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An analysis of the ecosystem health in aquatic habitats using quantitative remote sensing, with a focus on China's Heihe River Basin

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Abstract

To explain (1) how hydrological processes affect the distribution and structure of biological systems, and (2) how biological systems influence the water cycle," as stated by ecohydrologists, is the primary "goal of ecohydrology" (Baird and Wilby, 1999; Rodriguez-Iturbe, 2000; Bonell, 2002; Eagleson, 2002; Kundzewicz, 2002; Nuttle, 2002; Zalewski, 2002; Bond, 2003; Hunt and Wilcox, 2003; Newman et al., 2003; Van Dijk, 2004; Hannach" et al., 2004; Breshears, 2005). Ecohydrology is the study of hydrology's ecological impacts. " Gaining a better understanding of and a way to quantify the relationship between plants and water is one of the first steps in developing an ecohydrological approach to water resource management. Managing watersheds in arid regions continues to attract attention. of dwindling water supplies (Hibbert 1983). If accurate correlations can be established between groundwater recharge, runoff, hydraulic variables, and vegetation change, these operations can be used as water demand proxies (Walvoord and Phillips, 2004; Kwicklis et al., 2005). Vegetation is known to play an important role in the dynamics of groundwater recharge and outflow in arid regions, which has been studied using remote sensing techniques (Cayrol et al., 2000; Kerkhoff et al., 2004b). Rather than surface and subsurface sampling and analysis, vegetation mapping can be used to predict surface flow and groundwater recharge. Predicting the vegetation's response to changes in water input, as well as its impact on water fluxes, requires ecohydrological approaches and models that use remote sensing. technology and stowing away Improving satellite remote sensing capabilities may allow us to learn more about how vegetation responds to changes in hydrological processes. Understanding ecohydrological processes necessitates the integration of remote sensing techniques with hydrology.

Keywords: Groundwater Recharge, Remote Sensing Methods.

INTRODUCTION

According to Parsons and Abrahams (1994), dry, semiarid, and subhumid areas cover 50% of the Earth's surface. These areas are classified as water constrained because annual precipitation is frequently less than annual potential evapotranspiration (Guswa et al., 2004). These areas are typically sensitive and fragile due to low and unpredictable precipitation, limited water supplies, and scarcity of vegetation. Land desertification, groundwater depletion, salinization, and soil erosion are just a few of the environmental changes occurring in these dry regions (De Fries et al., 2004). Environmental changes are increasingly affecting human cultures, with a growing impact on global biogeochemical cycles (Schlesinger et al., 1990; Bonan, 2002). Native and cultivated vegetation have a significant impact on the environment. and are in turn influenced by "it" (Sabins, 1996). In water-stressed environments, vegetation acts as an environmental indicator and is frequently linked to both the causes and consequences of arid land degradation. Vegetation has long been recognized as playing an important role in regulating soil moisture, runoff, and streamflow dynamics (Wilcox et al., 1997, 2003b; Newman et al., 1998, 2004; Neave and Abrahams, 2002; Porporato et al., 2002; Ridolfi et al., 2003; Fernandez-Illescas and Rodriguez-Iturbe, 2004; Cayrol et al., 2000; Kerkhoff" et al., 2004b). Ecohydrology is based on an understanding of how vegetation influences hydrological changes (Newman et al. 2006). Measuring the relationship between plant and water resources is a critical step in developing sophisticated ecohydrological methodologies. Resource management and environmental changes.

LITERATURE REVIEW

The dry areas listed above occupy a quarter of China's landmass and cover 2.5 million square kilometers in northwest China. The Ejina area receives more than 250 mm of rain per year, with even lower amounts in the western plains (50-150 mm) and the western plains (less than 40 mm). In arid environments, potential evaporation ranges between 1,400 and 3,000 millimetres per year. Sand and gravel deserts, as well as other types of xeric shrublands, are uninhabitable for humans due to the region's arid climate. In recent years, vegetative components of Northwest China's ecosystems appeared to be widespread. Sandstorms have increased due to land desertification caused by the decrease of The oasis area and soil degradation. Water availability is the most important factor in determining plant diversity (Dawson, 1993; Burgess et al., 1998; Caldwell et al., 1998; Brooks et al., 2002; Zou et al., 2005; Santanello et al., 2007). When it comes to water, all of the oasis in China's northwest desert region are fed by surface rivers, and their size is proportional to river flow and groundwater depth. As a result, established ecohydrological analysis techniques, which frequently involve point observations and are only representative of small "scales," cannot be applied to large regions. As a result, these approaches cannot be applied to large areas. A number of important physical characteristics can be measured continuously and precisely using Remote sensing. In hydrology, these approaches are still used in a limited capacity in China to quantify changes in the eco-environment (Li et al., 2001; Lu et al., 2003; Guo and Cheng, 2004; Kang et al., 2007). Use remote sensing tools to quantify changes in China's eco-system, then apply this technology to ecohydrological applications.

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The Heihe River basin, one of China's two major interior river basins, is located in Gansu Province's Hexi Corridor. The watershed area measures 14.3104 m2. The Upper, Middle, and Lower Heihe Rivers run from the center of the Hexi corridor to the western Inner Mongolia Municipality. Qilian Mountains (the upstream area) are located in China's southern Heihe River basin, between 3000 and 5000 meters above sea level. A chilly temperature. This area serves as the primary source of surface water and groundwater for the Heihe River basin, which eventually flows into two lakes in the Ejina Oasis (the downstream area), the West Juyan Lake and the East Juyan Lake. The Zhangye basin, a major agricultural region in northwest China, lies in the "middle stream" area. Water use has steadily increased as the population and farming in the middle stream area have grown, with irrigation now accounting for the vast majority of that "demand." As a result, water levels in the downstream area are rapidly dropping, causing a severe decline in the ecosystem. The Chinese government prioritizes balancing water use in the downstream area, and has developed a new This focus has resulted in changes to water distribution policy. The ultimate goal of this research is to create a quantitative approach for assessing changes in the eco-environment in these Chinese Northwestern dry regions, as well as to provide scientific evidence for conserving and improving the eco-environment.

STATEMENT OF THE PROBLEM

In terms of complexity and heterogeneity, hydrological processes exist on a wide range of spatial and temporal scales. Point sensors have traditionally been used to measure hydrological variables because they are believed to be representative of large areas. However, in complex or diverse situations where point measurements are unlikely to represent large regions, this technique is ineffective. At the surface-atmosphere interface, a system with both spatial and temporal dynamics can be found (Cooper et al., 1992, 2000; Eichinger et al., 2000). Some ecohydrological processes can be observed using remote sensing, a set of non-contact observing technologies that can be used to collect data. We intend to create an integrated hydrologic remote sensing approach that combines Hydrologic remote sensing studies involving large-scale hydrologic processes. Historically, remote sensing products have focused on a single geophysical variable and were used to investigate short-term processes. We propose using remote sensing to estimate water-energy-ecosystem variables as an integrated method to improve this approach. This strategy can be used to solve hydrological research problems ranging from local to global in scope. On a global scale, it is clear that satellites can monitor many aspects of the Earth system. Hydrological processes and their interconnections can be better understood by using aircraft and ground-based technologies.

OBJECTIVE OF THE STUDY

Infrared technology will be used, as will ecohydrological technologies, to statistically analyze eco-environmental changes in large, arid regions.
Researchers chose to investigate the Heihe River Basin in northwest China to learn more about the spatial variability of water supplies and to resolve a water consumption dispute between the region's middle and upper reaches. The research aims to 1) assess the distribution of vegetation upstream and 2) determine how closely the dynamics of vegetation change are related to the occurrence of rainfall. As a result, it is necessary to formulate the following specific research queries:

• The goal is to analyze the vertical and horizontal spread of vegetation in mountainous terrain using remote sensing techniques.

Research Questions: • Can remote sensing technologies quantify vertical and horizontal distribution of vegetation in mountainous terrain?

RESEARCH METHODOLOGY

Most research using remote sensing data focused on two-dimensional horizontal patterns, though a few looked at the vertical distribution of plants in mountain areas (Franklin 1995; Edwards 1996; Guisan and Zimmermann 2000; Hansen 2000; Miller et al. 2004; Lookingbill et al. 2005). Zhao et al. (2006) used meteorological data and GIS modelling to predict the spread of Qinghai spruce (Picea crassifolia) in the Qilian Mountains. According to the findings, the Qinghai spruce may thrive at altitudes ranging from 2650 to 3100 metres. The primary goals of this study, which also serves to demonstrate the technique's efficacy, are the vertical and horizontal distribution of vegetation in the Qilian Mountain region, as well as its key influencing elements, such as elevation, aspect, and precipitation. After a A brief introduction to the subject region is provided, followed by detailed presentations and discussions of the datasets and results. Finally, the conclusion is given.

RESEARCH DESIGN:

The Global Inventory Modeling and Mapping Studies (GIMMS NDVI) data sets (Tucker et al., 2005) were created to provide a 23-year satellite record of monthly changes in terrestrial vegetation. The NDVI estimates green biomass by measuring the reflectance of red and infrared wavelengths in an area's electromagnetic spectrum (Deering, 1978). According to the NDVI's design, higher NDVI values indicate greater or more plant coverage, lower values indicate less or no vegetation coverage, and zero NDVI indicates rock or barren ground. "Due to orbital drift, the GIMMS-NDVI" dataset compensates for variations in NDVI caused by changes in solar zenith angle. (Pinzon et al. 2004; Piao et al. 2003; Pinzon 2002). Cloud cover, sensor inter-calibration discrepancies, impacts from solar zenith angle and viewing angle, volcanic aerosols, and missing data in the Northern Hemisphere during winter have all been corrected. The GIMMS dataset is based on 15-day composites and has a geographical resolution of 8 kilometres.

DATA ANALYSIS

In a regression analysis, the average annual GIMMS NDVI will serve as "the dependent variable" (y), while runoff levels measured at the Langxinshan station will serve as "the independent variables" (x0, "x1", and "x2").

CONCLUSION:

MODIS "Vegetation cover on hillsides can be measured with NDVI precision." Vertical plant distribution in the Qilian Mountains is influenced by height and aspect, which serve as proxy for precipitation and temperature. Between 3200 and 3600 meters, the vegetation should be densest and have the highest NDVI rating. Plant life thrives on the mountain's northern slope, where conditions are cooler and shadier. If you want your plants to thrive, the ideal conditions are 21 degrees Celsius soil temperature and 46 millimetres of rain per month. The SEBS uses data from a weather station to "predict evapotranspiration in the inland basin with high precision using the (Surface Energy Balance System) algorithm."

LIMITATIONS OF THE STUDY:

Hydrological processes. In terms of complexity and heterogeneity, they occur at a wide range of spatial and temporal scales. Point sensors have traditionally been used to measure hydrological variables because they are believed to be representative of large areas. However, in complex or diverse situations where point measurements are unlikely to represent large regions, this technique is ineffective. At the surface-atmosphere interface, a system with both spatial and temporal dynamics can be found (Cooper et al., 1992, 2000; Eichinger et al., 2000). Remote sensing, a collection of non-contact observing technologies, allows for the collection of information on some of the spatial and temporal ecohydrological processes.

REFERENCES

1. Agliardi, F., Crosta, G. B., 2003. High resolution three-dimensional numerical modelling of rockfalls. International Journal of Rock Mechanics and Mining Sciences, 40, 455-471.
2. Allen-Diaz, B., 1991. Water-table and plant species relationships in Sierra Nevada meadows.
3. Am. Midl. Nat. 126, 30-43.

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4. Allen, R B., Peet, R. K., 1990. Gradient analysis of forests of the Sangre de Cristo Range, Colorado. Canadian Journal of Botany, 68, 193-201.
5. Allison, G.B., Cook, P.G., Barnett, S.R., Walker, G.R., Jolly, I.D., Hughes, M.W., 1990. Land clearance and river salinisation in the western Murray Basin, Australia. Journal of Hydrology, 119, 1-20.
6. Baker, M.B., Ffolliott, P.F., DeBano, L.F., Neary, D.G., 2004. Riparian Areas of the Southwestern United States: Hydrology, Ecology, and Management. Lewis Publ., Boca Raton, Fla.
7. Bastiaanssen, W.G.M., 2000. SEBAL-based sensible and latent heat fluxes in the irrigated Gediz Basin. Turkey. Journal of Hydrology, 229, 87-100.
8. Bastiaanssen, W.G.M., Ahmed, M.-ud.-D., Chemin, Y., 2002. Satellite surveillance of evaporative depletion across the Indus Basin. Water Resources Research, 38, 1273- 1282.
9. Cooper, D.I., Eichinger, W.E., Holtkamp, D., Karl Jr., R., Quick, C., Dugas, W., Hipps, L., 1992. Spatial variability of water-vapor turbulent transfer within the boundary layer. Boundary-Layer Meteorology, 61, 389-405.
10. Crowley, J., Hubbard, B., Mars, J., 2003. Analysis of potential debris flow source areas on Mount Shasta, California, by using airborne and satellite remote sensing data. Remote Sensing of Environment, 87, 345-358.
11. Diouf, A., Lambin, E.F., 2001. Monitoring land-cover changes in semi-arid regions: remote sensing data and field observations in the Ferlo. Senegal. Journal of Arid Environment, 48(2), 129-148.
12. Dube, O.P., 2001. Remote sensing, climate change and land-use impacts in semi-arid lands of Southern Africa. International Geoscience and Remote Sensing Symposium (IGASS), volume, 6, pp.2686-2688.
13. Duell, L.W.F., 1990. Estimates of evapotranspiration in alkaline scrub and meadow communities of the Owens Valley, California, using the Bowen-ratio, eddy-correlation, and Penman-combination methods. USGS Water Supply Paper 2370-E.
14. Duune, S., Entekhabi, D., 2005. An ensemble-based reanalysis approach to land data assimilation. Water Resources Research, 41, W02013, doi:10.1029/2004WR003449.
15. Endress, B. A., and Chinea, J. D., 2001. Landscape patterns of tropical forest recovery in the Republic of Palau. Biotropica, 33, 555–565.
16. Faragalla, A.A., 1988. Impact of agrodesert on a desert ecosystem. Journal of Arid Environment, 15(1), 99-102.
17. Farmer, D., Slvapalan, M., Jothltyangkoon, C., 2003. Climate, soil, and vegetation controls upon the variability of water balance in temperature and semiarid landscapes: downward approach to water balance analysis. Water Resources Research, 39(2), 1035- 1056.

18. Guo, X.Y., Cheng, G.D., 2004. Remote Sensing study of evapotranspiration in the Heihe River basin, Northwest of China. International Geoscience and remote sensing symposium (IGARSS), Volume 6, pp. 3607-3610.
19. Gupta, R.S., 1989. Hydrology and Hydraulic System. Prentice-Hall, Englewood Cliffs, NJ.
20. Guswa, A.J., Celia, M.A., Rodríguez-Iturbe, I., 2004. Effect of vertical resolution on predictions of transpiration in water-limited ecosystems. Advances in Water Resources, 27, 467- 480.
21. Hannah, D.M., Wood, P.J., and Sadler, J.P., 2004. Ecohydrology and hydroecology: A "new paradigm"?. Hydrological Processes, 18, 3439-3445.
22. Johnson, E. A., 1981. Vegetation organization and dynamics of lichen woodland communities in the Northwest Territories. Canada. Ecology, 62, 200-215.
23. Kang, E., Lu, L., Xu, Z., 2007. Vegetation and carbon sequestration and their relation to water resources in an inland river basin of Northwest China. Journal of Environmental Management, 85, 702-710.
24. Liu, C.M., and Sun, R., 1999. Ecological aspects of water cycle: advances in soil-vegetation-atmosphere of energy and water fluxes. Advances in Water Science, 10, 251-259.
25. Liu, S., Mao, D., Hu, G., Lu, L., 2007. Estimation of regional evapotranspiration by TM/ETM+ data over heterogeneous surfaces. Photogrammetric Engineering and Remote Sensing, 73(10), 1169-1178.
26. Loheide, S. P., Gorelick, S.M., 2007. Riparian hydroecology: a coupled model of the observed interactions between groundwater flow and meadow vegetation patterning. Water Resources Research, 43, W07414, doi:10.1029/ 2006WR005233.
27. Loik, M.E., Breshears, D.D., Lauenroth, W.K., Belnap, J., 2004. A multiscale perspective on water pulses in dryland ecosystems: Climatology and ecohydrology of the western USA. Oecologiea, 141, 269-281.
28. Miller, J. R., Turner, M. G., Smithwick, E. A. H., Dent, C. L., and Stanley, E. H., 2004. Spatial extrapolation: the science of predicting ecological patterns and processes. Bioscience, 54, 310-320.
29. Mintz, Y., and Walker, G.K., 1993. Global fields of soil moisture and land surface evapotranspiraiton derived from observed precipitation and surface air temperature. Journal of Applied Meteorology, 32, 1305-1334.
30. Mirlas, V., Benyamini, Y., Marish, S., Gotesman, M., Fizik, E., Agassi, M., 2003. Method for normalization of soil salinity data. Journal of Irrigation and Drainage Engineering, 129(1), 64-66

31. Norman, J.M., Kustas, W.P., Humes, K.S., 1995. A two-source approach for estimating soil and vegetation energy fluxes in observations of directional radiometric surface temperature. Agricultural and Forest Meteorology, 77, 263-293.
32. Nuttle, W.K., 2002. Eco-hydrology’s past and future in focus. EOS: Transactions. American Geophysical Union, 83, 205-212.
33. Pinzon, J., 2002. Using HHT to successfully uncouple seasonal and interannual components in remotely sensed data. SCI 2002, Conference Proceedings, July 14-18, Orlando, Florida.
34. Pinzon, J., Brown, M.E., and Tucker, C.J., 2004. Satellite time series correction of orbital drift artifacts using empirical mode decomposition. In Hilbert-Huang Transform: Introduction and Applications. eds. N. Huang, pp. Chapter 10, Part II.
35. Porporato, A., D’Odorico, P., Laio, F., Ridolfi, L., Rodríguez-Iturbe, I., 2002. Ecohydrology of water-controlled ecosystems. Advances in Water Resources, 25, 1335-1348.
36. Rodriguez-Iturbe, I., Porporato, A., 2004. Ecohydrology of Water-Controlled Ecosystems: Soil Moisture and Plant Dynamics. 442 pp., Cambridge University Press, New York.
37. Roerink, G.J., Su, Z., Menenti, M., 2000. S-SEBI: a simple remote sensing algorithm to estimate the surface energy balance. Physics and Chemistry of the Earth (B), 25, 147- 157.
38. Sabins, F.F., 1996. Remote sensing: principles and interpretation. 3rd ed, W.H.Freeman and Company, New York.
39. Sakamoto, T., Yokozawa, M., Toritani, H., Shibayama, M., Ishitsuka, N., and Oho, H., 2005. A crop phenology detection method using time-series MODIS data. Remote Sensing of Environment, 96, 366-374.
40. Shalaby, A., AboelGhar, M., Tateishi, R., 2004. Desertification impact assessment in Egypt using low resolution satellite data and GIS. The International Journal of Environmental Studies, 61(4), 375-384.
41. Shalaby, A., Tateishi, R., 2007. Remote sensing and GIS for mapping and monitoring land cover and land-use changes in the Northwestern coastal zone of Egypt. Applied Geography, 27, 28-41.
42. Sun, R., Gao, X., Liu, C.M., and Li, X.W., 2004. Evapotranspiration estimation in the Yellow River Basin, China using integrated NDVI data. International Journal of Remote Sensing, 10, 2523-2534.
43. Tenhunen, J.D., Kabat, P. (Ed.), 1999. Integrating Hydrology, Ecosystem Dynamics and Biogeochemistry in Complex Terrains. Dahlem Workshop Report, 367 pp., John Wiley, Hoboken, N.J.
44. Titshall, L.W., O’Connor, T. G., and Morris, C. D., 2000. Effect of long-term exclusion of fire and herbivory on the soils and vegetation of sour grassland. African Journal of Range and Forage Science, 17, 70–80.

45. Tucker, C. J., and Sellers, P. J., 1986. Satellite remote sensing of primary vegetation.
46. International Journal of Remote Sensing, 22, 3827-3844.
47. Walvoord, M.A., and Phillips, F.M., 2004. Identifying areas of basin-floor recharge in the trans-Pecos region and the link to vegetation. Journal of Hydrology, 292, 59-74.
48. Walvoord, M.A., Plummer, M.A., Phillips, F.M., Wolfsberg, A.V., 2002. Deep arid system hydrodynamics: 1. Equilibrium states and response times in thick desert vadose zones. Water Resources Research, 38(12), 1308, doi:10.1029/2001WR000824.
49. Yepez, E.A., Williams, D.G., Scott, R.L., Lin, G., 2003. Patitioningoverstory and understory evapotranspiration in a semiarid savanna woodland from the isotopic composition of water vapor. Agricultural and Forest Meteorology, 119, 53-68.
50. Zalewski, M., 2002. Ecohydrology —The use of ecological and hydrological processes for sustainable management of water resources. Hydrological Sciences Journal, 47, 823- 831.
51. Zou, C.B., Barnes, P.W., Archer, S., McMurtry, C., 2005. Soil moisture redistribution as a mechanism of facilitation in savanna tree-shrub clusters. Oecologia, 145, 32-40.
52. Zwart, S.J., Bastiaanssen, W.G.M., 2007. SEBAL for detecting spatial variation of water productivity and scope for improvement in eight irrigated wheat systems. Agricultural Water Management, 89, 287-296.