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# A quantitative remote sensing investigation of ecosystem health in aquatic habitats, concentrating 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). Consequently, the study of the ecological impacts of hydrology is known as ecohydrology. " One of the first steps in developing an ecohydrological approach to water resources management is gaining a deeper understanding of and a means of quantifying the relationship between plants and water. Managing watersheds in arid regions continues to attract attention in the face of dwindling water supplies (Hibbert, 1983). If accurate correlations can be established between groundwater recharge, runoff, hydraulic variables, and the change in vegetation, then these operations can be used as proxies for water demand (Walvoord and Phillips, 2004; "Kwicklis et al., 2005). Vegetation is known to have a significant role in the dynamics of groundwater recharge and outflow in arid regions, and this has been studied using remote sensing techniques (Cayrol et al., 2000; Kerkhoff et al., 2004b). To foretell surface flow and groundwater recharge, vegetation mapping can be utilised instead of surface and subsurface sampling and analysis. Predicting the vegetation's response to changes in water input and the vegetation's impact on water fluxes requires ecohydrological approaches and models that make use of remote sensing technology "and stowing away Improving satellite remote sensing capabilities may help us learn more about the vegetation's response to shifts in hydrological processes. Understanding ecohydrological processes requires integrating remote sensing methods with hydrology.

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**Keyword:** Groundwater Recharge, Remote Sensing Methods

## INTRODUCTION

50 percent of the "Earth's surface is covered by dry, semiarid, and subhumid areas (Parsons and Abrahams, 1994). Because yearly precipitation in these areas is often lower than annual

potential evapotranspiration, they are considered water constrained (Guswa et al., 2004). Due to low and very unpredictable precipitation, limited water supplies and scant vegetation in these areas, they are typically sensitive and fragile. Land desertification, groundwater depletion, salinization and soil erosion are only some of the environmental changes taking place in these dry places (De Fries et al., 2004). Human cultures are increasingly affected by these environmental changes, which have a rising impact" on the global biogeochemical cycles (Schlesinger et al., 1990; Bonan, 2002).

Native and cultivated vegetation both have a significant impact on the environment and are in turn impacted by "it (Sabins, 1996). In water-limited habitats, vegetation serves as an environmental indicator and is frequently connected to both the causes and effects of arid land degradation. A critical function for vegetation has long been recognised 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 the role vegetation plays in influencing changes in hydrology (Newman et al., 2006). A fundamental step in creating sophisticated ecohydrological methodologies is measuring the link between plant and water resources, which is essential for supporting resource management and environmental change.

## LITERATURE REVIEW

A quarter of China's "landmass is occupied by the dry areas listed above, which stretch across 2.5 million square kilometres in northwest China. More than 250 mm of rain falls on the Ejina area each year, and even lower amounts may be found in the western plains (50-150 mm) and the western plains (less than 40 mm). Potential evaporation ranges from 1,400 to 3,000 millimetres per year in arid environments. Sand and gravel deserts, as well as other types of xeric shrublands, are uninhabitable for humans due to the region's dry environment. In recent years, the vegetative components of the ecosystems in Northwest China looked to be widespread. There was an increase in sandstorms due to land desertification induced by the decreasing of the oasis region and soil degradation. The availability of water is the most important element in determining the diversity of plants (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 closely linked to river flow and groundwater depths. As a result, established techniques of ecohydrological analysis that often involve point observations and are only indicative of small "scales cannot be extended to big regions. Consequently, these approaches cannot be applied to huge areas. There are a number of important physical characteristics that can be measured continuously and accurately using remote sensing. In hydrology, these approaches are still utilised in a limited capacity in China to quantify the 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-environment, and then apply this technology to ecohydrological applications.

Gansu Province's Hexi Corridor is home to the Heihe River basin, one of China's two major interior river basins. "Watershed area: 14.3104 m2 Upper, middle and lower Heihe River spans from centre of Hexi corridor to western Inner Mongolia Municipality. From 3000 to 5000 m above sea level, Qilian Mountains (the upstream area) are located in the southern section of the Heihe River basin in China. A chilly temperature and ample precipitation make this area the primary supply of surface water and groundwater for the Heihe River basin, which ultimately ends up at 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, is located in the middle stream" area. Water use has risen steadily as the people and farming in the middle stream area have expanded, and irrigation now accounts for the majority of that "demand. As a result, water levels in the downstream area are dropping precipitously, creating a severe decline in the ecosystem. The Chinese government places a high priority on balancing water use in the downstream area and has developed a new water distribution policy as a result of this focus. The ultimate purpose of this work is to develop a quantitative approach for assessing changes in the eco-environment in these Chinese Northwestern dry regions and to provide scientific" evidence for conserving and enhancing the eco-environment.

## STATEMENT OF THE PROBLEM

Hydrological processes "have a wide variety of scales, both spatial and temporal, in terms of complexity and heterogeneity. Point sensors have traditionally been used to measure hydrological variables since they are thought to be representative of broad regions. However, in complex or diverse situations, where point measurements cannot be expected to represent huge regions, this technique is not especially useful. At the surface-atmosphere interface, a system that is both spatially and temporally dynamic can be found (Cooper et al., 1992, 2000; Eichinger et al., 2000). Some ecohydrological processes may be seen via remote sensing, which is a set of non-contact observing technologies that can be used to gather information. We plan to develop an integrated hydrologic remote sensing technique that combines studies from across the hydrologic remote sensing spectrum with large-scale hydrologic processes. A single geophysical variable has historically been the focus of remote sensing products, which have been used to examine short-term processes. We propose that remote sensing be used to estimate water-energy-ecosystem variables as an integrated way to improve this approach. Hydrological research problems can be answered using this strategy on a local to global scale. On a global scale, it is evident that satellites can monitor many elements of the Earth system. Hydrological processes and their interconnections can be better understood through" the use of aircraft and ground-based technologies.

## OBJECTIVE OF THE STUDY

Infrared technology and "For the purpose of statistically analysing eco-environmental changes in broad, arid regions, ecohydrological technologies will be implemented. Researchers decided to look at the Heihe River Basin in northwest China to learn more about the spatial variability of water supplies and to find a solution to a water consumption dispute between the region's middle and upper reaches. The goals of the research are to 1) evaluate the distribution of vegetation upstream and 2) establish how closely the dynamics of vegetation change are correlated with the occurrence of rainfall. Therefore, it is necessary to formulate in order to "of the specific research queries below:

- To identify the "methods for analysing the vertical and horizontal spread of vegetation in a mountainous terrain" using remote sensing techniques.

**Research Questions**

- In a "mountainous terrain, can remote sensing technologies be used to quantitatively analyse both the vertical and horizontal distribution" of vegetation?

## RESEARCH METHODOLOGY

Using remote "sensing data, most research focused on two-dimensional horizontal patterns, although 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-modeling to anticipate the spread of Qinghai spruce (Picea crassifolia) in the Qilian Mountains. According to the findings, the Qinghai spruce may thrive in altitudes between 2650 and 3100 metres. Both vertical and horizontal distribution of vegetation in the Qilian Mountain region and its key influencing elements, such as elevation" and aspect or precipitation, are the primary goals of this study, which also serves to illustrate the efficacy of the technique. After a brief introduction to the subject region, the datasets and results are presented and discussed in detail. At the end, the conclusion is given.

## RESEARCH DESIGN

Global Inventory "Modeling and Mapping Studies (GIMMS NDVI) data sets (Tucker et al., 2005) were developed to offer a 23-year satellite record of monthly changes in terrestrial vegetation. According to the NDVI, green biomass may be quantified by measuring 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 non-vegetated covering, and zero NDVI denotes rock or barren ground. "Due to orbital drift, the GIMMS-NDVI" dataset corrects for variations in NDVI induced by changes in solar zenith angle (Pinzon et al., 2004; Piao et al., 2003; Pinzon, 2002). Corrected for cloud cover, sensor inter-calibration discrepancies, solar zenith angle and viewing angle impacts, volcanic aerosols, as well as interpolation for missing data in the Northern Hemisphere during winter. Based" on 15-day composites, the GIMMS dataset has a geographical resolution of 8 kilometres.

## DATA ANALYSIS

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

## CONCLUSION

MODIS "Vegetation cover on hillsides may be measured with NDVI's precision. Vertical plant distribution in the Qilian Mountains is influenced by factors such as height and aspect, which act as surrogates for precipitation and temperature. Vegetation should be at its densest and highest NDVI rating between 3200 m and 3600 m. Plant life thrives in the cooler, shadier conditions on the mountain's northern slope. If you want your plants to thrive, maybe the greatest conditions for them are 21 degrees Celsius soil temperature and 46 millimetres of rain every month. The SEBS uses data from a weather station to "The evapotranspiration of the inland basin can be predicted with high precision using the (Surface Energy Balance System) algorithm.

## LIMITATIONS OF THE STUDY

Hydrological "processes have a wide variety of scales, both spatial and temporal, in terms of complexity and heterogeneity. Point sensors have traditionally been used to measure hydrological variables since they are thought to be representative of broad regions. However, in complex or diverse situations, where point measurements cannot be expected to represent huge regions, this technique is not especially useful. At the surface-atmosphere interface, a system that is both spatially and temporally dynamic can be found (Cooper et al., 1992, 2000; Eichinger et al., 2000). As a collection of non-contact observing technologies known as remote sensing, it is possible to gather" information on some of the spatial and temporal ecohydrological processes.

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