SPATIAL CLUSTER ANALYSIS OF HYDROLOGICAL DROUGHT INDICATOR IN AN OASIS ECOSYSTEM

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1. INTRODUCTION

Remote sensing methods have been applied over a number of regions worldwide to monitor land cover dynamics[1, 2]. Since agricultural activities, aquifer-recharge, and ecological changes are influenced by soil moisture, this study has been focused on drought anomaly assessment using normalized difference moisture index (NDMI) data derived from satellite data. Normalized difference moisture index (NDMI) and standardized moisture index (SMI) have been used to assess drought anomaly. Finally, relative hotspots of high drought risk of the Ejin basin have been compared. This research can improve our understanding of drought risk assessments and their spatial characteristics on a regional scale. This study can also assist future studies of drought risk assessment and drought monitoring in detecting hotspots with high drought risk.

2. MATERIALS AND METHODS

This study tried to delineate hot spots of drought anomaly using MODIS data on the TERRA satellite. NDMI data (2001-2006 used as the base period) used in this study were bi-weekly composites of the study area, excluding cloud pixels. These data were used to calculate standard moisture index (SMI) to assess soil moisture dynamics. A NDMI is utilized:

$$NDMI_{ijk} = \frac{NIR_{ijk} - SWIR_{ijk}}{NIR_{ijk} - SWIR_{ijk}} \qquad (1)$$

where, NIR_{ijk} and $SWIR_{ijk}$ is the reflectance values at the near infrared and short-wave infrared wavelengths of MODIS on the TERRA satellite, respectively, for pixel i during season j for year k.

$$SMI_{ijk} = \frac{\left(NDMI_{ijk} - \overline{NDMI_{ij}}\right)}{\sigma NDMI_{ij}} \qquad (2)$$

where where $\overline{NDMI_{ij}}$, $NDMI_{ijk}$, and $\sigma NDMI_{ij}$ are the multiyear average NDVI for pixel *i* in bi-week *j*, bi-weekly NDMI for pixel *i* in week *j* for year *k*, standard deviation of NDMI for pixel *i* in bi-week *j* respectively.

In this study, the Getis-Ord's G_i^* was calculated as a measure of the degree to which high and low values of selected images of drought indices occurred close together in an array of interested extents[3]. A key advantage of using the Getis-Ord's G_i^* is that G_i^* is capable of indicating the extent to which a location is surrounded by a cluster of high or low values for the variable under consideration[4]. The equation for G_i^* was calculated for each pixel using the following equation:

$$G_i^* = \frac{\sum_j W_{ij}(d)x_j - W_i^* \bar{x}}{s\left[W_i^*(n - W_i^*)/(n-1)\right]^{1/2}} \quad (3)$$

where W_i^* is the count of the pixels within distance, d, of the central pixel i, d defines the size of the kernel by the number of pixels from the central pixel, i, $\bar{x}$ is the image digital number mean, s is the image digital number standard deviation, and n is the total number of pixels in the image. The local Getis statistic computed for SMI is to examine the drought anomaly characteristics of the Ejin oasis in an arid environment.

3. RESULTS AND CONCLUSIONS

This study is successful in delineating detailed spatial information concerning the drought anomaly areas of the 2003 drought anomaly in the Ejin Oasis, western Inner-Mongolia. The index, SMI, derived from satellite data enhance drought anomaly identification mapping. The results show that the indices significantly helped assessments of drought anomaly detection. The use of the Getis statistic (G_i^*) provides insights on the spatial relationships of drought anomaly (Figure 1). Specially, the location of significant G_i^* values identified areas where the potential areas of hydrological drought risk occur and are spatially clustered. This information may then be used to map the high drought risk areas and help governments to improve the use of local water resources.

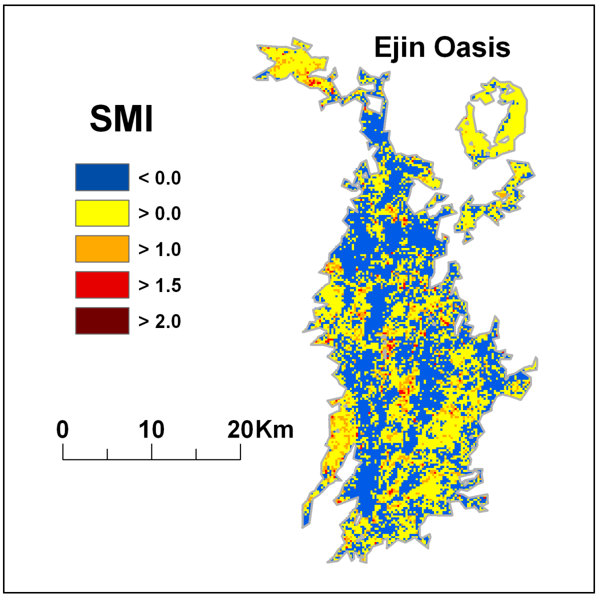

Fig. 1. Standardized moisture index (SMI) for summer in the year 2003.

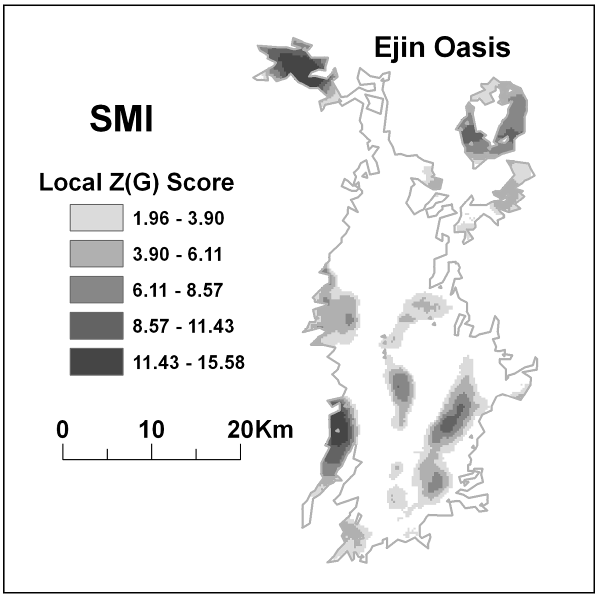

Fig. 2. Spatial clustering of high-value cells in SMI based on the Z scores of local G-statistics.

4. REFERENCES

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