The use of remote sensing in temporal change analysis for grassland monitoring

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Abstract

The purpose of this research was to analyze changes in vegetation type and productivity in Grasslands National Park from 1974 to 2006 and to predict how the vegetation here may change under future climate scenarios. Remotely sensed data from the Landsat satellites were used to perform the analyses. Using vegetation indices, changes in vegetation were monitored and then compared to meteorological data to determine how productivity has fluctuated in the past with changes in meteorological conditions.

Background

Remote sensing is very useful in measuring the productivity of vegetation in an area. The spectral characteristics of vegetation allow for the monitoring of vegetation cover and productivity. Radiation in the red part of the visible electromagnetic spectrum is absorbed by plant pigments, while near-infrared radiation is strongly reflected (Ustin, 2004). The ratio of these two wavelengths has been related to the photosynthetic activity of plants. Vegetation indices are the biophysical functions that exploit the characteristics of this ratio to determine the state of vegetation in an area.

Grasslands National Park is a mixed grass prairie ecosystem located in southern Saskatchewan, along the U.S.-Canadian border. Throughout the last century, vegetation in the Grasslands National Park area has undergone extensive changes, from natural prairie grassland to ranching and agriculture. Since 1981, the federal and provincial governments have been acquiring land in the Val Marie-Killdeer region in order to return this land to a natural prairie ecosystem (Parks Canada, 2002)

Methods and Data

Data from three Landsat sensors were used in order to analyze changes in vegetation diversity and productivity. These sensors are the Multi-Spectral Scanner (MSS), Thematic Mapper (TM) and the Enhanced Thematic Mapper (ETM). It is necessary to use data from three different sensors because data from the same sensor does not cover the temporal scale of the study.

The remotely sensed images were supplemented with *in situ* data collection. Field work was done in Grasslands National Park in order to correctly identify land cover types seen the images. Vegetation and land cover type locations were identified and compared to the images. Daily weather data from 1974 to 2006 were also collected and statistical analyses were used to determine periods during

which the meteorological conditions varied from precipitation and temperature normals. Vegetation conditions were then analyzed, using the remotely sensed data, in order to determine how the vegetation responds to meteorological changes (ie. Periods of drought or periods of heavy precipitation).
In order to analyze the remotely sensed data, Principal Component Analyses were used. A Principal Component Analysis is a redundancy reduction technique that separates the variations in the image data that are not due to land-cover change from the changes that are due to land-cover change (Jensen, 2005). A PCA maximizes the variance between variables (Piwowar and LeDrew, 1995). The variances in vegetation productivity found using this method were then compared to the meteorological data so that vegetation response could be monitored.

Results

The results to date show that over the last 35 years there has been a large amount of variation in vegetation productivity, and that these changes are affected by meteorological conditions. The research also shows that vegetation productivity can be influenced by human activities in some areas of the park. Through this research, it is expected that the specific degree of variation in productivity and the statistical significance of this variation and correlation to meteorological conditions will be determined. These data may then be used to make predictions on how the vegetation in the park will change based on future climate change scenarios.

References

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