Vegetation Phenology and Intensity along an Ephemeral Desert River as a Function of Climate and River Flows, 2000 -2010

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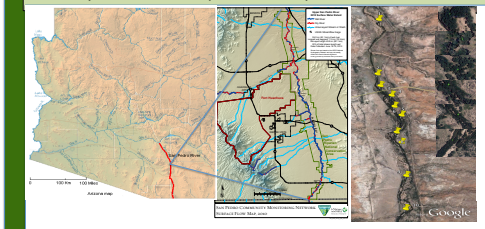
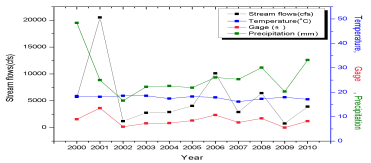
Abstract:

The San Pedro River, located in the Sonoran and Chihuahuan Deserts, is one of the most biologically diverse ecosystems in the Rocky Mountains of the southwestern United States. Riparian vegetation dynamics related to the changes in length of seasons may affect the life and migration of many wildlife species. Vegetation density is related to river flows, depth to groundwater, air temperature and precipitation, which vary year to year. MODIS products (Enhanced Vegetation Index (EVI) and Normalized Difference Vegetation Index (NDVI)) were used to monitor riparian vegetation dynamics during an 11-year period (2000-2010) to examine the impacts of climatic and hydrologic variables on the onset of greenness, senescence, and maximum vegetation density. Data on temperature, rainfall and water flows were extracted from Parameter-elevation Regressions on Independent Slopes Model (PRISM) and gages. The phenology profiles from time series data and relationships between the vegetation index and climatic and hydrologic data not only show extension in length of seasons but also allow us to identify how vegetation responds to moisture stress in the riparian areas of the San Pedro River. By using remote sensing data for the San Pedro River basin, we can assess the response of vegetation to different biophysical variables in the spatial and temporal domains. Our short-term efforts will continue and will be focused on the quantification of this response across the basin using field measurements that can help us to validate our results.

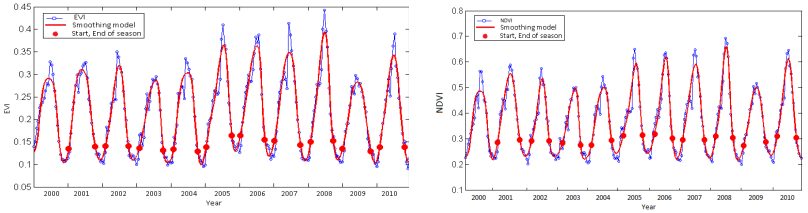
Materials and Methods:

- Study areas: 10 sample sites of riparian area from the Middle to Upper San Pedro River.





Stream flows, temperature, gage and precipitation from 2000-2010.



Time series MODIS EVI and NDVI 16 day, 250m with start and end of season from 2000- 2010 by using TIMESAT.

-Extract a single pixel EVI and NDVI filtered mean values from MOD13Q1 250m 16 day composite for 11 years (2000-2010) of each site , available at (www.modis.ornl.gov)

- Using TIMESAT implements the smoothing method to capture seasonal changes and lengths of season.
- Climate data :Temperature, Precipitation from PRISM and AZmet sites.
- Hydrologic condition: Ground water, Surface water, Stream Flows, Gage data at Tombstone station from USGS site.
- Evapotranspiration: ET= 1.22 ET_o x EVI*(Nagler et al, 2005)

Results:

EVI annual anomaly of the growing season (Fig.1) has showed variations that could have caused these including temperature, precipitation and surface water (Fig.2) to a longer growing season (Fig.3). The ANOVA results not only show the best correlation between EVI and ET (Fig.4); similar to the find of Nagler et al.2005 a, but also a significant mean differences between EVI and the other three variables : temperature, precipitation and surface water.

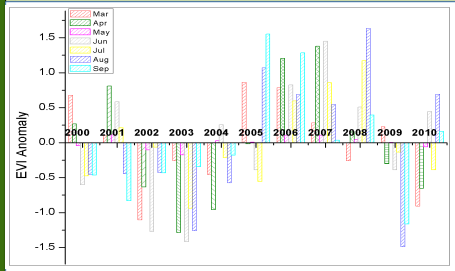


Figure 1. EVI anomaly from March to September (growing season) 2000-2010.

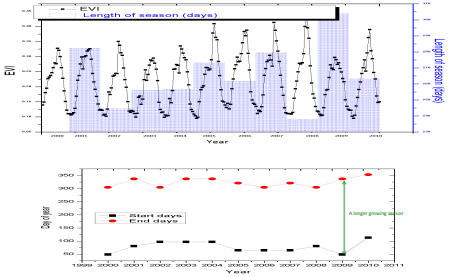
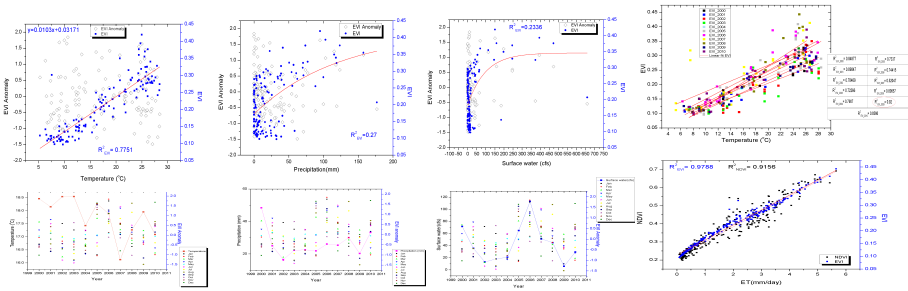


Figure 3. EVI with length of season 2000-2010 and the day of year when start or end of season.



ANOVA	MeanDiff	SEM	q Value	Prob	Alpha	Sig	LCL	UCL
Temperature EVI	17.65658	4.48265	5.57041	5.07253E-4	0.05	1	5.12104	29.19211
Precipitation EVI	26.01212	4.48265	8.20647	4.95391E-5	0.05	1	14.47658	37.54765
Precipitation Temperature	8.35554	4.48265	2.63606	0.24436	0.05	0	-3.17999	19.89107
Surface Water EVI	37.38733	4.48265	11.79519	0	0.05	1	25.8518	49.92287
Surface Water Temperature	19.73076	4.48265	6.22478	7.01954E-5	0.05	1	8.19622	31.26629
Surface Water Precipitation	11.37522	4.48265	3.58872	0.05491	0.05	0	-0.16032	22.91075

Figure 2. Correlation of mean EVI and Temperature, Precipitation and Surface water 2000-2010 within EVI anomaly. The variation in EVI anomaly compared with average annual temperature, precipitation and surface water in eleven years. The significant difference between EVI and precipitation, surface water might cause to changes in length of season and moisture stress in the riparian area.

Figure 4.Relationship EVI and Temperature in single year from 2000-2010 appears high R^2 (0.92) in 2009 and the best correlation between ET and EVI.

Conclusions:

-Anomaly values and length of seasons extracted from Enhanced Vegetation Index gave a significant picture of riparian vegetation dynamics, which varied year to year. The shortage of sources of water and high temperature in 2009 might cause a longer period of growing season and lower Vegetation Indices.

- The correlation between ET and EVI showed strong relationship in the landscape with temperature since plants tend to show conservative production on their leaves (Glenn et al, 2010). However, to estimate how moisture stress affects in this riparian area, we need to study more about canopy structure and other biophysical variables based on field measurement to predict leaf-level transpiration on the plant.

References:

Glenn, E.P, Nagler, P.L., & Huete, A.R. (2010). Vegetation Index Methods for estimating evapotranspiration by Remote Sensing. Surv - Geophys, 31:531-555.

Nagler, P. L., Glenn, E. P., Curtis, C., Schiff-Hursh, K., & Huete, A. R. (2005a). Vegetation mapping for change detection on an arid-zone river. Environmental Monitoring and Assessment, 109, 255–274.