

Land Use Trends

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Objectives

Determine status and trends of land use activities adjacent to Organ Pipe Cactus National Monument, and assess threats to monument ecosystems and wilderness values.

Introduction

Changes in land uses adjacent to protected lands can contribute to habitat fragmentation and loss of wildlife corridors. Disturbed lands are also more susceptible to invasive species, which can spread to natural landscapes. Organ Pipe Cactus National Monument shares its Arizona boundaries with lands managed by the Tohono O'odham Nation (TON), the Bureau of Land Management (BLM) and the Cabeza Prieta National Wildlife Refuge (CPNWR). While livestock trespass has sometimes been a problem in the past on the TON and BLM boundaries, most of the land on these three sides of OPCNM is relatively pristine and not subject to significant development. The monument's 48 kilometer southern boundary intersects the U.S./Mexico international border in a semi-rural area of Sonora, Mexico that has been steadily developing in recent decades. Agricultural development and associated groundwater depletion, along with the effects of other agricultural practices (pesticide drift, soil contamination, etc.), were early concerns of resource managers, and in recent years an increase in population and urban development has increased impacts adjacent to monument lands.

In the *Land Use Trends Surrounding Organ Pipe Cactus National Monument* (Bruce Brown, Great Western Research, 1988) project, conducted in 1987 and 1988, researchers examined agricultural development in the Sonoyta Valley adjacent to the monument in Sonora, Mexico. Agricultural and urban development in this area has the potential to negatively impact the natural

resources of the monument through depletion of the aquifer in the Rio Sonoyta watershed that is shared by the monument and Mexico. In addition, other aspects of agricultural and urban development are of concern. The aerial application of agricultural pesticides is a threat due to wind drift. Increased human habitation causes impact from pollution and wind blown trash, habitat degradation and land clearing, woodcutting, livestock trespass, non-native plants and animals, and altered wildfire frequency.

The Mexican portion of the Sonoyta Valley is a prime site for agricultural development. At the conclusion of the research phase of the project in 1988, over 12,140 hectares had been developed for irrigated agriculture. Total water withdrawal from the approximately 165 agricultural wells in 1987–88 was estimated to be 83,152 acre-feet ($1.026 \times 10^8 \text{ m}^3$), more than 2.5 times the average annual groundwater recharge rate of 28,135 acre-feet ($3.472 \times 10^7 \text{ m}^3$). Although moratoriums have been in effect to (1) prohibit development of new wells for irrigation and (2) limit the land developed for irrigated agriculture to the present 12,950 ha, this is of little reassurance when one realizes that the total current annual pumping capacity in the Sonoyta Valley is estimated to be 191,000 acre-feet ($2.357 \times 10^8 \text{ m}^3$), or more than 6 times the estimated annual groundwater recharge rate.

Four different methods were recommended in the monitoring protocol to track agricultural development in the Sonoyta Valley:

1. Biannual photo-point photography of the entire border area to detect changes through time;
2. Periodic aerial photography of the same area;
3. Collection of data from Mexican agricultural officials on crops, acreage, and chemical use;
4. Estimation of the amount of water being

pumped for agriculture based on computations using well depths and electrical consumption of the pumps.

Monument resource management staff have conducted the agricultural photo-point monitoring protocol since 1988. These photo-points are located adjacent to the international border, both in Mexico and the United States, and offer long-term visual information on changes in land use.

As recommended in the Land Use Trends final report, a good working relationship has been maintained with Mexican agricultural officials from the Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA), formerly the Secretaría de Agricultura, Ganadería y Desarrollo Rural (SAGAR), formerly the Secretaría de Agricultura y Recursos Hidráulicos (SARH), located in Sonoyta, Sonora. Resource management personnel have regularly provided depth-to-water data from monument wells and agricultural photo-point photos to these officials. In return, the monument has received data on depth-to-water and electricity use at Mexican agricultural wells, and information on crops and pesticide use. As will be mentioned elsewhere, there have been problems with data availability. The depth-to-water data became unavailable after 1993, due to budget restrictions that eliminated the annual well depth measurements. Electrical data for the pumps became unavailable, or at least prohibitively difficult to obtain, after 1997 due to its centralization in Caborca, Sonora, some 100 miles to the south. Crop and pesticide use data have been intermittently available.

Methods

Agricultural Photo-points

Twice each year, in April and November, a sequence of photos was taken from each of the 8 established photo points along the border. Four of these points are on the Mexican side of the border, while 4 are on the U.S. side. Each photo-point consists of a tagged rebar and 3 painted

spots indicating the placement of the tripod. The head of the tripod was leveled by shortening two of the legs, and thus the photos were taken from exactly repeatable locations. Each individual photo in each panoramic sequence was located by means of comparison to existing black and white photos that are contained in the monitoring field book. These photos each had a vertical mark in the center to correspond with the cross-hairs focusing screen used in the camera. Elevation was also similarly set by using the top of a distant feature such as a mountain top. Each photo sequence was shot using both color slide and black and white print film. Once processed, the slides, prints, and negatives were labeled and archived. One duplicate set of black and white prints was provided to SAGAR.

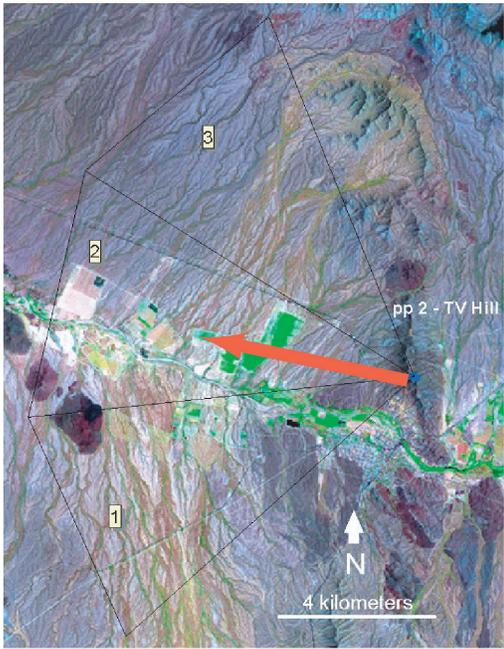
Mexican Agricultural Data

Soon after the beginning of each year, from 1987 through 1997, electrical and well-depth data have been retrieved from Mexican agriculture and utility officials. These data were entered into a Lotus spreadsheet which calculated, using assumed pump efficiencies, the amount of water being drawn from each well. A copy of this spreadsheet, when completed, was provided to SAGAR. Information from SAGAR on well depths has not been available since 1993 due to the lack of money to conduct the survey. It is hoped that the wells will be sounded again sometime in the foreseeable future. Consequently, the calculations used in the estimates for water pumping for the years 1994 - 1997 were based on well depths from 1993. These estimates were considered reasonable in that the consumption of electricity by the pumps is much more highly variable than the well depths.

Results

All 8 boundary photo points have been visited and photos taken without incident. Slides and prints showing Mexican agricultural development on the monument boundary (Figure 15-1 - 15-3) were processed and archived in the monument museum vault. Copies of the black-and-white photos were provided to agency officials in

ORPI Ecological Monitoring Program
Land Use Trends
Photopoint #2-2 -- TV Hill



November 9, 1988



November 13, 1992



May 27, 1996



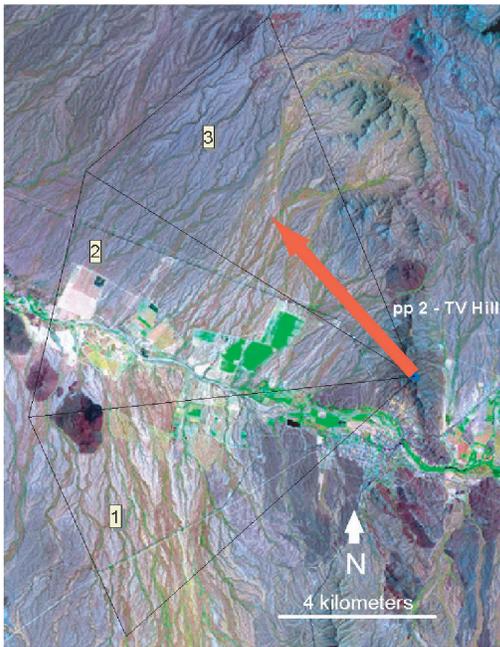
November 13, 2000



November 9, 2004

Figure 15-1. Land use trends photopoint #2-2 (TV Hill), 1988-2004.

ORPI Ecological Monitoring Program
Land Use Trends
Photopoint #2-3 -- TV Hill



November 9, 1988



November 13, 1992



May 27, 1996



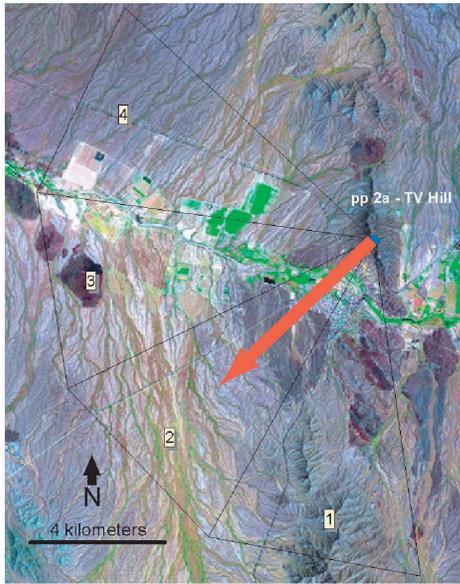
November 13, 2000



November 9, 2004

Figure 15-2. Land use trends photopoint #2-3 (TV Hill), 1988-2004.

ORPI Ecological Monitoring Program
Land Use Trends
Photopoint #2a-2 -- TV Hill



November 9, 1988



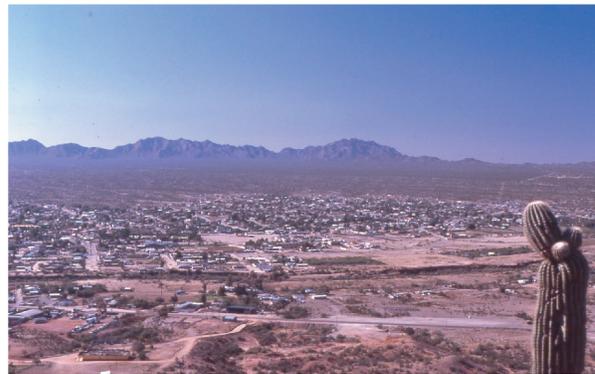
November 13, 1992



May 27, 1996



November 13, 2000



November 9, 2004

Figure 15-3. Land use trends photopoint #2a-2 (TV Hill), 1988-2004.

Sonoyta.

Electrical data for the agricultural wells in Mexico has not been available since 1997. As mentioned before, well depths have not been taken since 1993, so depths from that year were used through 1997 for pumping estimates. These figures were processed and entered into the appropriate Lotus spreadsheets. No water pumping calculations have been done since 1997.

Discussion

Up to 1997, the last year for which data were available, agriculture in the Sonoyta Valley seemed to be somewhat on the rebound, with water usage nearly equal to 1991 levels. Cotton prices have dropped and energy is still expensive. More data on crop acreage and chemical use would be useful, as would data on municipal water use by the growing town of Sonoyta. Mexican officials are trying to revive the program of checking well depths, although the standard procedure has been to get a reliable *static* level by shutting down the pumps for a few days and then getting a stable reading. This is useful for monitoring groundwater depletion, but *dynamic* levels (when the pumps are operating) are much more relevant to the calculation of the volume of water being extracted. It is not clear when or if these measurements will be made. Overall, many factors relating to agriculture besides well establishment and water use, such as seed, fertilizer, and pesticide use, are tracked by SAGARPA and related agencies, and it might be well worth the effort to try to utilize this valuable information in our attempt to monitor this significant activity on our southern boundary.

The most notable result seen from the photo points has been the recent rapid increase in urbanization along the border. Whole settlements have sprung up, as well as facilities for travelers, communication towers, etc. Large patches of land have been cleared in preparation for further development, and much of this is along Mexican Route 2 adjacent to the boundary with OPCNM. Development along this highway corridor has the

very real potential to impede wildlife movement.

Anecdotal reports from monument staff indicate a large increase in trespass by domestic and/or feral dogs near the south boundary, and sometimes several miles north of the boundary. Wind blown trash from border settlements is also increasing. Historic structures on the border have experienced degradation from vandalism and wood theft. As the Sonoyta population grows, these impacts to wilderness values and natural and cultural resources will likely increase.

Recommendations

- Seek funding for SAGARPA to measure the well depths.
- Attempt to acquire data now stored in Caborca, Sonora.
- Request more data, as before, on crop acreage and pesticide and fertilizer use.
- Generally reestablish and solidify relations with resource agency personnel in Mexico, both in Sonoyta and elsewhere.
- Develop educational programs for Sonoyta schools on cross-boundary conservation issues in conjunction with the Pinacate Biosphere Reserve staff.
- Continue the border photo-point photos at a reduced frequency (once per year), due to budget constraints.
- Acquire or produce better maps of the developed zone along the border, including ejido boundaries and well locations; quantify and map land use boundaries using satellite imagery.

Acknowledgements

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as providing valuable crop data for the Sonoyta Valley. Roy Irving (NPS) set up the initial photo points and data spreadsheets, and Ami Pate (NPS-ORPI) did a significant amount of the field work.

Literature cited

Land Use Trends Surrounding Organ Pipe Cactus National Monument (Bruce Brown, Great Western Research, 1988)

