Determination of Gravity Irrigation Capability of Barmasia Village, Giridih Using Geospatial Technology

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Abstract- With the combined information of geospatial technology and ground data, it is tried enhance the potential of irrigation. In this research gravity or surface irrigation model is being created using parametric evaluation system for Barmasia village of Giridih district, Jharkhand. In this parametric evaluation system Soil texture, soil depth, soil type, drainage density and slope which are measurable or estimable, it is advantageous to use these values to enhance irrigation, crop yields and forest of the study area. The study was carried out for Gravity or Surface irrigation capability and it is found that the 38.58 % suitable, 28.84% moderately suitable and 32.58% unsuitable areas of the village.

Index Terms-Gravity irrigation, GIS, Rating Index, DEM, Soil etc.

1. INTRODUCTION

Land and water are the two basic natural resources which are being exploited for various developmental activities. As the population increases, the exploitation of these resources is also increasing and in this process they are subjected to stress [1]. Now near about 76 % of fresh water is used for by humans.Irrigation scheduling is one of the major factors that influence the agronomic and economic viability of our country. So Irrigation is the backbone of present Society. According to Directorate of Economics and Statistics (DES), India the irrigated area statistics fully accounts for the 162 major and 221 medium irrigation projects. In 1960s, there were near about 100,000 bore wells in India whether today is anywhere between 21 and 26 million.

There are different types of irrigation system but two types of irrigated areas have been reported. One is Drip irrigation systems and another is Surface irrigation system. In the case of Drip irrigation systems, the water is applied directly to root zone of the plant through a pipe line with the help of emitter. But now days the surface irrigated land is supplied from surface water sources, while ground water use has been started on primary phases. The surface system is the natural irrigation scheme. Due to gravitational force of the planet the surface water is flow towards the higher sloppy area to lower sloppy areas. Surface irrigation is follow this law that’s why surface irrigation is also knows as Gravity Irrigation. This not only depends on surface slope but also depend on Soil characteristic, drainage condition and surface cover etc. This type of irrigation is useful only when it is properly managed and controlled. Present study is shows the importance the natural resources for Surfaces irrigation.

2. OBJECTIVES

The main objectives of the present study are mentioned as the Assessing the capability of Gravity or surfaceirrigation and identification of suitable gravity irrigation zone of the study areas with Surface topography, Soil characteristics and Drainage based data.

3. STUDY AREA

This study area of Barmasia village is situated at Giridih of Jharkhand state in India. The geographical location of this area is between 24°5'45”N to 24°7'15”N latitude, and 86°25'05E to 86°26'50E longitude.

4. METHODOLOGY

To calculate the land suitability for Gravity or Surface irrigation, the parametric evaluation system, 1991 was applied, using the Surface and soilcharacteristics. These characteristics are mainly concern the Slope factors, drainage properties, soil physical properties etc. They are rated base on their characteristic and importance for Surface irrigation and also used to calculate the Gravity Irrigation Capability index (GICI) according to the formula:

$$\text{GICI} = \frac{A * B}{100} * \frac{S}{100} * \frac{D}{100}$$

Where GICI indicate the capability index for irrigation; A is Soil texture rating; B is Soil depth rating; Sis Slope rating and D is Drainage rating.

4.1 Soil Texture rating

The water-holding capacity of a soil determines by its texture, which is playing an important role to hold sufficient or inadequate soil moisture. If the texture of the soil has more sand in its content, the soil becomes less water holding capacity and the moisture. The significant amount of water will be lost through deep percolation or infiltration, further is not uptake by the crop roots. If the texture of the soil has more clay in its content, the soil becomes more water holding capacity and the moisture. On the other hand more water holding capacity increase the more surface water irrigation possibility. But not only water holding capacity, the slope of the surface is also effect on surface or gravity irrigation. The relation between soil texture, % of slope and water Infiltration rate of soil is shown in Table 1.

It can express textural classes as sand, sandy loam, loamy sand, loam, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay,silty clay and clay (Guidelineet al., 2011).

4.2 Soil Depth rating

The water holding capacity and surface is direct or indirect influence by soil depth, are effect on water irrigation possibility. Soil depth also determines the potential rooting depth of plants. All the soil layers of sand, gravel and also bedrock can physically limit root depth. Clay loams with organic content are the ideal soils for most of the vegetables growing. But soil depth is not less than 0.75 m. Different vegetables may require different types of soil depth, one may require 3 feet of soil and another may require 4 feet. On the other hand the vegetation cover and soil depth influence the hinder irrigation. It can also create problems when using irrigation.

4.3 Slope rating

Topography and slope type is influence on effective gravity or surface run-off. When the slope will gradually increased run- off will increase parallel, particularly on heavy clay soils due to low infiltration rate and gravity forces, on the other hand when the slope is decreased the flow of water will be decrease and infiltration may be higher on coarse textured soils with high percolation rate.

Heavy irrigation of sloping and undulating lands may cause soil erosion. The amount of irrigation water applied should be decided based on the water sources, hydraulic conductivity, Soil textural class, soil depth and water retentive capacity of the soil. The suitable slope for different soil types are shown in Table 2.

For slope generation a circular neighbourhood with 3 map unit or cell is applied over generated CARTOSAT-1 stereo DEM [6] in this model to smooth the DEM (Digital Elevation Model). The average value with the 3 cell circle value of DEM is assign into the center cell of the circular neighbourhood matrix. The slope generations processes will take into action, over the smooth DEM in percentage. Again thecircular neighbourhood processes are applied over theslope as a same way.After successful generation of slope, the slope isclassified base on six classes [3].The algorithm is described below:

The percentage (%) of Slope is calculated using theformula given in Fig 3.

4.4 Drainage rating

Drainage indicates the water logged conditions and flow direction base on surface topography. In most areas, drain capacity is dictated by stream flows. The capacity of a drain depends on the rain fall, Surface slope, Soil condition and time over which drainage occurs etc. In the present study the drainage classes are divided into six classes' base on their density. After that these classes are assigning into drainage rating with its importance according to parametric evaluation system.

After generating the all primary layers, are classified and rating the all classes respect on its importance andparametric evaluation system.

4.5 Result and Discussion

The processing of the parametric evaluation system for gravity irrigation gave the results that are represented in Fig 7 and summarized in Table 4. It should be highlighted that the surface irrigation, there are three classes for irrigation suitable. Only 38.58% of the study area is suitable and 28.84% areas are slightly moderate suitable. 32.58% areas of the study area is classified as unsuitable areas for Surface irrigation. The following Figs (from Fig 1, Fig 2 and Fig 5 and Fig 6) show the result.

Table 1. Infiltration rates for different Soil textures

	Infiltration rate mm/hour		
	Slopes	Slopes	Slopes
Soil group on texture and profile	0 - 8%	8 - 12½%	>12½%
Sands and light sandy loams uniform in texture to 1.5 meters	31	25	20
Sandy loams to 0.5 meters overlying heavier subsoil	20	16	12
Medium loam to sandy clays over heavier subsoil	16	12	10
Clay loams over clay subsoil	12	10	7
Silt loams and silt clays	10	7	5
Clays	6	5	4

Sources: IRRIGATION HYDRAULICS Supports learning against competency unit, RTE4602A Determine hydraulic parameters for an irrigation system (NSW Department of Education and Training), 2004.

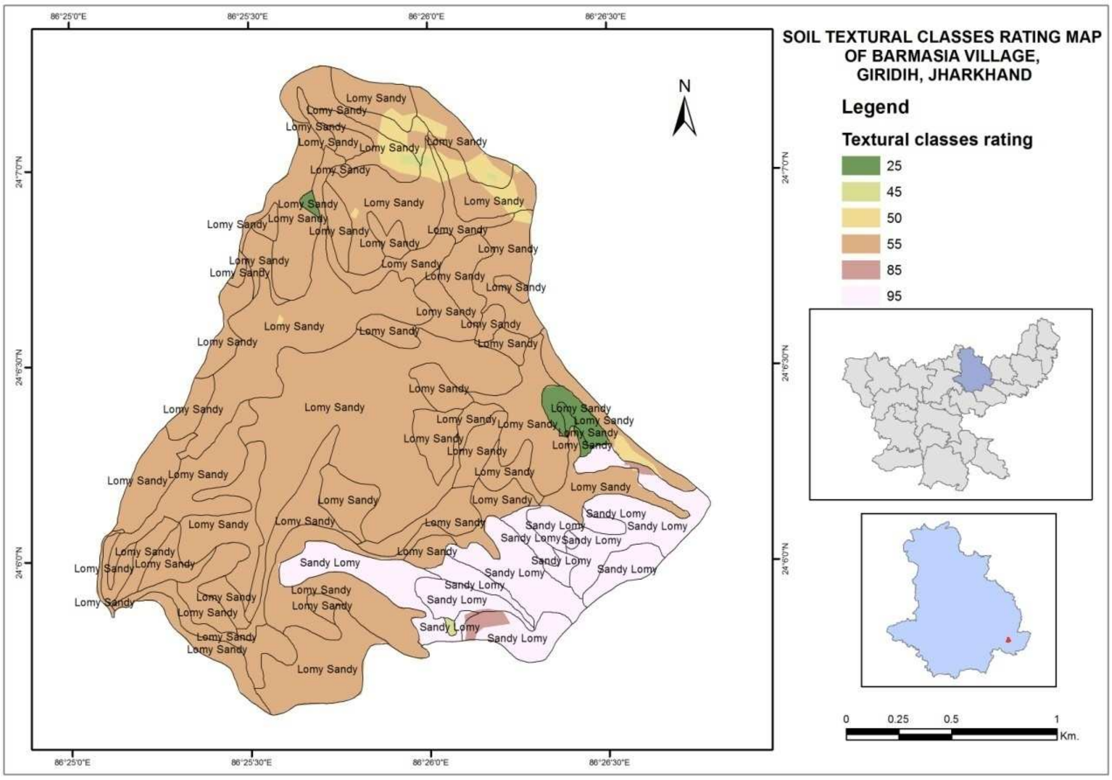


Fig. 1. Soil texture rating of Barmasia village, Giridih.

Table 2. Slope of furrow related to soil type

Soil type	Maximum recommended slope, %
Sand	0.25
Sandy loam	0.4
Fine sandy loam	0.5
Clay	2.5
Loam	6.25

Source: Irrigation Agronomy Manual, Revised version, former MoA /ADD, March 1990, Addis Ababa.

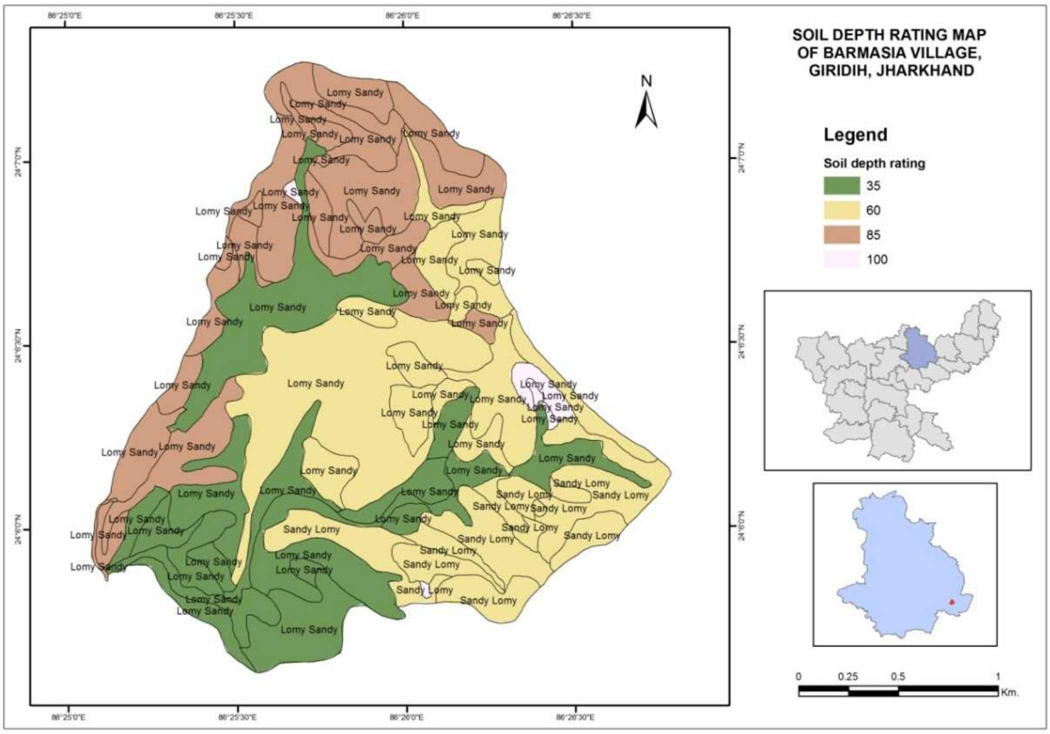
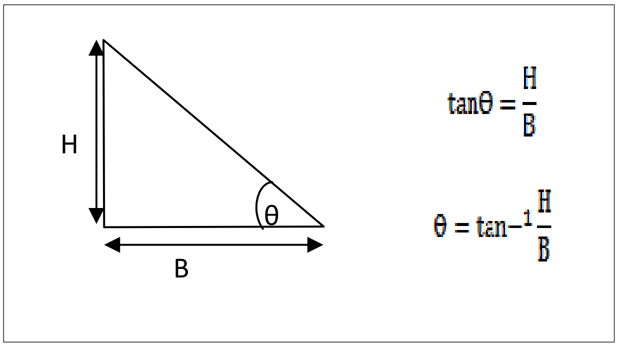


Fig. 2. Soil depth rating of Barmasia village, Giridih.



$$\% \text{ Slope} = \frac{\text{Vertical Distance (H)}}{\text{Horizontal Distance (B)}} \times 100$$

Fig. 3. Logic behind the slope calculation.

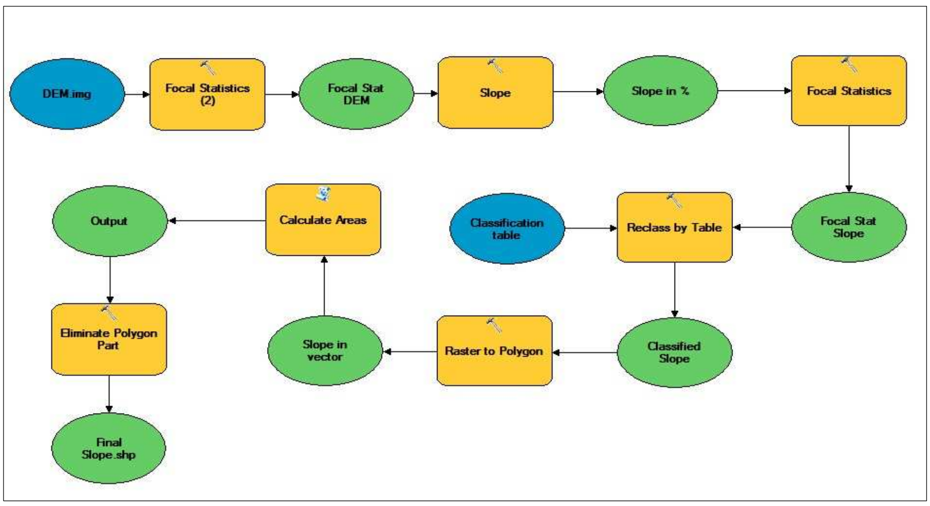


Fig. 4. Model base Workflow Diagram of slope generation.

Table 3. Detail of slope of Barmasia areas

Slope in Percentage (%)		
From	To	Classes
0	1	1
1	3	2
3	8	3
8	15	4
15	30	5
30	>30	6

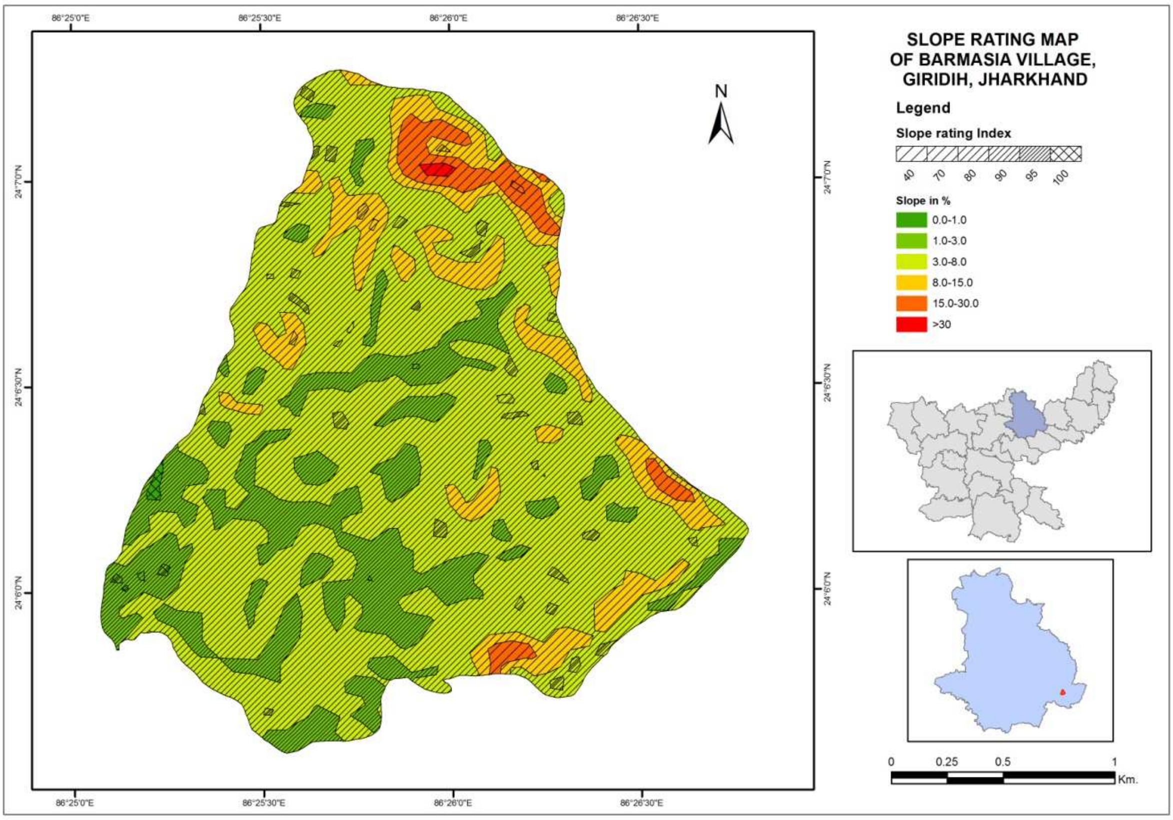


Fig. 5. Slope rating of Barmasia village, Giridih.

Table 4. Detail of Gravity suitability classes of Barmasia areas

Gravity suitability classes	Areas in sq m	% of areas
Currently unsuitable	1600900	32.586551
Moderately suitable	1416571	28.834507
High suitable	1895292	38.578942

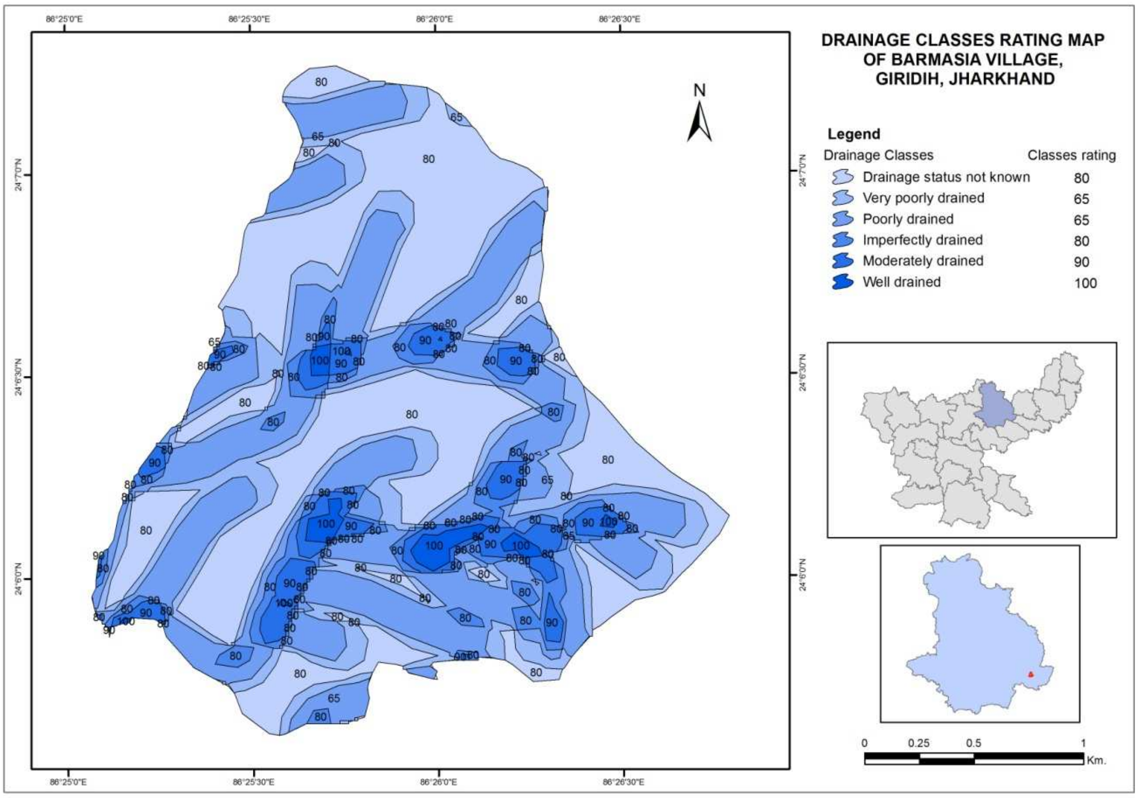


Fig. 6. Drainage rating of Barmasia village, Giridih.

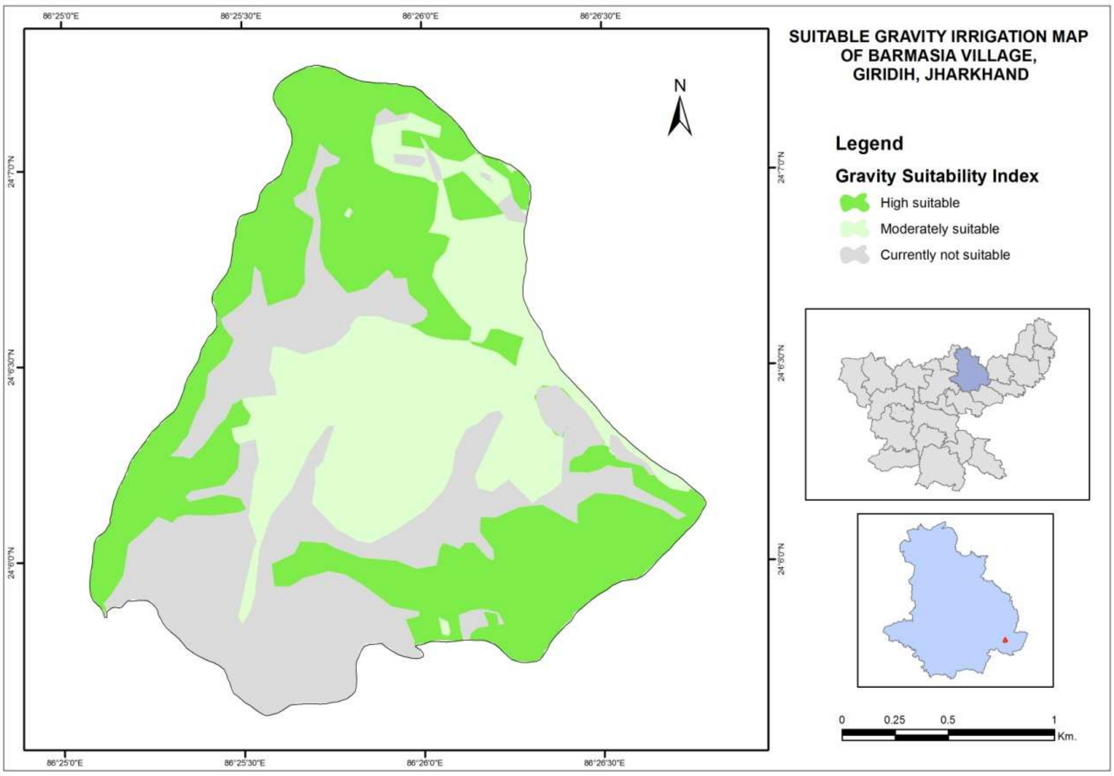


Fig. 7. Suitable Gravity irrigation map of Barmasia village, Giridih.

6. CONCLUSION

Integration of GIS and remote sensing provides the techniques to water resources analysis and mapping based on different collateral data and satellite images. GIS enables the proper handling of databases necessary for the integration of data from different sources.

This workshas introduced the ways to evaluate the surface or gravity irrigation potential zone of Baramasia village, Giridh. It also identified opportunities for improvements in irrigation performance of this area. By applying principles and managements, it can improve irrigation efficiency and productivity.

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