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Water Scarcity Zonation Mapping using MCDM Method in District, NAMCHI, South Sikkim using QGIS

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Abstract: A major worldwide issue, water scarcity has especially serious repercussion like India that have an abundance of water. There are only so many fresh water sources available to meet the growing demand for water brought on by urbanisation, industrialisation, and population expansion, Since the limited water supplies cannot satisfy the population's needs, a state of water scarcity has resulted. The present research is conducted in CCCT Chisopani, Sikkim, India. Water scarcity is a major issue in the area we selected, the multiple criteria decision making (MCDM) approach will be used in this case study to solve the ranking water scarcity problem, and the next upcoming major problem for water scarcity is the growing population in the study area. Along with the households the area consists of 2 study institutes due to which the population may increase in the coming years effecting the water management. The first step was to conduct a survey in and around the study area by preparing questionnaire including total population of household, highest qualification in the house, storage capacity, tenants, local source, rain water harvesting, hours water received, water fetched manually or not? Type of roofs, distance to perennial source. After collection, the data was evaluated and standardised to guarantee comparability across numerous criteria. Further the study was continued with water scarcity index calculation making it easier to prepare the zonation map for the study area. The MCDM method exhibits how the method can be used against the water scarcity problem. The main focus of the study was to create a scarcity map for the study zone in QGIS using RS&GIS method.
Keywords: QGIS, Water scarcity, MCDM, WSI, RS&GIS

I. INTRODUCTION

Sikkim is known for having abundant water resources. On the other hand, as the result of the industries and population rapid increase, there is a growing scarcity of water, this puts stress on these resources quality and quantity. A probe called water is used to find evidence of climate change, particularly in hilly areas. Lakes, springs, and rivers get their water from glaciers that are melting they are the main source of water for irrigation in both the plains and the mountains. The weather has a major impact on the amount of water flow, in the highlands winter is frequently a dry season as opposite to summer or monsoon. The state, known for its breathtaking mountain, verdant forests, and cascading waterfalls, experienced water scarcity issue, particularly in certain regions and during dry seasons. Various initiatives are underway to address this challenge. Efforts to protect and restore natural habitat, including forest and wetlands are crucial for maintaining the water balance in the region.

One methodical technique that helps identify and prioritise areas with the most challenging water scarcity issue is MCDM (multiple criteria decision making). Water being the most common problem faced by the entire nations and world which is caused by several problems. A lot of several water management technique been used which ended up being ineffective. The MCDM method allows the decision maker to keeps their preferences and opinion

II. METHODOLOGY

The case study was further carried out using the following methodology:

1) Data collection: The starting step for the case study was to gather relevant information through the use of survey. Which included information on the population, storage, qualifications, and gender distribution of the population, as well as data on the availability of local sources, rainwater harvesting, the amount of water obtained from the public sources, the distance, to perennial sources, the number of pets and the type of roofing of the household. The above data was the input used in the MCDM study.

2) Criteria weighting: Appropriate weight was allocated to each requirement in order to represent its relative importance. Expertise judgement survey was utilized to establish the weighted. The weight reflects the relative importance of each condition in relation to the scarcity of water.
3) Analysing Suitability: The selected MCDM technique the weighted sum model (WSM) was used to calculate the water scarcity index for each place within the research region. The standardized data needed to be combined with the allotted weight in order to produce a composite score would indicate the severity of the water scarcity.
4) Zonation mapping: Using the QGIS software, the study zone was further multiplied into various maps based on the results and with the help of the maps a visual representation of the zonation map was created of the study area.

III. PROCEDURE

A. Preparation of questionnaire for field survey

Developing questionnaires for a field survey on water scarcity zonation requires careful consideration of what questions
Would best capture relevant data aligns with the goals of the study.
To prepare the questionnaires, the following steps were completed:

1) Defining the Goals: The goals of the survey were first clearly expressed. The exact information required for water scarcity zonation was found, including the household's storage capacity and highest qualification level, as well as the factors that contribute to water scarcity, availability, patterns of water use, or community needs related to water resources.
2) Resolving the Primary Themes: The primary topics or ideas that the survey will address were identified. Among these consist of water obtained from the public supply, methods of farming, infrastructure, water demand, economic factors, and so on. Each category's questions were categorized to ensure an orderly progression throughout the questionnaire.
3) Choosing Question Types: Appropriate question types were selected based on the data that was required.
4) Leaving Questions Easy to understand: The questions were written in an organized way to prevent any room for interpretation or misunderstanding. The questions were designed to be understandable for the target audience.
5) Logical Question Sequencing: The questions were put in a logical order to maintain the flow of the questionnaire. First, general questions were posed to set the tone, and then progressively more delicate or specific topics were brought up the questionnaire was completed and made easier to understand once the required adjustments were made.

B. Data Collection

The study objectives should outline the precise data that will be required from the field survey. This will guarantee that
The survey is focused on relevant subjects and act as a guide for the data collection.

1) Methods for Developing Survey Tools: Construct suitable survey instruments, like checklists for observations, questionnaires, and interview guides. These devices need to collect the necessary data in an accurate and efficient manner
2) Methodology: As part of the sample plan, decide which areas or target population to survey. Take statistical significance, accessibility, and diversity into consideration when choosing a representative sample that aligns with the objectives of the study.
3) Gathering Data: Conduct a field survey in the research region, adhering to the survey's goals and instruments when gathering data. This could involve measurements, dissemination of surveys, individual or focus group interviews, and direct observations. To ensure the data's accuracy and consistency, keep detailed records of all the information acquired.

C. Criteria weighting

Appropriate weights were assigned to each condition in order to represent the relative importance of each one. The weighting was decided by professional opinion and citizen interviews. Water scarcity is affected by each condition, and the weights take that into consideration.

D. Water scarcity index

Weighted sum models are used to calculate a water scarcity index by first giving weights to various water scarcity indicators or criteria. These weighted sum indicators are then combined using a weighted sum formula. The steps to calculate a water scarcity index with this model are listed below:

1) The indicators of the water scarcity index were first defined. The total number of households, storage capacity, accessibility to nearby resources, availability of rainwater harvesting systems, amount of time spent using water from the public supply, gender disparities in the population, type of rooftop, and highest qualification of households to observe patterns of appropriate water use are some of these indicators.

2) Each indicator is given a weight according to how much of an impact it has on the scarcity of water the values were established by a survey of experts and consumers.
3) Weighted sum calculation: Each indicator's matching weight was multiplied, and the results were added together. The weighted total is calculated using the following formula:
4) Weighted sum= (weight1*Indicator1) + (weight2*indicator2) + …. + (weight N * indicator N)
5) Analysing the index: The water scarcity index is represented by the weighted total that is produced. Depending on the scale used for normalization, the index can have different meanings. Higher values of the index, which likewise varied from 0 to 10, point to greater water scarcity. The indicators were adjusted between 0 and 10.

E. Zonation mapping

Google Earth was digitalized to make the boundary map. Afterwards, the kMl file downloaded from Google Earth was transformed into a shape file in QGIS, which was subsequently utilized in this investigation. In MS Excel, the survey data and the determined scarcity index were converted to comma-delimited (.CSV) format and stored. After that, the CSV file was imported into QGIS and processed using a processing tool. The csv file and shape file were cut using the Vector Geoprocessing tool Plug-in. Based on each household's unique scarcity index values, the scarcity zone was divided into three categories: no scarcity, low scarcity, moderate scarcity, and high scarcity. After that, QGIS's zonation map was exported to image format.

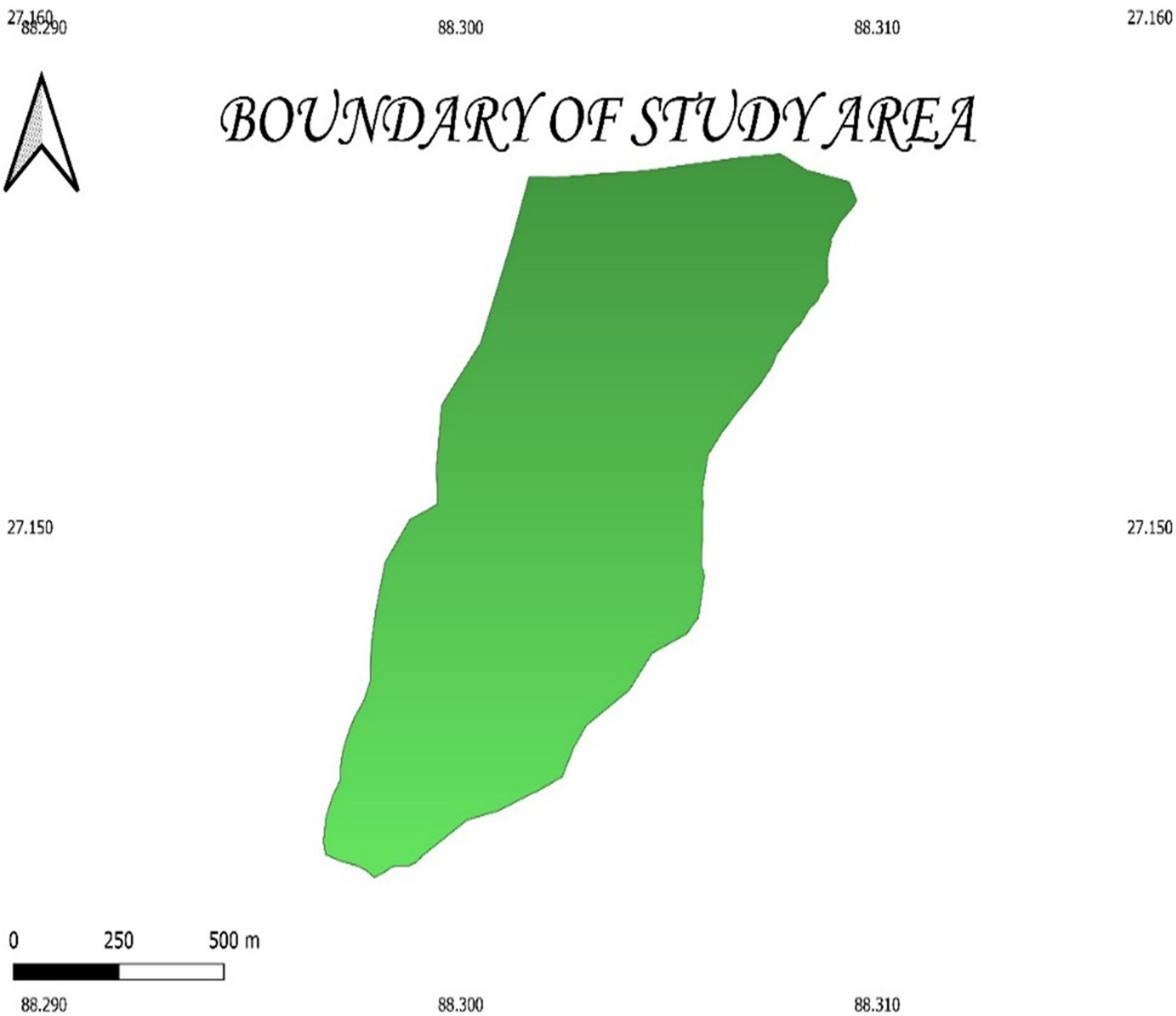

Fig.1. Boundary of study area

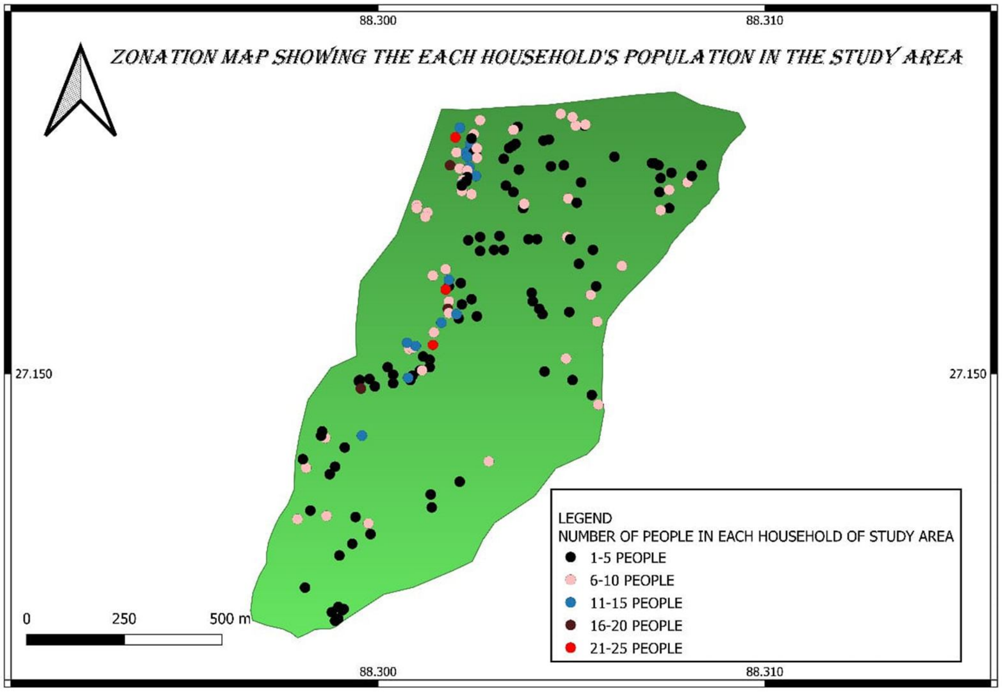

Fig.2. The above survey shows the number of people in each household: 90 households consist of 1–5 people, and 46 households consist of 6–10 people,13 households consist of 11-15 people, 6 households consist of 16-20 people,3 households consist of 21-25.

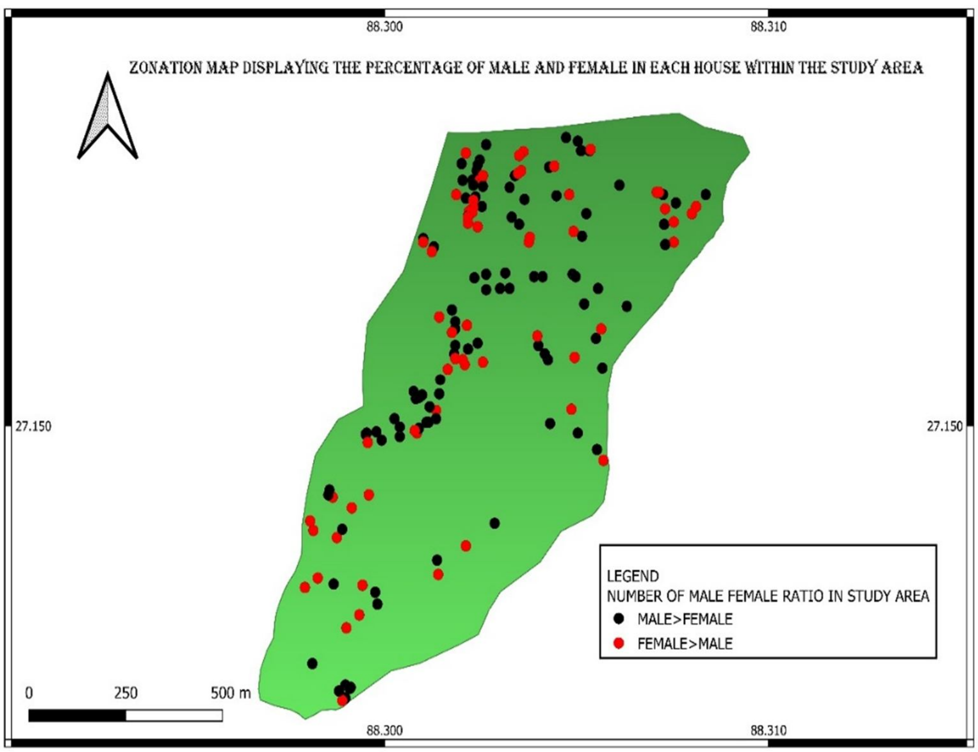

Fig.3. The survey mention above indicates that each households has a total percentage of males and females in the study area as follows: males>female is 88, and the total number of females>male is 70, as per the survey.

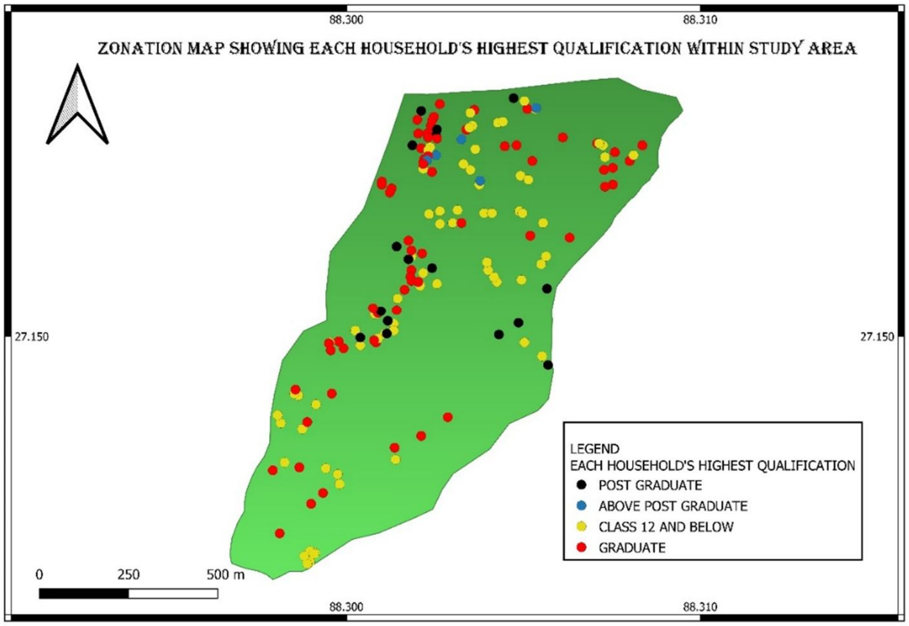

Fig.4. According to the survey above, there are a total of 14 postgraduates in a households, there are 6 above postgraduates in a households, and 76 people in a households below class 12, and 62 graduates overall who live in each family as per the survey.

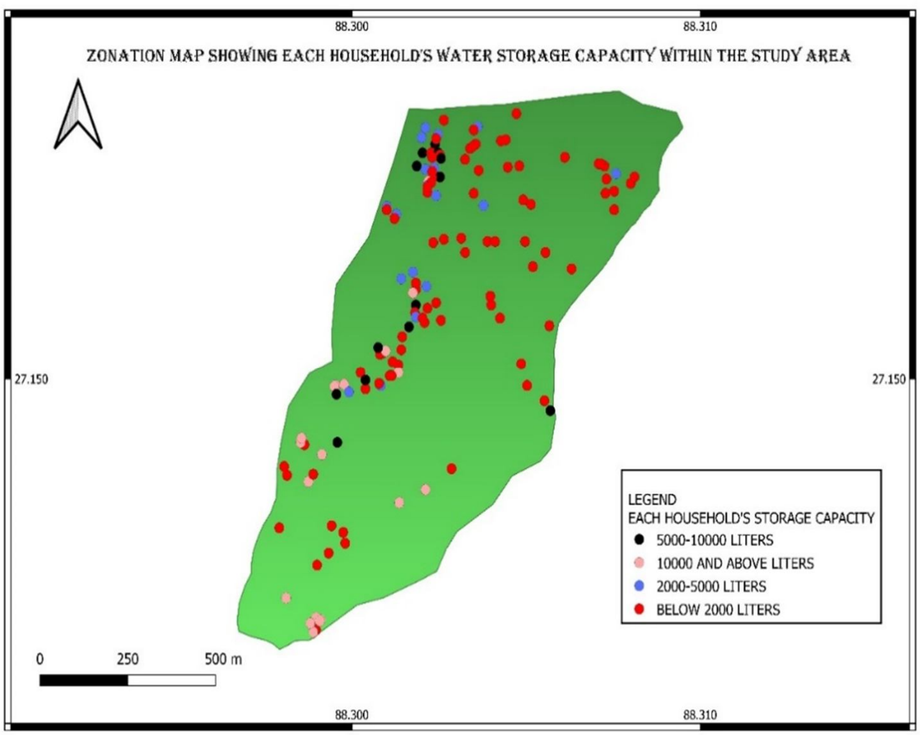

Fig.5. According to the survey data above, there are 158 households, of which 108 have storage capacity less than 2000 litres, 18 have storage capacity between 2000 and 5000 litres, 13 have storage capacity between 5000 and 10000 litres, and 19 have storage capacity greater than 10000 litres.

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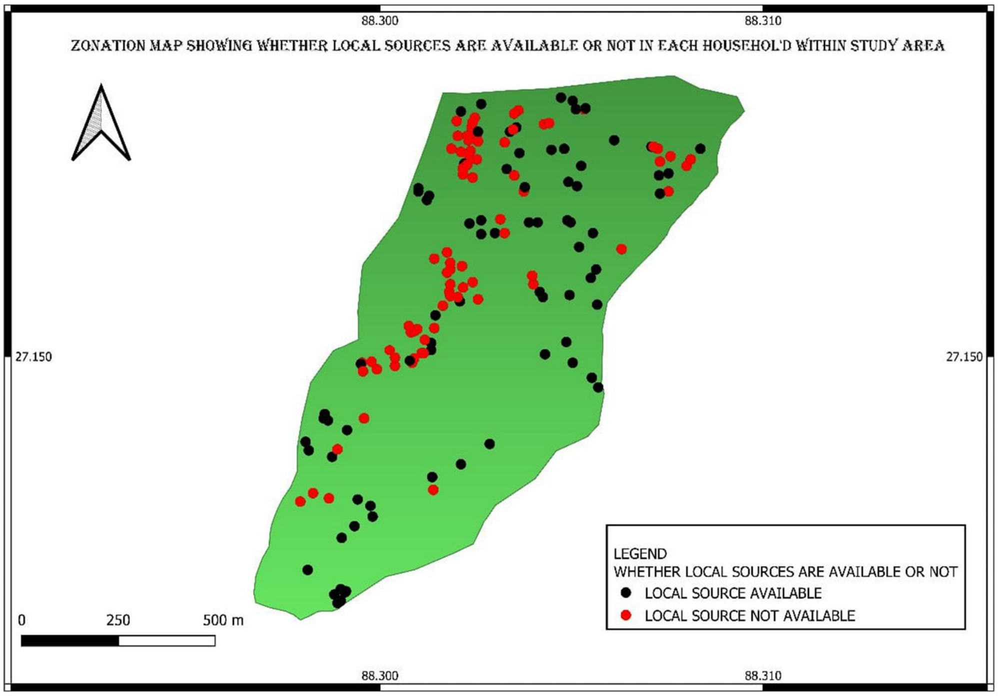

Fig.6. According to the survey provided above, there are 78 total households that have a local source available, while there are 80 total households that doesn't have a local source available.

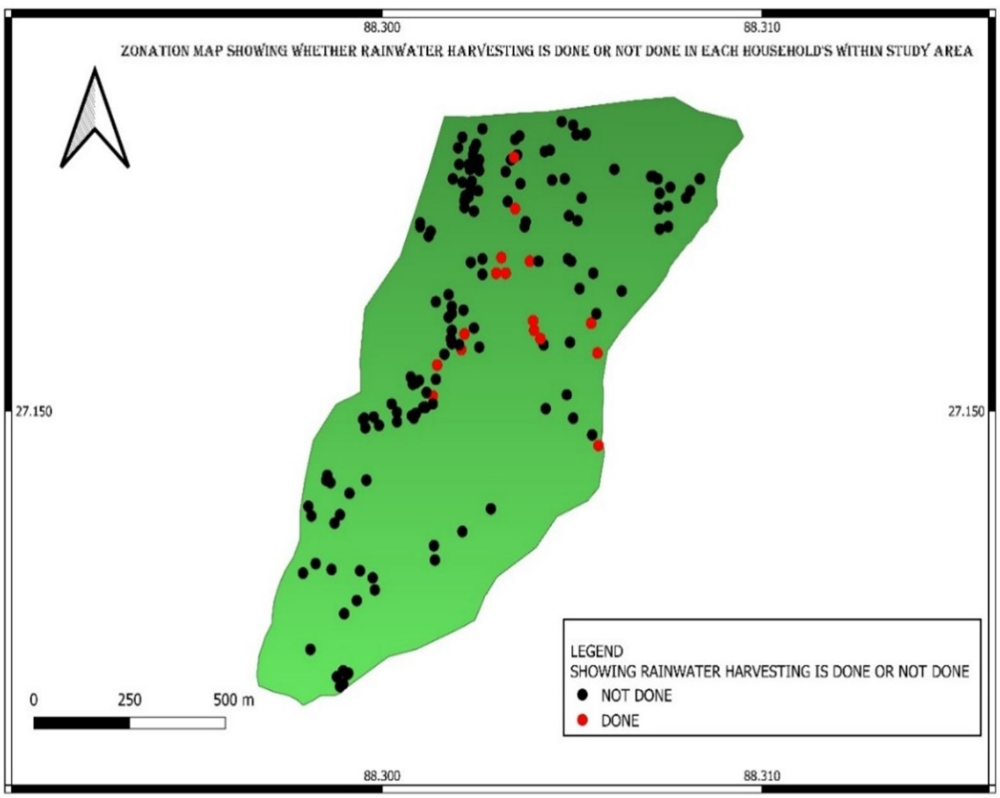

Fig.7. According to the survey data above, there are 158 households, in which 16 households practice rainwater harvesting, and the remaining 142 households don't practice rainwater harvesting as per the survey.

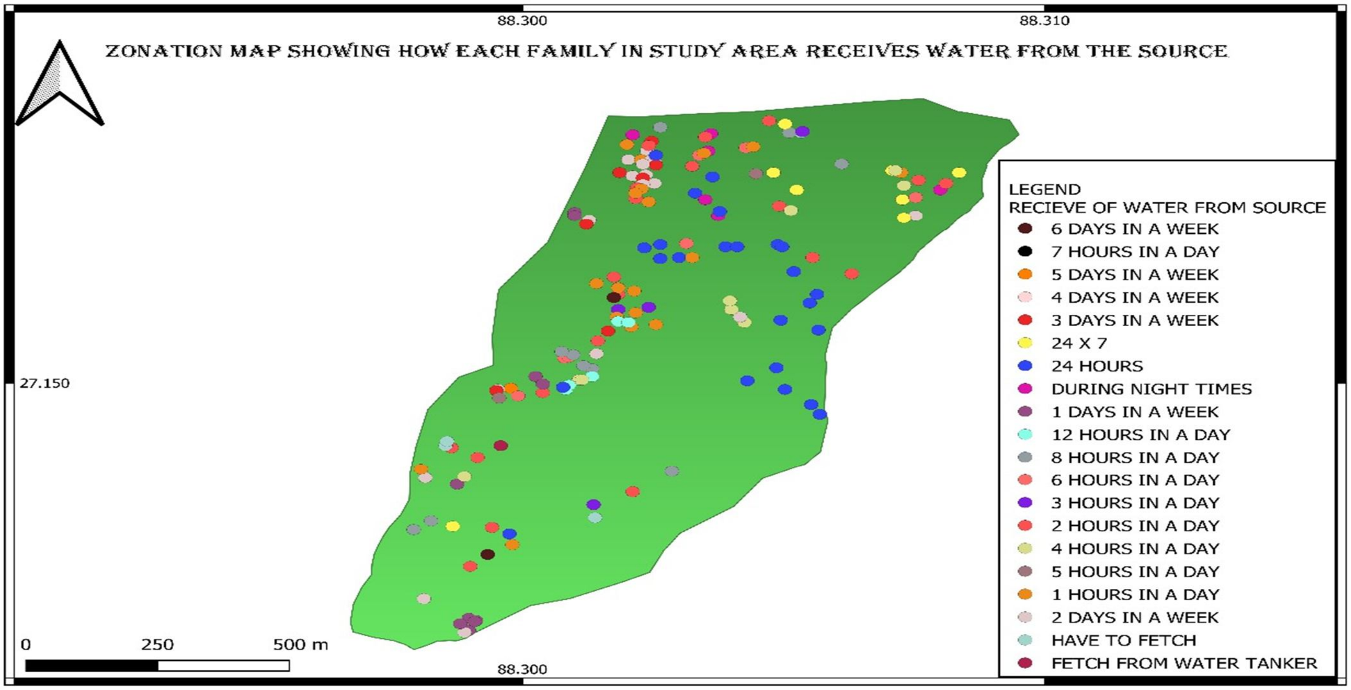

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Fig.8. After the conduct of the survey, the results were that out of 158 households, the houses that received water 1 hour a day was 12 households, 2hours a day was 12 households, 3hours a day was 4 households, 4 hours a day was 6 households, 5 hours a day was 5 households, 6 hours a day was 6 households, 7hours a day was 4 households, 8hours a day was 9 households, 12 hours a day was 15 households, 24 hours a day was 28 households, 1 day in a week was 9 households, 2 days in a week was 10 households, 3 days a week was 7 households, 4days a week was 5 households, 6 days a week was 8 households, the households that have to fetch water was 4 households, the households that has to fetch water during the night is 2 households, the household that has to fetch water from the tank is 1 household, and the households where water is available 24X7 all day and night in households is 8.

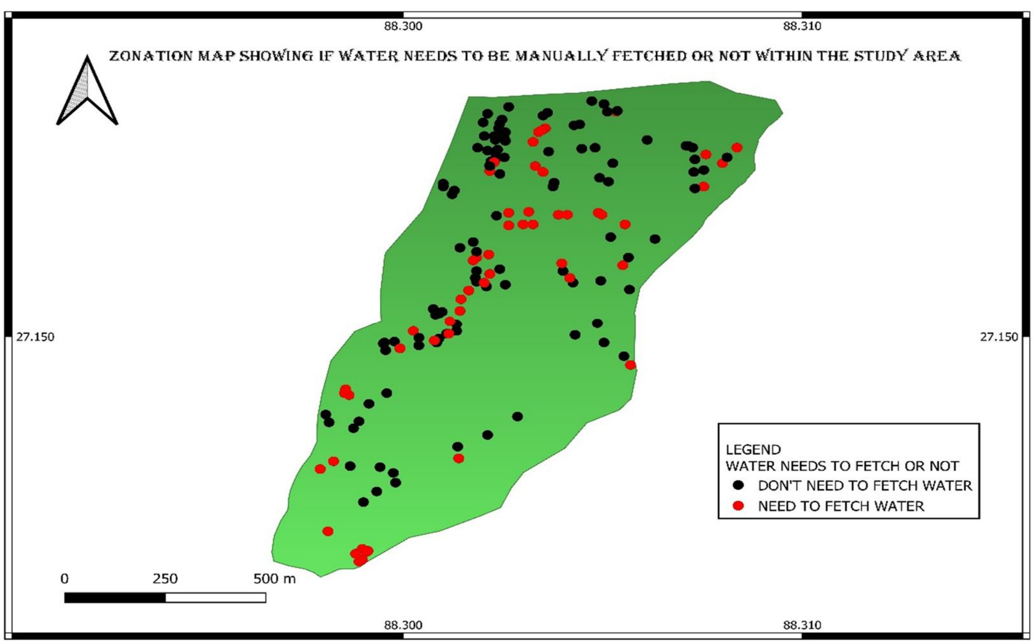

Fig.9 According to the survey provided, there are 96 households that does not fetch water and there are 54 households that fetch water.

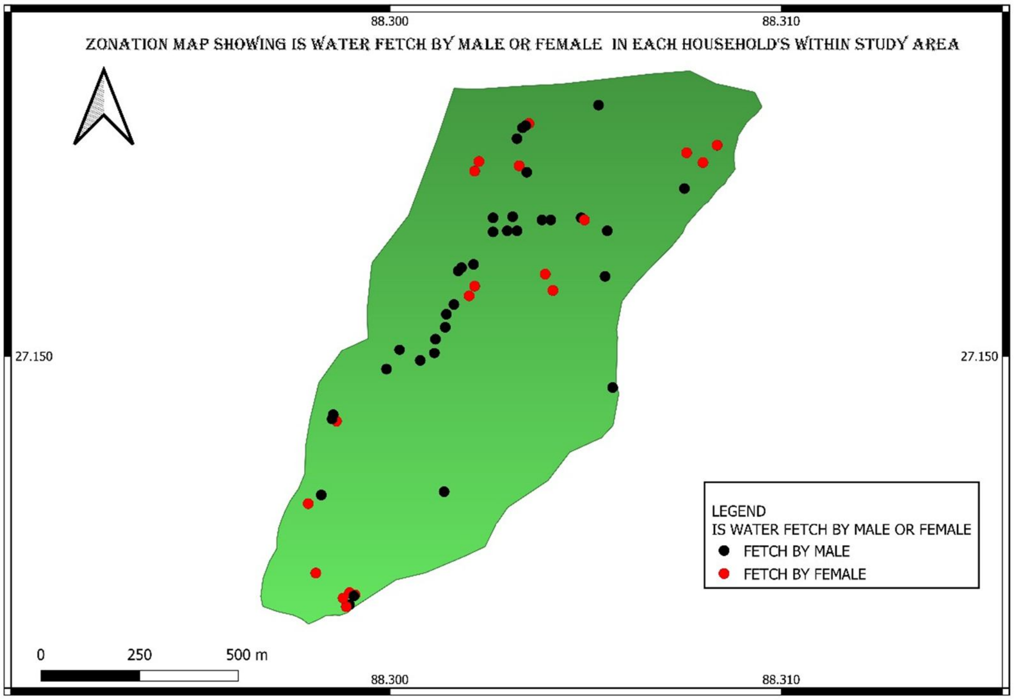

Fig.10 According to the survey data above, there are 158 household, of which 34 households have male water carriers and the remaining 20 households have female water carriers, while the remaining 104 households don't have to fetch water.

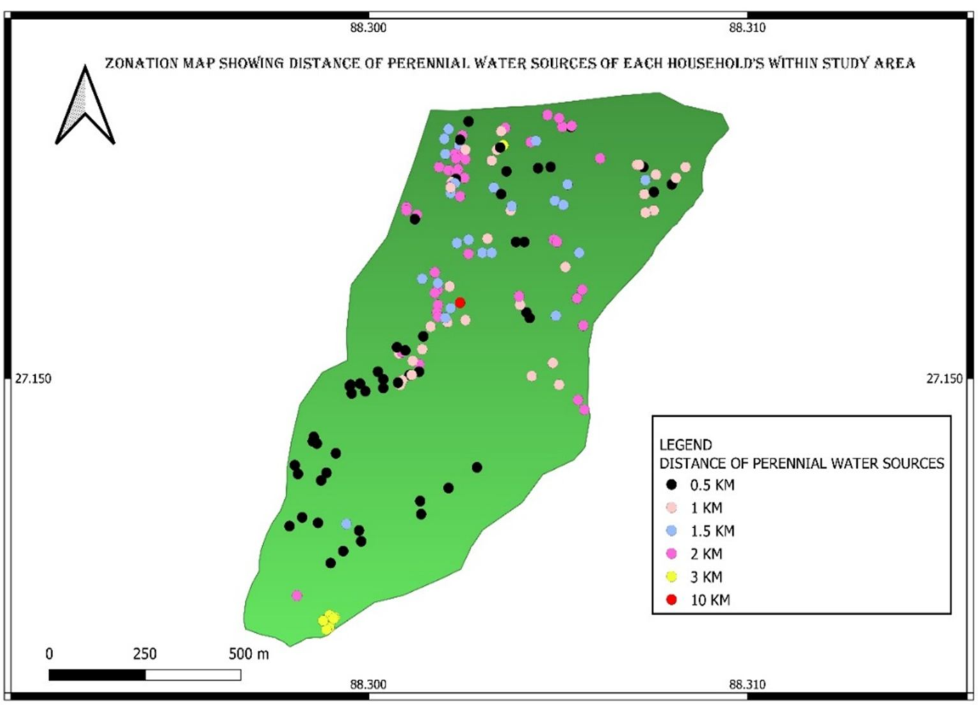

Fig.11. The following are the survey results about the distance between households and perennial water sources:

Households lying under 0.5km are 55, households lying under 1km are 32, households lying under 1.5km are 24, households lying under2km are 39, Households lying under 3km are 7, household lying under 10km is 1.

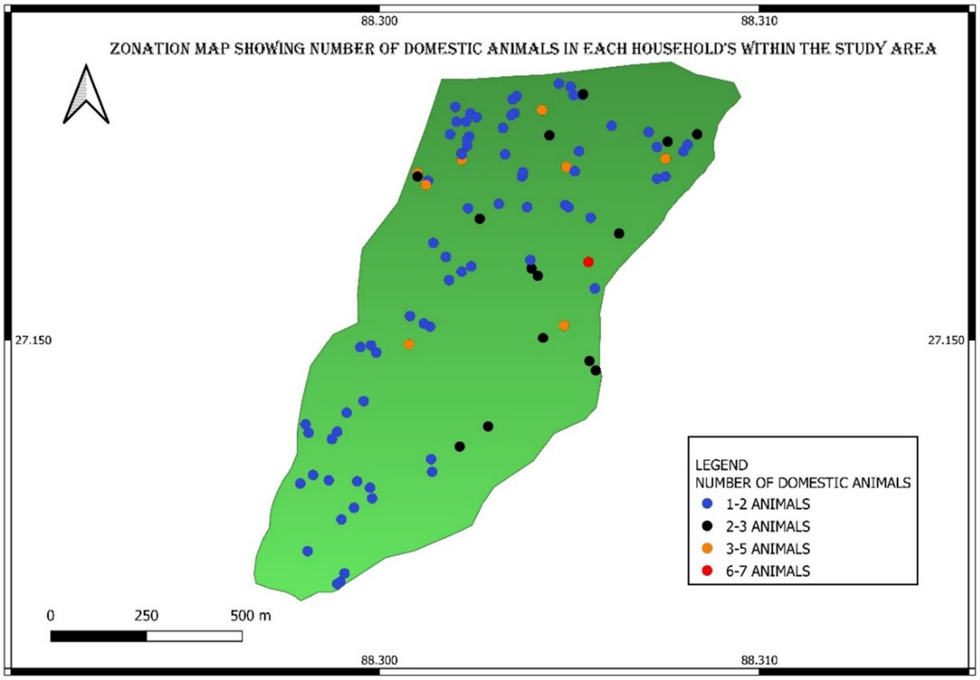

Fig.12. Based on the survey results, the research area's total households count with domestic animals is as follows:

There are 72 households consisting of 1-2 domestic animals; there are 14 households consisting of 2-3 domestic animals; there are 8 households consisting of 3-5 domestic animals; and there is 1 household that consisting of 6-7 domestic animal.

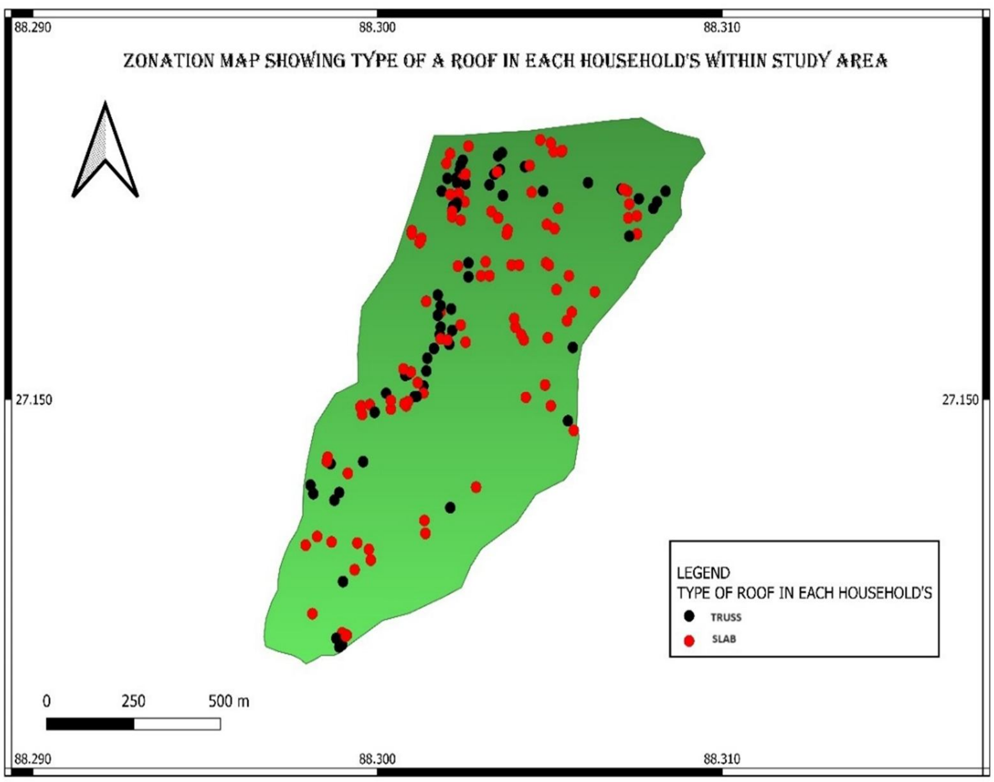

Fig.13 According to the survey, there are a total of 60 trusses and 98 slabs present in each households within our study area, as indicated by the above data.

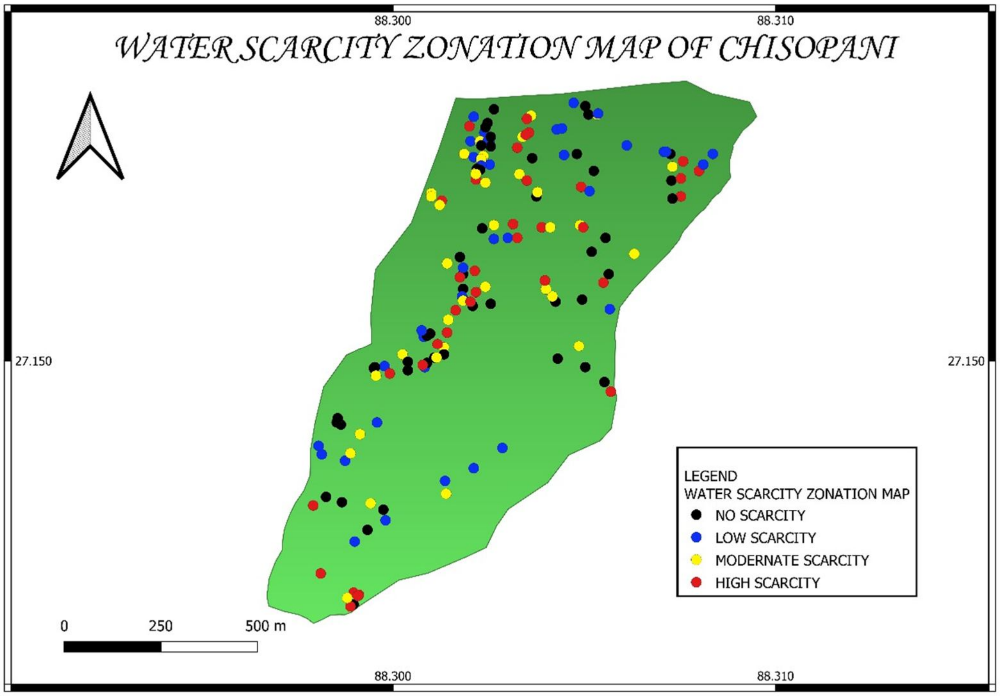

Fig.14 According to our survey, the study area comprises 158 houses, of which the overall scarcity falls into the following categories: no scarcity (50), low scarcity (38), modernized scarcity (36), and high scarcity (34)

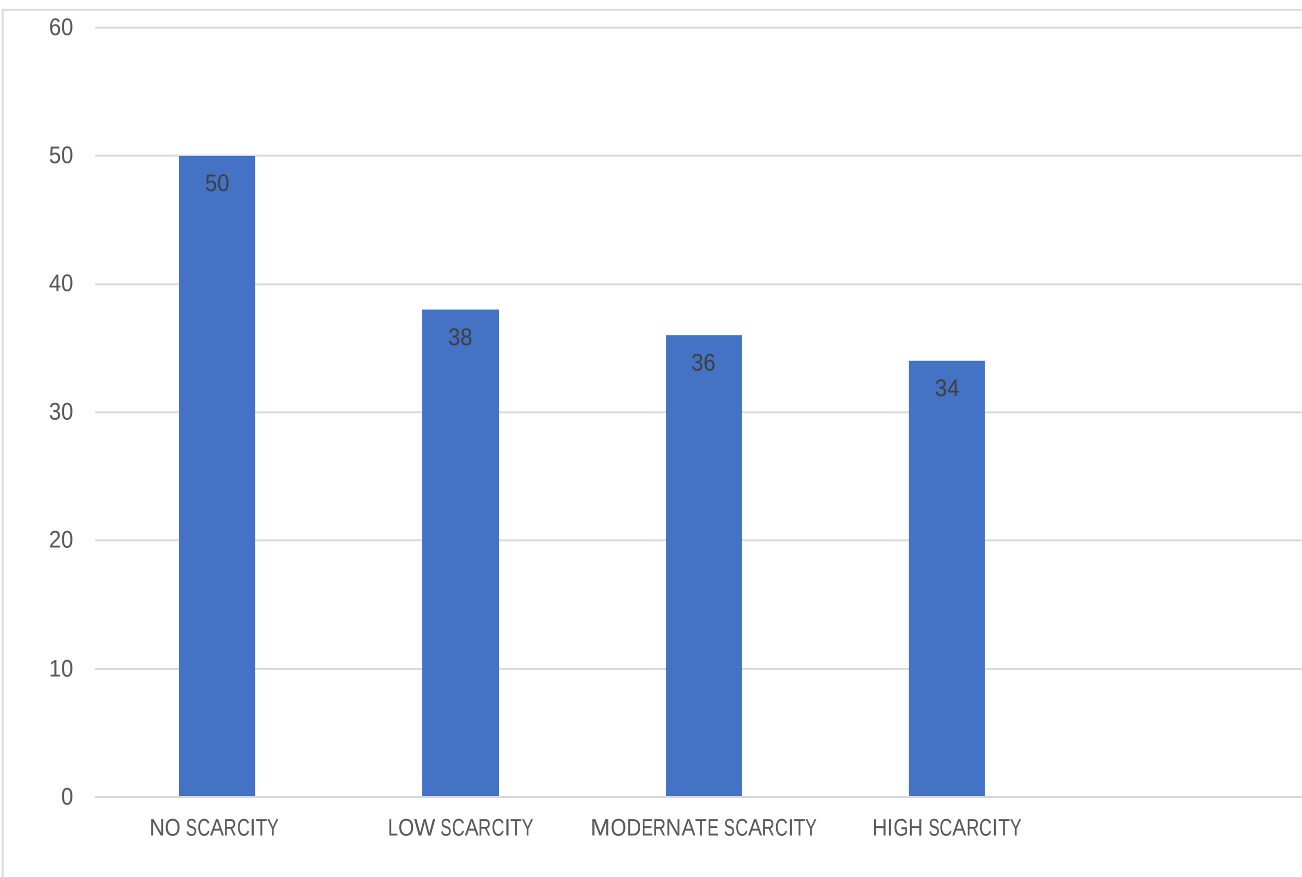

Fig.15 Chart showing number of households falling in which range of water scarcity index

IV. CONCLUSION

1) By looking over the outcome, it was observed that out of 158 households, 50 households fell under no scarcity zone, 38 households fell under low scarcity zone, 36 households fell under medium scarcity zone and 34 households fell under high scarcity zone.
2) During the field survey, it was noted that proper water management is not carried out while distributing water.
3) A significant amount of potential for rainwater harvesting was noted in the research area. Public education on the advantages of rainwater harvesting is a responsibility of the government.
4) Water scarcity in the study area was found to be primarily caused by a lack of local sources, a reduction in the quantity of water obtained from the public supply, and decrease in the amount of water that homes could store.

REFERENCES

[1] https://scialert.net/fulltext/amp.php?doi=ajps.2007.884.891
[2] https://www.ijraset.com/research-paper/water-scarcity- zonation-mapping-of-household-in-district-Soreng-west-Sikkim
[3] https://scialert.net/fulltext/amp.php?doi=ajps.2007.884.891
[4] https://www.sciencedirect.com/science/article/pii/S240584402201533X
[5] https://www.sciencedirect.com/science/article/pii/S2352801X21000680
[6] https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=040695423e6a5ddee28780e52fc65cecff4f5472
[7] https://www.researchgate.net/publication/338481226_GIS_and_Remote_sensing_Approach_in_Identifying_Ground_Water_Recharge_Zones_of_Cheriyal_Watershed
[8] https://www.sciencedirect.com/science/article/pii/S2405844023011738
[9] https://www.mdpi.com/2071-1050/15/13/10075
[10] https://www.slideshare.net/tpjayamohan/identification-of-ground-water-potential-zones-using-gis-and-remote-sensing