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Spring Inventory and Identification of Probable Ground Water Potential Zones, Gajuri Rural Municipality

Background

In Nepal, the absence of storage reservoirs and effective river regulation, as well as inadequate watershed management practices in the mountains and hills, contribute to a significant issue. During the monsoon season spanning from June to September, lasting for four months, a substantial amount of rainfall is converted to runoff. This runoff is drained by channels, rivulets, and rivers, leading to the formation of flash floods and inundation in flatter areas, particularly in Terai. As a result, during monsoon period, there is an excessive amount of water beyond manageable levels, whereas the remaining eight months are characterized by water scarcity for various essential purposes such as irrigation, drinking water, and hydropower generation.
Research conducted on global groundwater utilization has revealed that this valuable natural resource is experiencing strain caused by excessive extraction to satisfy the rising demands and needs resulting from population growth. Nepal is likewise impacted by this issue.

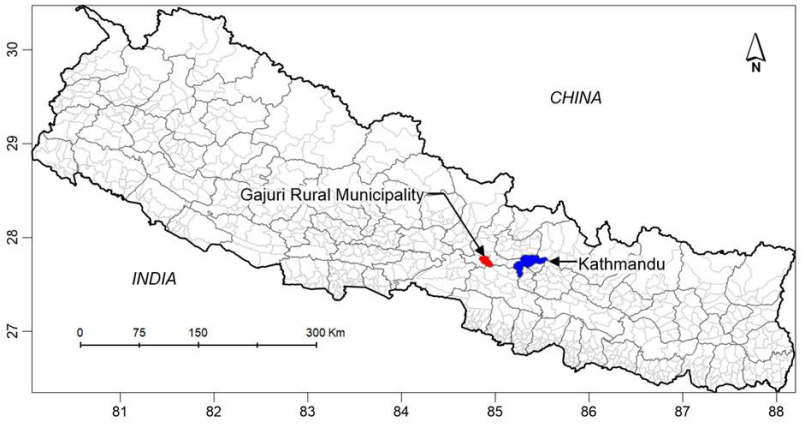

Figure1: Location map of study area

Figure2: Observed springs

Objective

The aim of this study is to gather and compile a comprehensive inventory of springs and develop a methodology for delineating groundwater potential (GW) zones in mountainous regions using remote sensing and Geographic Information System (GIS) techniques. The information on groundwater potentiality can then be utilized to effectively identify suitable areas for extracting water for rural communities.

Methodology

In order to find out the general trend of surface water and groundwater (GW) sources within Gajuri Rural Municipality along with different parameters for GW potential mapping, a comprehensive field work was carried out in the first week of February 2023. During the field visit, altogether 161 sources of water were visited. Accessibility to the site by gravelly road, occurrence of springs based on preliminary desk study, and discussion with local contacts were the main criteria considered for the selection of the field sites. In this study, Logistic Regression (LR) method was used to delineate GW. LR is a statistical method used to analyze data and make predictions about binary outcomes. It is a type of classification algorithm that models the probability of a certain event occurring, given a set of predictor variables. In LR, the dependent variable is binary or categorical, meaning it takes only two possible values, such as yes or no, 0 or 1, etc. The independent variables, also known as predictor variables, are continuous or categorical variables that are used to predict the outcome.

Results

LR combines spring data and uses a correlative approach of statistical methods for GW potential. LR supports the output format as a logistical value, which is straightforward to analyze and gives an estimate between 0 and 1 of the probability of presence. Once a model is setup, we must validate the model determining the degree of which the model represents the observation accurately. The most relevant criterion for model validation is the assessment of accuracy, which is performed by analyzing the agreement between the model results and observed data. Receiver-operating characteristic (ROC) curves are an excellent way to verify the validity of the model accuracy.

The performance of the model was obtained using 80% of training data and the AUC was calculated as 73.5% predictive capability was calculated using 20% test data set, and found 66%.

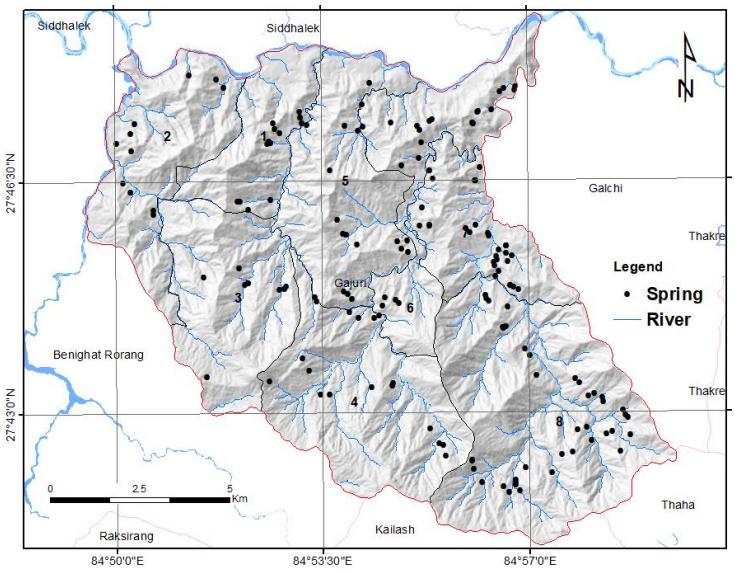

Figure 3: Spring inventory of Gajuri Rural Municipality

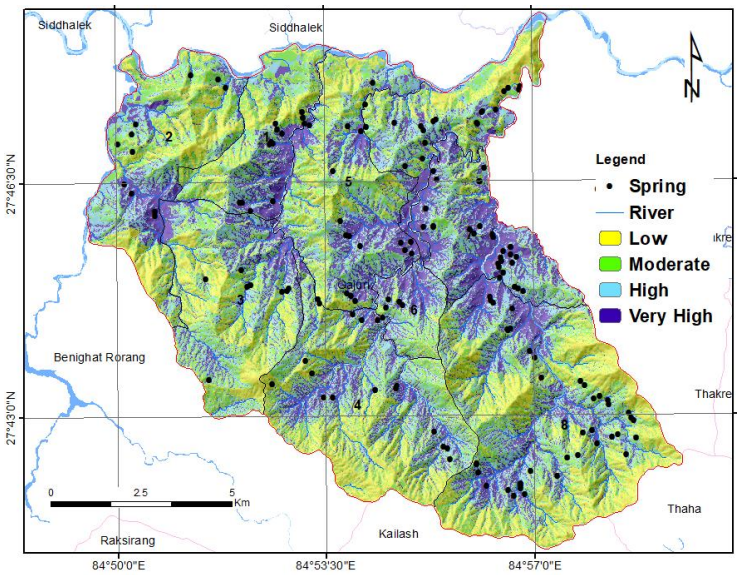

Figure 4: GW potential map of Gajuri Rural Municipality

To classify the GW map, natural break classification method was used. The natural break classification method is a data-clustering method designed to determine the best arrangement of values into different classes (Jenks, 1967). The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values. The groundwater potential map was classified into four probability zones using the natural break cut-off values, namely very low (<0.29), low (0.3–0.4), moderate (0.41–0.50) and high (>0.51).

Conclusions

These results demonstrated the capability of LR model for the capturing of GW potential areas in the mountainous terrain. Altogether, 161 spring locations were identified in the study area. The occurrence of groundwater in the study area is constrained by elevation, slope, curvature, TPI, TRI, drainage density, TWI, geology, lineament density, and landuse as revealed from literature and field investigations. The final result was validated using ROC. The final GW map can be utilized to regional groundwater development plans, determination of promising regions for groundwater exploitation

Reference

Jenks, G.F., 1967. The Data Model Concept in Statistical Mapping. Int Yearb Cartogr 7:186–190.

FOR FURTHER INFORMATION:
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