San Pedro River

A Landscape Approach to Community-Based Environmental Protection

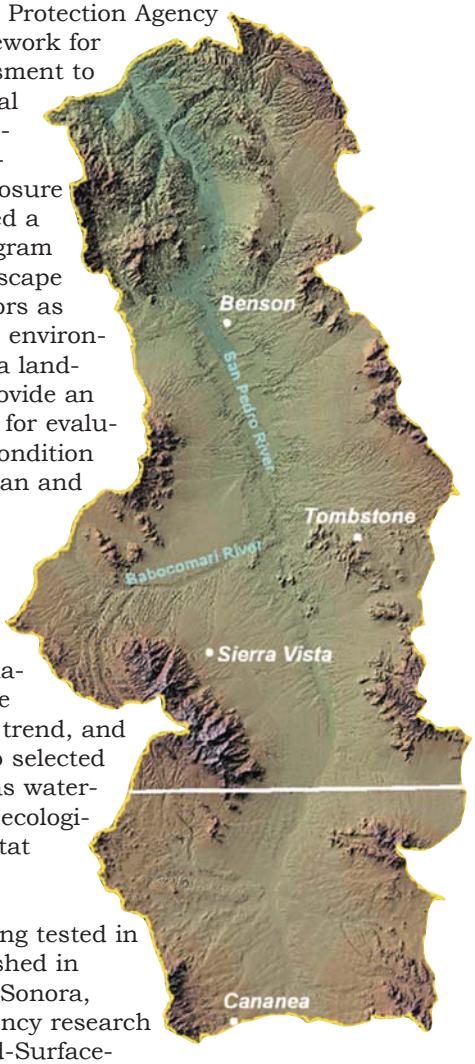
Office of Research and Development

National Exposure Research Laboratory

Environmental Sciences Division

Landscape Ecology Branch

In 1992, the U.S. Environmental Protection Agency (EPA) developed a national framework for conducting ecological risk assessment to evaluate vulnerability of ecological resources to environmental stressors (EPA/630/R-92/001). Subsequently, the EPA National Exposure Research Laboratory implemented a landscape analysis research program to test the concept of using landscape composition and pattern indicators as sensitive measures of large-scale environmental change. The purpose of a landscape analysis approach is to provide an effective and economical method for evaluating watershed and ecological condition related to disturbance from human and natural stresses.



Landscape pattern indicators are derived from remote sensing data, process models, spatial statistics, and geographic information system technology. They are used to estimate current status, trend, and changes of condition in regard to selected environmental endpoints, such as watershed condition, sustainability of ecological goods and services, and habitat condition.

This process is currently being tested in a small community-based watershed in southeast Arizona and northern Sonora, Mexico under a regional interagency research initiative entitled Semi-Arid Land-Surface-Atmosphere (SALSA) program. SALSA is a collaborative research project composed of international scientists committed to the study of land degradation processes in semi-arid areas using space-based technologies. The research is sponsored by EPA, other federal agencies such as the USDA Agricultural Research Service, and other national research institutes such as IMADES and IRD (the Mexican and French scientific research institutes for sustainable development, respectively)

The current research is focused on the upper San Pedro River basin which originates in Sonora, Mexico and flows north into southeastern Arizona. It is an international basin with significantly different cross border legal and land use practices. The watershed embodies a variety of characteristics which make it an exceptional outdoor

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laboratory for addressing a large number of scientific questions in arid and semi-arid hydrology, ecology, meteorology, and the social and policy sciences. The upper basin represents a transition area between the Sonoran and Chihuahuan deserts with significant topographic and vegetation diversity, and a highly variable climate. Elevation ranges from 900 - 2,900 m and annual rainfall ranges from 300 to 750 mm. Biome types include desertscrub, grasslands, oak woodland-savannah, mesquite woodland, riparian forest, coniferous forest, and agriculture. The upper watershed encompasses an area of approximately 7,600 km^2 (5,800 km^2 in Arizona and 1,800 km^2 in Sonora, Mexico) and represents one of the most ecologically diverse areas in the United States and northern Mexico. The riparian zone in Arizona has been Congressionally designated as a National Conservation Area and is managed by the U.S. Department of the Interior.

Landscape research in the upper San Pedro River basin has focused on the influence of land cover composition, connectivity, patch size, and patch abundance to evaluate ecosystem resilience, watershed condition, and wildlife habitat suitability. It utilizes a series of images derived from Landsat orbiting satellites equipped with the Multi-Spectral Scanner (MSS). The MSS imagery has been obtained from three periods (5 June 1973, 10 June 1986, and 2 June 1992) and remapped and projected to UTM coordinates at 60-m pixel resolution. The derivative products include digital land cover maps which can be interfaced with other relevant biophysical data and ecological and hydrological process models to assess the trend and consequences of landscape change on sustainable resources. Additionally, an 8 June 1997 Landsat Thematic Mapper (TM) image has been added to the database. Preliminary results about changes in land cover for the study period indicate that extensive, highly connected grassland and desertscrub areas are the most vulnerable ecosystems to fragmentation and actual loss due to encroachment of xerophytic mesquite woodland. In the study period, grasslands and desertscrub not only decreased in extent but also became more fragmented. That is, the number of grassland and desertscrub patches increased and their average patch sizes decreased. In stark contrast, the mesquite woodland patches increased in size, number, and connectivity. These changes have important impact for the hydrology of the region, since the energy and water balance characteristics for these cover types are significantly different.

While primary anthropogenic stressors in the project area include urbanization and livestock grazing, they differ in their magnitude and distribution throughout the watershed. The preliminary results from this project indicate that the approach provides a useful methodology to 1) measure landscape change over large geographic areas and 2) determine 25-year trends in ecological and hydrological condition using advanced space-based technologies (especially in regard to land degradation in arid and semi-arid regions of the United States and Mexico).

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http://www.epa.gov/nerlesd1/land-sci/san-pedro.htm
Also, see:
http://www.tucson.ars.ag.gov/salsa/salsahome.html