The Changing Watershed: A 25-Year History of Land Cover Change in the San Pedro River, an American Semi-arid Bioregion

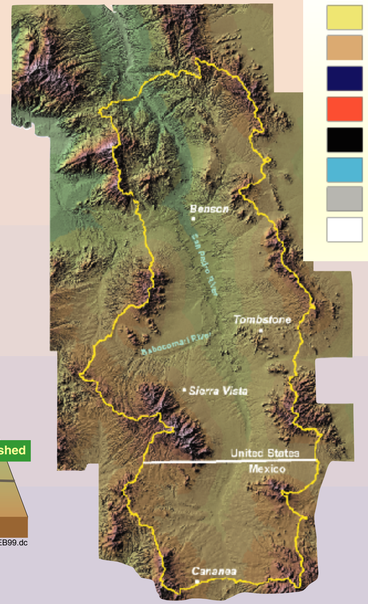
Vegetation change in the American West has been a subject of concern throughout the twentieth century. Although many of the changes have been recorded qualitatively through the use of comparative photography and historical reports, little quantitative information has been available on the regional or watershed scale. It is currently possible to measure change over large areas and determine trends in ecological and hydrological condition using advanced space-based technologies. Specifically, this is being tested in the Upper San Pedro Watershed using a system of landscape pattern measurements derived from satellite remote sensing, spatial statistics, process modelling, and geographic information systems technology. These technologies provide the basis for developing landscape composition and pattern indicators as sensitive measures of large-scale environmental change and thus, may provide an effective and economical method for evaluating watershed condition related to disturbance from human and natural stresses.

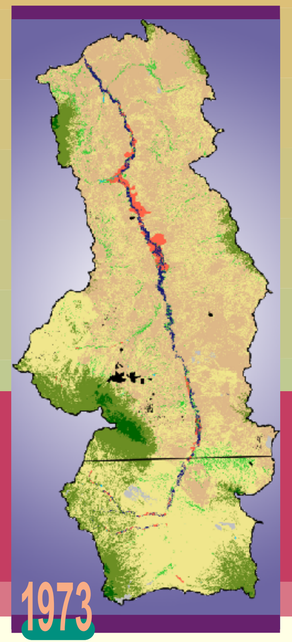
Land managers in the Southwest have traditionally been interested in status and trend in environmental conditions. The principal degradation processes that have occurred throughout the western rangelands involves 1) changes of vegetative cover which result in the introduction of exotic annual species or woody shrubs and trees, and 2) acceleration of water and wind erosion processes which result in soil loss and decrease water infiltration and storage potential. Historically, these have been linked to livestock grazing and short-term drought. However, rapid urbanization in the arid and semi-arid Southwest within the last 25 years has become an important anthropogenic factor in altering land cover composition and pattern.

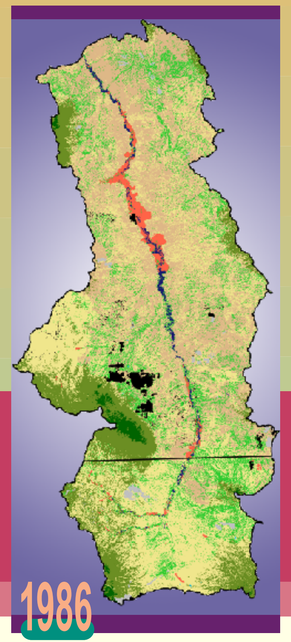
Land Cover Legend

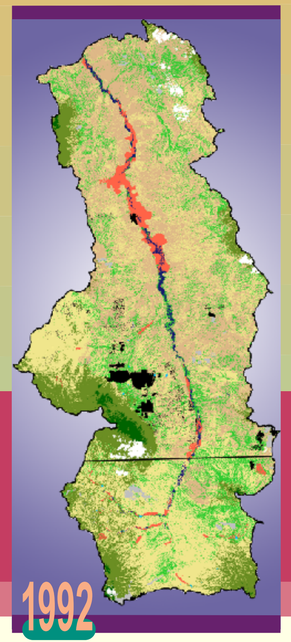
- Forest
- Oak Woodland
- Mesquite Woodland
- Grassland
- Desertscrub
- Riparian
- Agriculture
- Urban
- Water
- Barren
- Clouds ('92 and '97 only)

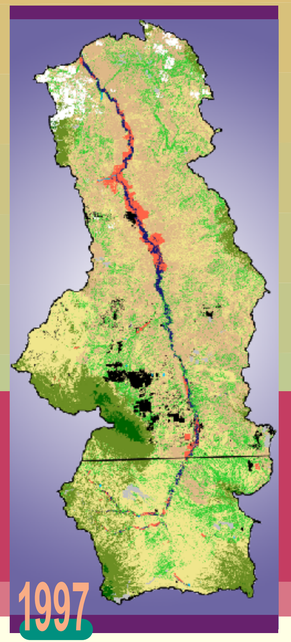
Upper San Pedro Watershed











Land cover has been derived from a multi-date satellite imagery database which incorporates Landsat Multi-Spectral Scanner (MSS) imagery from the early 1970s, mid 1980s, and early 1990s and Landsat Thematic Mapper (TM) imagery from 1997. The MSS imagery has been remapped and projected to Universal Transverse Mercator ground coordinates at 60 meter resolution; the 30 meter TM imagery has been resampled and mapped at 60 meter resolution for comparison. The land cover has been generated in a 10-class system using a modification of the Brown, Lowe, and Pase (BLP) hierarchical vegetation classification nomenclature. All vegetation has been classed to the BLP Formation level and an urban cover class has been added. The four land cover images represent a quarter century of change across the watershed (5 June 1973, 10 June 1986, 2 June 1992, and 8 June 1997). The painted relief map was developed from 30 meter digital elevation model data and depicts the dramatic differences in topographical relief present in the watershed. Elevations vary from 900 to 2,900 meters and annual rainfall ranges from 300 to 750 mm. The total area of the upper watershed encompasses nearly 7,600 km^2 (5,800 km^2 in Arizona and 1,800 km^2 in Sonora) and represents one of the most ecologically diverse areas in the United States and northern Mexico.

Landsat observations have evolved from an experimental system in the 1970s to a required capability to ensure our ability to explore, characterize, monitor, manage, and understand changes in the Earth's land surface. Landscape ecology is a relatively new science which helps place the changes and pattern of land cover into perspective relative to their impact on important ecological and hydrological processes.

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