Dr. Pamela Nagler is a Research Physical Scientist with the Terrestrial Drylands Ecology Branch of the Southwest Biological Science Center (SBSC) in Tucson, AZ. Dr. Nagler performs research that spans three main SBSC themes: river ecosystems; plant, soil, water interactions; and wildlife (habitat). Her goal is to perform science that emphasizes conservation and management of biological and water resources for the southwestern U.S. Natural resource managers of local, state, federal and tribal governments within this Southwest USGS region are tasked with conservation, preservation and/or restoration of their lands. These managers are greatly concerned with issues of land cover change, wildfire, drought, water supply, water availability and use, as these areas are undergoing some of the highest urban growth rates and most severe climate changes in the U.S. Dr. Nagler's job is to understand the environmental issues facing the Southwest and to provide actionable science for USGS partners, decision- and policy-makers.

Dr. Nagler's research focuses on the intersection of remote sensing and ecohydrology in arid/semi-arid aquatic (wet) and terrestrial (dry) ecosystems, and those in between, in the transition zone known as the riparian ecotone. A primary research effort has been the long-term study of these riparian and wetland ecosystems, which includes their upland shrubs and grasslands as well as adjacent agricultural lands. Dr. Nagler's research is heavily focused on developing novel remote sensing approaches to provide answers to scientific inquiries about the changing terrestrial landscape and specifically to identify the key bioclimatic processes that threaten riparian ecosystems and their water management. Riparian ecosystems are not as dry as upland terrestrial ecosystems but not as wet as aquatic ecosystems; these areas are transition zones or ecotones and have characteristics of both aquatic and upland terrestrial ecosystems (Zaimes, 2007). Riparian areas occur from high mountains with narrow and deep ravines or canyons, to lowland floodplains in wide areas with streams exhibiting large meanders. The geomorphic setting can have a major impact on the type of vegetation present in the riparian area, and include terms such as riparian buffer zones, cottonwood floodplains, alluvial floodplains, floodplain forests, bosque woodlands, cienegas, and meadows. They may be supported by groundwater or ephemeral, intermittent, or perennial surface water. Functioning riparian areas are very dynamic and disturbance-driven (Cartron et al., 2000), which leads to rapid changes in riparian vegetation composition and environmental conditions (Larsen et al., 1997). In the arid/semi-arid southwestern US, riparian areas are estimated to be less than 2% of the total land area (Ffolliott et al., 2004), yet these ecosystems reflect the presence of a larger number and more diverse species, are more productive, and serve more ecological functions compared to adjacent terrestrial uplands and other ecosystems in the arid/semi-arid southwest (Zaimes, 2007; Schultz et al., 2000). Importantly, these riparian ecosystems, wetlands and groundwater-dependent ecosystems are hotspots of biodiversity and act as refugia to aquatic and terrestrial flora and fauna (Springer et al., 2008). However, riparian areas have undergone significant transformations due to intensive land use, water management for anthropogenic and environmental uses, non-native species introductions and other global change processes. The net result of these environmental changes has been a reduction in native riparian vegetation extent and associated reductions in biodiversity, wildlife habitat and other critically important ecosystem services. Dr. Nagler's research seeks to create new ways to identify impacts of drought, landcover and other changes to these ecosystems to help land and water resource managers cope with these changes. Dr. Nagler's research aims to highlight cutting edge tools of riparian ecosystem investigation including those in remote sensing and ecology, ecophysiology, and ecohydrology, and process modeling. Dr. Nagler's research also evaluates management strategies that may apply high risk / high reward approaches such as environmental flow releases from water impoundments, targeted water deliveries from agricultural return flows, assisted migration efforts and other management strategies.

In addition to riparian woodlands, a secondary research effort has been the study of the biomes along the southwestern U.S. -Mexico border which include the undeveloped desert scrublands, shrublands, grasslands and rangelands that also provide habitat to myriad species. The Borderlands is also an area of high biodiversity, despite having less dense vegetation cover than in riparian corridors. These lands provide habitat for endangered and threatened birds and plants, and for iconic and rare vertebrates. Managing species and habitats across borders is a challenge for those working in conservation in the southwestern United States (U.S.) and northwestern Mexico. Remote sensing research is used in the culturally, ecologically, and topographically complex border region to provide scientific support to inform land management decisions and to meet management needs of stakeholders of the transboundary desert ecoregions.

Remote sensing methods and imagery acquisition in vast and inaccessible regions are key to improving the understanding of ecological, hydrological and bioclimatic processes within myriad ecosystems. The application of remote sensing methods improves the ability to comprehensively study the arid and semi-arid Southwestern U.S. ecosystems, as well as those around the globe with similar biomes. Dr. Nagler's research uses a multi-sourced data fusion approach to classify vegetation communities. In all of her research, she uses optical remotely sensed imagery from myriad sources, including Google Earth/Maps, a suite of products provided by NASA/USGS including the newly available Planet imagery (5-m) and Landsat OLI 8 (30-m) and MODIS Terra/Aqua (250-m) satellite data covering a range of spatial resolutions. For riparian areas, available 3D Elevation Program data, comprised from lidar point clouds and digital elevation models (DEMs) as part of the USGS National Geospatial Program (ca. 80% completed for US landcover) is an ideal source of data for detection and discrimination of riparian vegetation communities. Lastly, where feasible, hyperspectral data and shortwave infrared algorithms previously developed by Dr. Nagler for separating senescent or standing plant litter from background soils, are helpful for detection of land cover types. To move from coarse resolution MODIS data to high-resolution maps, machine learning algorithms to classify vegetation communities are employed, so that her research relies on creative data fusion of machine learning algorithms and field observations. While current maps of plant communities may exist for these ecosystem study areas that include the narrow riparian corridors and Borderlands transboundary region, their level of refinement and geographic extent are inadequate for regional conservation planning and management. Dr. Nagler's research is providing innovative methodologies to generate new plant community metrics, especially vegetation dynamics, a measure of land use and environmental change. Because of rapid changes in riparian vegetation composition due to environmental pressures (i.e., increased frequency and duration of heat waves and droughts) and disturbances (i.e., non-native species such as tamarisk and the tamarisk leaf beetle, *Diorhabda* spp.), she uses time-series trends from satellite vegetation indices (using greenness and phenology metrics) to create dynamic maps of regions to support critical landscape conservation planning and habitat management needs. A nexus project is examining the relationships between vegetation indices, water use estimates and drought indices.

A tertiary research effort of Dr. Nagler has focused on urban green spaces (UGS) with colleagues abroad. There is a growing interest in the application of my vegetation health and water use methods to urban areas and forests, not only in arid regions of Australia but also in Europe, as many countries are suffering impacts from excessive heat. Dr. Nagler's actionable science data and research findings provide critically important information for short- and long-term management decisions, especially of interest to managers of dryland ecosystems since these have been exacerbated by both anthropogenic and environmental stressors (i.e., urban growth, fire, drought).

Dr. Nagler's research methods have the benefit of being easy for managers to use and to understand. Recent advancements in remote sensing and accessibility to free satellite imagery (e.g. MODIS, Landsat, Sentinel) have allowed scientists and researchers around the globe to utilize my landcover change and water use methods for drylands. With the availability of advanced platforms like Google Earth Engine (GEE), a student has created the first GEE-based application of the optical-only, remote sensing ET method for use in drylands – across many land covers that include cultivated, cropped and irrigated agricultural lands, riparian woodlands and their adjacent landcovers, uplands, grasslands and rangelands.

Dr. Nagler's research position includes responding to the end-user community by providing easy-to-access data on vegetation health, phenology and water use in SBSC's dryland region landcover plant communities. With funding from USGS Ecosystems, her partners in the Vegetation Index and Phenology (VIP) Lab at the University of Arizona, built an online, searchable Data Explorer for end-users. This prototype data server reduces the time-consuming tasks of acquisition, processing, QA/QC and simply provides near real-time data. The data provided covers riparian areas of interest in Arizona (thus far) and the transboundary land cover types and their vegetation communities for the southwestern U.S. transborder region (coming shortly). USGS must approve the Data Release and provide a DOI number before the public, end-users, collaborators, partners, stakeholders, and decision- and policy-makers have full access to the Data Server. Dr. Nagler and her colleagues at the VIP Lab have built and populated the server with remote sensing data at multiple spatial scales since the year 2000. All available USGS/NASA satellite imagery was acquired within the USGS SBSC boundary, to include the Borderlands and the Colorado Basin, and then translated to water use using the Nagler ET algorithm developed for arid land vegetation.