

# GIS applications in riparian management

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**Abstract.-GIS** was used to prioritize watersheds for treatment needs across the USDA Forest Service Southwestern Region. Factors in this analysis included soil condition, riparian habitat, population centers and mining sites.

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Hydrologic units, or watersheds, are a basic subdivision of the ecological hierarchy for Ecosystem Management utilized by the USDA Forest Service (McNab and Avers 1994). To determine appropriate management strategies for each watershed, it is critical to have information about the condition of the watershed as influenced by environmental factors and management activities. GIS (Geographic Information System) was used in this study to compile information about various factors affecting watershed condition and to analyze their cumulative impact on the watershed. The desired outcome of the study is to rank each of the Southwestern Region's 11-digit hydrologic units for priority for treatment.

This study was initiated by conducting an information needs assessment to determine the digital map layers needed to perform the analysis in GIS. The list of map layers identified as important included: 11-digit hydrologic units, USDA Forest Service General Ecosystem Survey (GES), mine locations, areas of significant human population, threatened and endangered species habitat, water quality data, and road locations. A survey of data availability was conducted to determine which of these data layers could be obtained within a time frame to be included in the initial analysis.

The data layers that were both available and readily useable within an ARC/INFO GIS, included 11-digit hydrologic units, General Ecosystem Survey, mine locations and population centers. State-wide coverages of 11-digit hydrologic units were obtained from the Arizona and the New Mexico offices of the Natural Resources Conservation Service (NRCS). The General Ecosystem Survey divides the Southwestern Region into mapping units based on soil, water, and vegetation components. These mapping units were delineated at the 1:250000 scale by the USDA Forest Service. GES contains information about soil condition and riparian areas. The mine location data was derived from the Mineral Industry Location System managed by the U.S. Bureau of Mines. Data for Arizona cities with populations greater than 5,000 came from the Arizona State Land Department's Arizona Land Resources Information System. The cities data for New Mexico came from the New Mexico's Resource Geographic Information System Program.

Data identified in the information needs assessment that were not readily available for this study included roads, threatened and endangered species habitat, and water quality. A region-wide coverage of roads is not yet available in digital format. Electronic versions of seven and one-half minute quadrangle maps are available for most of the Southwestern Region. These digital maps only contain a portion of the total number of roads that actually exist on the ground. A comprehensive road layer is needed to calculate road densities within watersheds.

The threatened and endangered species habitat locations exist in the U.S. Fish and Wildlife's Heritage tabular database, but not as GIS layers.

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The Forest Service has region-wide locations for Mexican Spotted Owl habitat, but not for other species. Water quality data for Arizona have been mapped. Water quality data for New Mexico exist only in tabular and narrative format.

The geographic extent of the GIS data set constrained the analysis because the data for soil condition and riparian areas exist only for areas within Forest Service boundaries. The analysis looks at management problems of entire watersheds, but these data sets were limited to only the Forest Service portion of each watershed.

Map layers received from various sources did not come "ready to use". It needed to be converted into a format useable by ARC/INFO. The map coverages needed to be reprojected into a geographic projection identical to the rest of the data sets. Some data needed to be edited and attributed before it was useful within the design of this analysis.

After each data set was edited and converted to a common format and geographical projection, initial maps of each data layer were produced. This visual display helped to determine the appropriate model for the study. The Regional Hydrologist developed the following model:

$$\text{Rank} = (\text{NFS acres/total acres}) + (\text{unsat. soils/NFS acres}) + (\text{riparian/NFS acres}) + (\text{Municip.} > 5\text{K}) + \text{mines}$$

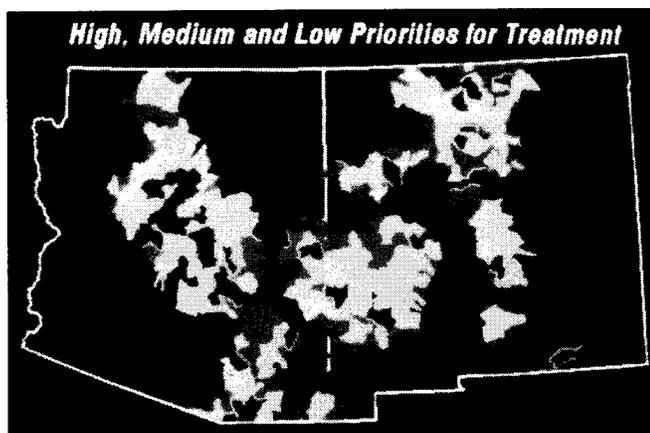


Figure 1. High, medium, and low priorities for watershed treatment.

This translates for each watershed as the ratio of National Forest Service (NFS) acres to total acreage of the watershed, plus the ratio of acres of unsatisfactory soils to NFS acres, plus the ratio of riparian acres to NFS acres, plus (yes or no) the presence of a municipality over 5,000 in population, plus the number of mine sites. Each resulting ratio was assigned a weighting factor. The presence of a municipality over 5,000 population was given a weighting factor, and weighting factors were assigned according to the number of mine locations.

To calculate the ratios in the model, each data layer had to be merged with the watershed layer. The cities and the mine location data had state-wide extents. These layers were clipped to the watershed boundaries. Ratios calculated for each factor were broken out into categories by percent and assigned a weighting factor. The five factors, forest acres, unsatisfactory soils, riparian areas, cities and mines were summed for each watershed and a ranking was assigned. Calculations to produce the rankings were performed within the INFO database of ARC/INFO. Initial tabular results and corresponding maps were produced and reviewed by the authors.

The rankings were checked against the maps. The mine location data that was used covered the full extent of the watersheds, not just Forest Service Land. This appeared to give too much weighting to mine locations over other factors in the equation. The analysis was repeated, with the mine data clipped to Forest Service Land. Final tabular results and a final map were produced. The map showed high, medium, and low priority watersheds. The distribution of the data appeared to be normal, with the greatest number of watersheds receiving a medium priority ranking. The authors concluded that GIS is a useful tool for the prioritization of watersheds. The study will be more valuable as additional information becomes available for GIS and is included in further analyses.

## LITERATURE CITED

- McNab, W. Henry; and Avers, Peter E. 1994. Ecological Subregions of the United States: Section Descriptions. Ecosystem Management. United States Department of Agriculture. Forest Service. Washington, D.C.