OHV recreation in this area. Dust suppression by spraying water on trails is ill-advised as the frequent wetting and drying of soil may promote fungal growth and spore production (Fisher 2006).

In summary, this study provides an example of how existing geospatial data can be utilized in conjunction with known modeling factors to generate valuable information and potentially gain new insights. Through the proper use of such techniques, it's possible to distill a variety of related factors into an easily-understood product to inform decision makers as well the lay person without any specialized GIS knowledge. In this case, the modeling process made use of existing data related to geology, soils, hydrology, vegetation, topography, and physiography, and provided information that assisted natural resource management and disease mitigation efforts.

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