

Drought impact on agriculture and groundwater in Dhangadhi, Nepal

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Introduction

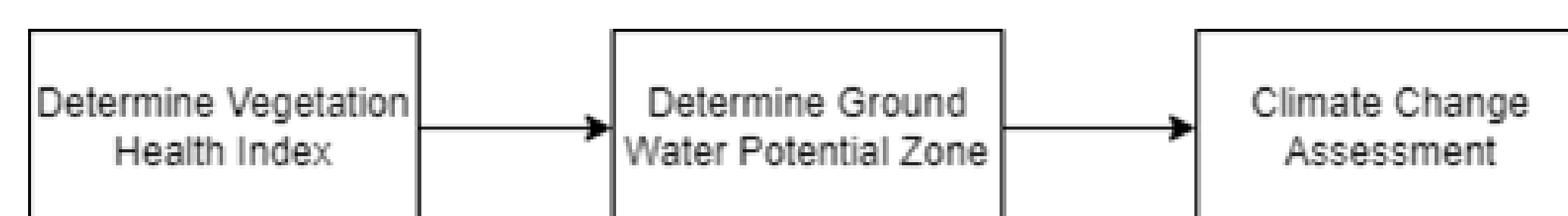
Drought is a global issue affecting water and food security, leading to severe economic and social impacts. Drought can be classified under meteorological, agricultural, hydrological, and societal types. Vulnerable communities are most affected. Satellite-based remote sensing has advanced drought monitoring, improving global understanding of its effects.

Research questions

- What are the VCI, TCI and LST patterns in the study area?
- What do Vegetation Health Index (VHI) and Normalized Differential Vegetation Index (NDVI) indicate about crop health?
- What are the groundwater potential zones

Methodology

- The task was divided into three parts:



Determine Vegetation Health Index (VHI): Initially, Normal Differential Vegetation Index (NDVI) and Land Surface Temperature (LST) was determined using Google Earth Engine. Sentinel 2 Satellite imagery were used for the study. Then VCI and TCI were calculated accordingly.

$$NDVI = (NIR - RED) / (NIR + RED)$$

$$VCI = VCI = 100 * (NDVI - NDVI_{min}) / (NDVI_{max} - NDVI_{min}) \text{ (Kogan, 1990)}$$

$$TCI_i = \frac{LST_{max} - LST_i}{LST_{max} - LST_{min}} \times 100$$

$$VHI = 0.5VCI + 0.5TCI \text{ (Luisa Febrina Emalo et al 2017)}$$

Determine Ground Water Potential Index (GWPI)

Following parameters were used:

1. Fractional impervious surface (FIS)

The impervious surface denotes the environmental quality of any region.

Initially, NDVI was derived from Sentinel 2 data. Fractional vegetation Cover (FVC) and (FIS) were calculated with the following formula:

$$NDVIs = (NDVI - NDVI_{low}) / (NDVI_{high} - NDVI_{low}) \text{ (1)}$$

$$FVC = (NDVIs)^2 \text{ (2)}$$

$$FIS = 1 - FVC \text{ (3)}$$

Understanding the drought pattern: After the determination of the VHI and GWPI values, areas are calculated as per the classes. The minimum value and maximum value are divided into 3 different classes, resulting in its area value to high, medium and low drought conditions

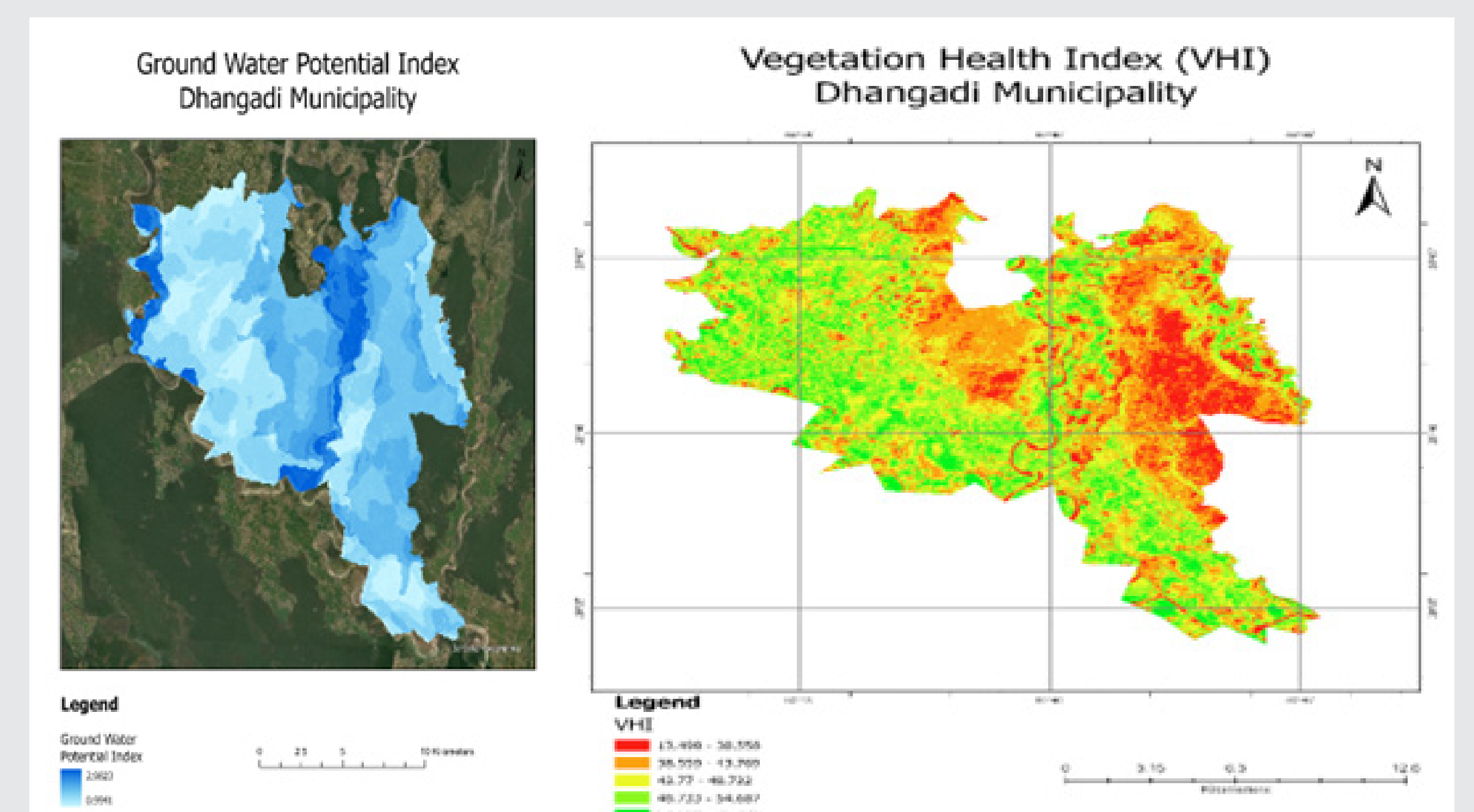
Conclusion

Approximately 17% of the land exhibits very low vegetation health index values, indicating a high susceptibility to drought. The Groundwater Potential Index values range from 0.99 to 2.98, with most of the land falling into low index categories. Observations indicate that only areas proximate to rivers exhibit good groundwater potential. polyhouse method more profitable as compared to open field method of vegetable production.

- Support programmes should focus on training farmers to make the polyhouse structure with locally available materials, capacity building for establishment, repair and maintenance of drip irrigation system, mulching, bio-pesticide preparation, and awareness creation for commercial production.

Key findings

- Vegetation Health Index (VHI) Distribution: Most of the land in Dhangadhi Municipality falls within the medium to very high VHI categories, indicating generally good vegetation health. Specifically, around 54.6% of the land is categorized as medium, 27.9% as high, and a small portion as very high; approximately 17% of the land is classified under very low VHI.
- Normalized Difference Vegetation Index (NDVI) Analysis: Land areas with NDVI values less than 0 cover approximately 1.063 km², while ranges between 0-0.1 cover 18.367 km². Higher NDVI ranges show greater vegetation health, with values exceeding 0.5 covering 2.263 km². The total area analyzed is 262.453 km².



- Thermal Condition Index (TCI) Distribution: TCI ranges show significant variation in thermal conditions across land areas. The 0-15 range covers 61.810 km², while the 45-60 range includes 92.500 km². Values exceeding 60 cover a minimal area of 7.712 km².
- Land Surface Temperature (LST) Range: The majority of the land falls within the 30-35°C LST range, covering 154.585 km², with smaller areas in other temperature categories, including below 30°C (91.763 km²) and exceeding 40°C (0.150 km²).
- Groundwater Potential Index (GPI): GPI values range from 0.99 to 2.98, with most land areas falling into low potential categories.

