A Study Focused On China's Heihe River Basin Using Quantitative Remote Sensing To Study Ecohydrology In Water-Scarce Habitats

Xu Hongmei[1*], Aiman Al-Odaini[2]

1*Research Scholar Lincoln University College Malaysia
2Lincoln University College Malaysia
Email: hongmei@lincoln.edu.my

ABSTRACT
Ecohydrology is the study of how ecosystems and the water cycle are impacted by the movement of water. Ecohydrology examines the natural effects of water flow. No text is available for researchers to input. In order to manage water resources in an ecohydrological way, it is necessary to understand and measure the relationship between plants & water. Because there isn't enough water, dryland watershed management is still a problem. If valid correlations can be found, indications of water demand may be derived from groundwater recharge, drainage, hydraulic factors, and changes in vegetation. In arid areas, the impact of vegetation for groundwater circulation has been the subject of several remote sensing studies. Surface flow and groundwater recharge predictions may be better made using vegetation mapping than with surface and subsurface sampling and analysis. Ecohydrological models and techniques, including remote sensing, are necessary for predicting a plant's response to changes in water intake & flow. By improving satellite surveillance, researchers may be able to learn how plants respond to changes in water levels. Ecohydrological processes can only be understood with the use of hydrology and remote sensing.

Keywords: *Groundwater recharge, Remote sensing methods, Heihe river basin, Water-scarce habitats.*

1. INTRODUCTION:

Three provinces in Northwest China make up the HRB, an endorheic basin: Qinghai to the north, Gansu to the west, and the autonomous region of Inner Mongolia to the far south. Within the latitude and longitude of 97.1-102.0° E and 37.7-42.7° N, lies the 143,000 km2 HRB. Near the Qilian Mountains' midpoint, the HRB emerges. As to Cheng et al. (2014), the region has a northern boundary with Mongolia, an eastern border with the Shiyang River basin and a western border with the Shule River basin. On the southern side, the region borders the Datong-Huangshui & Qinghai Lake basins. Upstream, the HRB is at a height of 2000–5000 m; midstream, it is at 1000–3000 m; and downstream, it is at 800-1700 m, with the elevation decreasing from south to north. Various forms of land use and cover are present in the HRB. The three primary land uses in the HRB are as follows: glaciers—0.5% of the total—grasslands—10.1%—or evergreen needle-leaved forests—including 0.5% of Qinghai spruce——croplands—3.6%—empty land—29.4%—a mixture of forests and shrubs—0.2%—populus euphratica Oliv. or Tamarix—and barren lands—9.4%— (Lyu et al., 2019).

Various soil types are distributed around the HRB. Upstream, you'll find mostly Gelic Cambosols, Ustic Isohumosols, and Orthic Aridosols; in the center and downstream, you'll find mostly Sandic Primosols & Calci-orthic Aridosols. at the upstream region, sand makes up 27.9% of the soil particles, while clay accounts for 11.2% at the outermost layer (0-5 cm). Similar to downstream soils, midstream soils have 39.9% sand and 10.0% clay. According to Yang et al. (2016) and Song et al. (2016), the downstream region has a higher concentration of sand, averaging 63.4%, in comparison to the upstream and midstream sectors.

2. BACKGROUND OF THE STUDY:

(Parsons, and Brahams, 1994) found that dry, semiarid, & subhumid zones make up around half of the Earth's surface area. Researchers call these places water-limited because their yearly precipitation is usually lower than their potential evapotranspiration (Guswa et al., 2004). Despite the variety in physiography, geology, & soils, these ecosystems are particularly vulnerable and fragile due to low and very unpredictable precipitation, limited water sources, and scarce vegetation. Desertification, salinization, depletion of groundwater, and soil erosion are some of the environmental changes that are happening across large areas in these dry regions (De Fries et al., 2004). According to a growing body of research, human civilizations are being influenced by changes in the environment, which in turn affect global biogeochemical cycles (De Fries et al., 2004).

Both naturally occurring and artificially induced vegetation are very responsive to their environments. Vegetation is a measure of environmental health in ecosystems with limited water resources; it has been linked to desertification and its causes and consequences. Streamflow, soil moisture, and runoff are all significantly impacted by vegetation, according to many studies (De Fries et al., 2004). Understanding the role of plants in water cycles is fundamental to ecohydrology. Research to measure the relationship between plant life and water supply is therefore necessary for advanced ecohydrological approaches that help with resource management & climate change.

3. THE PURPOSE OF THE RESEARCH:

Ecohydrology studies how hydrological processes affect biological systems & the water cycle. Ecohydrology studies water ecology. Ecohydrological water resource management requires monitoring vegetation-water resource interactions. Dry watershed management study and implementation remain important as water becomes scarcer. Measured and monitored recharge of groundwater, runoff, hydraulic variables, and vegetation change can estimate water demand. Remote sensing has examined how vegetation affects groundwater recharge and discharge in arid environments. Without sampling or analysis, vegetation mapping predicts surface flow & groundwater recharge. Remote sensing-based ecohydrological systems predict vegetation response to water input, flow, and storage (Chao et al., 2017). Satellite images show how hydrological changes affect plants. Hydrology & remote sensing describe ecohydrology.

4. LITERATURE REVIEW:

Forests are essential in mountainous areas. Forests and other flora support many animals and plants. Vegetation cover reduces erosion and affects local and regional climates. For millions of people and their enterprises, the trees and flora of mountain cities are an absolute need. People are also shielded from hazards including rockfall, landslides, debris flows, and floods by vegetation cover. Alpine forest cover protects population and transportation routes from wind and landslides. Many scholars have studied vegetation growth patterns and their determinants in these locations (Zhang et al., 2021).
Elevation, aspect, & slope indirectly affect mountain vegetation. Since it represents precipitation and temperature, elevation is the most important of these three factors. Elevation, aspect, & slope affect microclimate, which affects vegetation. Remote sensing, among the most powerful technologies, helps research vegetation distribution. AVHRR and MODIS data have been utilized in remote sensing investigations of worldwide vegetation distribution & land cover (Wei et al., 2020). Scientists generate the normalised difference vegetation index (NDVI) using red and infrared reflectance data to compare green biomass across areas. Landscape primary production patterns of landscapes and vegetation phenology are often calculated using this indicator. The normalized difference vegetation index (NDVI) is a measure of the extent to which a given area is covered by plants; a lower value implies less vegetation, and a value of zero indicates no vegetation at all (Wang et al., 2019).

5. RESEARCH QUESTION:

i. Is it possible to use remote sensing technology to accurately measure the vertical and horizontal distribution of plants in a mountainous area?

6. RESEARCH METHODOLOGY:

Two-dimensional horizontal trends have dominated satellite data analysis. Few studies have examined mountainous vegetation horizontal distribution. Qinghai fir (Picea crassifolia) spread in the Qilian Mountains was predicted using climate data and GIS-modeling. (Aboelnga et al., 2020) found that Sichuan spruce thrives at 2650–3100 meters. This research examines the Qilian Mountains' horizontal and vertical vegetation distribution and its factors, such as elevation aspect, & precipitation. This study also tests the method's effectiveness. Briefly describe the problem, then detail the datasets and outcomes. In conclusion.

- **Research Design:**

Satellite imaging tracks monthly land changes in vegetation over 23 years in GIMMS NDVI data. By measuring red and infrared photon reflections, the Normalised Differential Vegetation Index (NDVI) assesses green biomass. Higher (NDVI) values imply greater plant covering. Rocky or desolate terrain is NDVI 0. GIMMS-NDVI corrects orbit drift-induced solar apex angle variations in NDVI. Consider cloud cover, sensor testing, sun angle, information viewing angle, volcanic ash, and northern winter missing data. 15-day composites provide GIMMS 8-km spatial resolution.

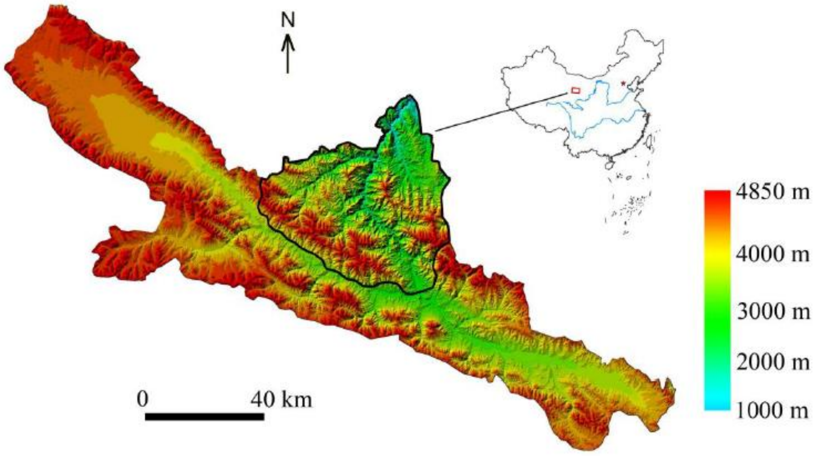
- **Data Analyse:**

The mean annual GIMMS NDVI will be the "dependent variable" (y) in a model with regression, using Langxinshan station runoff levels as the "independent variables" (x0), "x1", and "x2".

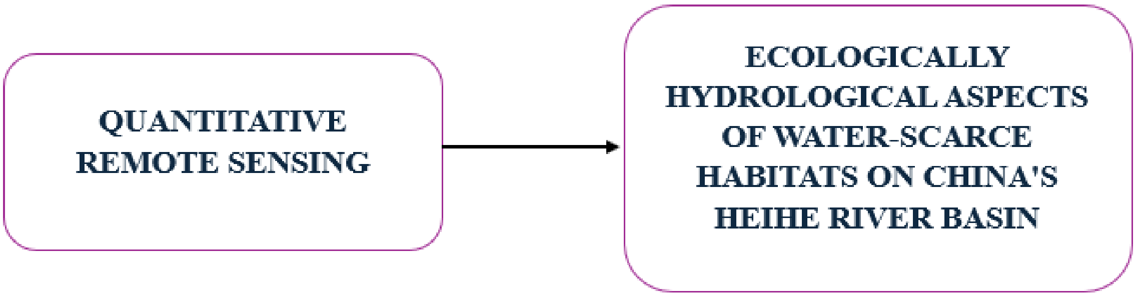
- **Study Area:**

Steep and ranging in altitude from 1,680 to 5,100 meters, the Qilian Mountains are located in the upper basin of the Heihe River.

Figure 1: A 100-meter-resolution DEM (digital elevation model)



- **Theoretical Framework:**



7. RESULTS:

Elevation affects plant cover distributions from temperature and precipitation. Most northern Qilian Mountains vegetation is between 1800 & 4500 meters. Quantitative geography-based trends and distribution studies were unavailable. This free NDVI project measures global vegetation distribution. All 270 locations are 1800–4500 meters above sea level, 10 meters apart. Dividing 360 degrees by five degrees yielded 72 intervals. These divisions gave 19060 of 19,360 cells NDVI readings over zero. Each cell's 2000–2006 NDVI was averaged. Averages demonstrate how elevations & orientations affect plant growth. Figure 2 depicts the north Qilian Mountains contour map with average NDVI, elevation, & aspect. After applying the Gaussian smoothing filter to gridded data and low pass convolution, Figure 2 shows the uniform & smoother map. In Figure 2, aspects and altitude impact highland plant growth in great detail. Scientists will find that height impacts both temperature and rainfall, the two most important climate factors for plant growth. From 3400 m, its height-dependent normalized difference vegetation index (NDVI) drops substantially. Between 3200 and 3600 meters, NDVI levels exceed 0.50, promoting plant growth. Below 3200 meters, NDVI values are < 0.50.

Figure 2: Higher than 3600 m, or else plant growth is not as vigorous as it is between 3200 and 3600 m.

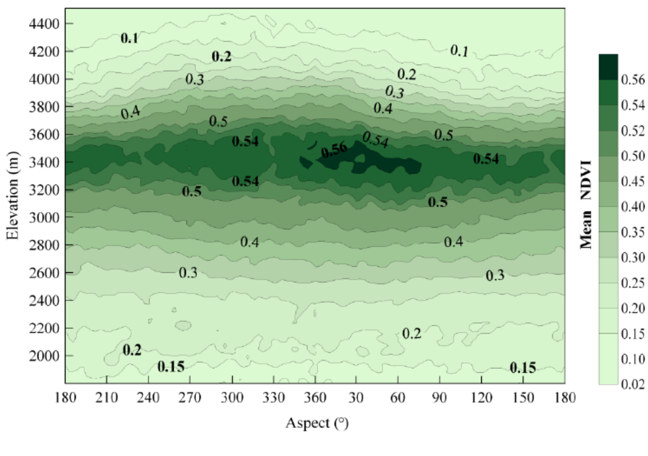
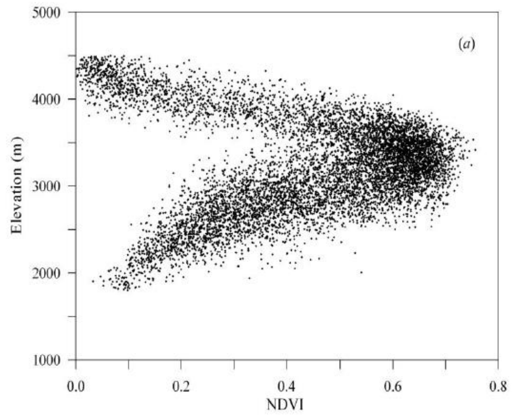


Figure 2 demonstrates how height and direction affect northern Qilian Mountains average NDVI values. Gridding data using the Gaussian smooth filter with a low pass inversion created a smoother map. Over 0.5 NDVI was adjusted to 0.02.

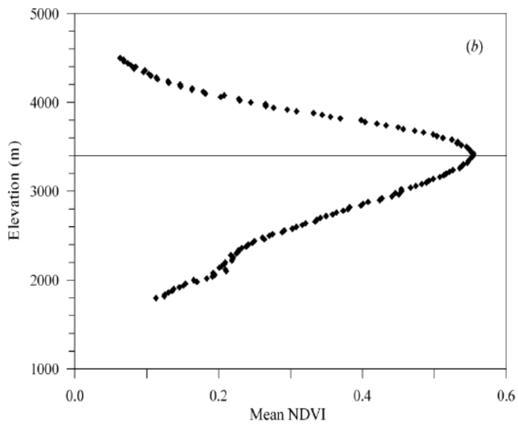
Figure 3: The impact of altering altitude on NDVI values for the northern Qilian Mountain before



(a)

average at the same height and the research area thereafter.

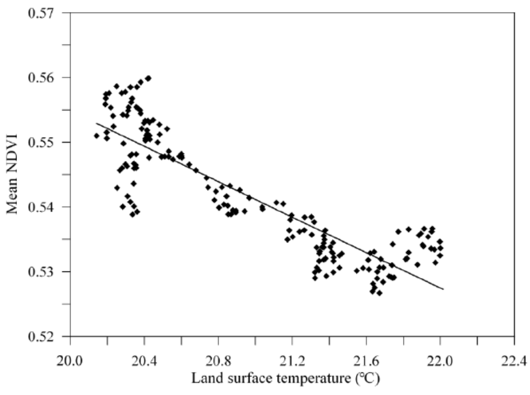
The NDVI corresponds with elevation. Researchers averaged NDVI readings at the same height to show how altitude affects plant development. 28 MODIS NDVI images of the 16-day composite in the months of June, August, and September generated 221142 NDVI-elevation pairs from 2000 to 2006.



(b)

At 3400 m, when the development of plants is at its highest, the average NDVI rises to 0.56. However, it then decreases again beyond this height.

Figure 4: Thus, hillslope aspect, solar radiation, and land surface temperature strongly impact Qilian plant growth.



Ground surface temperature-NDVI relationship. Using linear regression, the solid line provides a good match to the data (R2 = 0.77).

8. DISCUSSION:

Sunlight is necessary for Qilian Mountains plant growth. Plant growth is mostly affected around 3200–3600 meters. In Figure 2, vegetation is most abundant between 340 degrees northwest to 70° northeast. Above 0.56 NDVI, green is deepest. Slopes with the greatest shadow may have healthier plants. Shaded soil has reduced moisture stress due to lesser evapotranspiration. Less snow sublimation, which lowers temperatures, & higher relative humidity may affect soil moisture in winter. Shadows alleviate semi-arid Qilian Mountain plant soil moisture stress. The north- & northeast-facing side exhibits higher plant development throughout a larger elevation range, as demonstrated by NDVI values of at least 0.50 between 3100 and 3700 meters horizontally at N 0 degrees & 3200 to 3600 meters S 180 degrees. The shaded Qilian Mountains may chill, green, and darken the water's cycle and climate. Figure 2's third feature is the NDVI curve's height slope. Lower between 2000 m and 3400 m, and bigger above 3400 m, imply plant development is more vulnerable at higher elevations. Upper elevation requires a distance of 200 meters to convert 0.3 to 0.4, whereas lower height requires a distance of 300 meters (2600–2900 m). Elevation affects NDVI. Researchers averaged NDVI values at the same height to show how altitude affects plant growth. Between the years 2000 and 2006, 28 MODIS NDVI images were taken during 16-day composite in June, August, & September, giving 22,1142 elevation-NDVI pairs. When plant growth is best around 3400 m, the average NDVI climbs to 0.56 before dropping again as altitude rises. Graphs NDVI values with aspect to show how aspect impacts plant growth at 3200 and 3600 m. NDVIs above 0.55 and aspects of 70 degrees northeastern (NE) from 340 degrees northwest promote plant development. NDVI < 0.54 indicates low vegetation from East 90° to West 270°. This confirms our contention that mountain slopes greatly affect plant growth. Shaded semi-arid Qilian mountains have more plants than sunny ones. Due to sun radiation and greater ground temperatures. Sunny soil has increased moisture stress due to higher ET. Since temperatures and precipitation influence plant development and reproduction, they presumably affect global plant cover the most. Complex indirect relationships occur between ecological climate & plant growth. Regional atmosphere-biosphere modeling of processes requires understanding this link (Martin, 1993). Why do plants on each side of the Qilian Alps grow differently? For solar radiation or temperature surface fluctuations. The study depicts land surface temperature changes at 3200-3600 m. The image illustrates that T peaks at 21.6 °C (SE 155o to SW 235o) & drops below it on the dark side.

9. CONCLUSIONS:

This thesis uses remote sensing and ecohydrology to quantify eco-environmental changes in dry regions on a wide scale. To do this, each thesis part covers a study subject from paragraph 1.3. Can researchers utilize remote sensing to study plant both vertical and horizontal distribution in mountainous terrain and growth factors? Upstream across the southern Heihe River basin are the Qilian Mountains. Most river basin water comes from precipitation runoff. Changing plant cover may impact local temperature and water resources, making it an important environmental indicator. Since terrain represents warmth and precipitation, it affects plant cover greatly. Microclimate affects height and aspect-based vegetation spread.

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