# KATHMANDU UNIVEERSITY

## SCHOOL OF ENGINEERING

## DEPARRTMENT OF GEOMATICS ENGINEERING

**FINAL REPORT ON**

**SURFACE IRRIGATION SUITABILITY**

**MAPPING USING ARC GIS AND AHP**

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ABSTRACT

Although the goal of the project is exploration, weighted index overlay analysis is used to assess the quality of land for surface irrigation in kapagad watershed using a geographic information system (GIS) and the Analytical Hierarchy Process (AHP). The study took into account five critical factors: slope, soil texture, land use/land cover (LULC), distance to a watercourse, and distance to a road. The weight of each parameter according to percent of influence on land suitability potential was determined by Analytical Hierarchy Process according to the relative influence of each. The generated land suitability potential for surface irrigation map has four ranks (score), 4, 3, 2 and 1, in which its classes are most suitable, more suitable, less suitable, and not suitable, respectively, based on its land suitability potential availability rank and class. The area coverage is 0.003%, 0.6% and 75.50%, 23.90 % of the study area, respectively. As a result, the map generated by this platform can be used to locate suitable irrigation locations within the required area.

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GIS: Geographic Information System

MCDA: Multi-Criteria Decision Analysis

MCDM: Multi-Criteria Decision Making

AHP: Analytical Hierarchy Process

UTM: Universal Transverse Mercator

DEM: Digital Elevation Model

WGS: World Geodetic system

LULC: Land Use Land Cover

VDC: Village Development Committee

CFUGs: Forest User Groups

GON: Government Of Nepal

USAID: United States Agency for International Development

RS: Remoting Sensing

NP: Nagar palika

GP: Gaun Palika

FAO: Food and Agricultural Organization

CI: Consistency Index

RI: Random Index

CR: Consistency Ratio

JPG: Joint Photographic Experts Group

GIF: Graphics Interchange Format

PNG: Portable Network Graphics

TIF: Tagged Image File Format

BMP: Bitmap

PSD: Photoshop Document

AI: Adobe Illustrator

CDR: CorelDRAW

SVG: Scalable Vector Graphics

# 1. INTRODUCTION

Streams and rivulets are the main sources of water used for drinking, irrigation, sanitation, energy and domestic purposes. Surveys reveal that water sources are drying out, and some areas (Mannakapadi, Ghagal, Kahirala, Mohanyal, Nirauli and Nigali) are facing acute water stress. Across households, accessing drinking water is most common through piped systems (72%) followed surface water harvesting (18%), waterfalls (4%), dug wells (2%), and tube well boring (1%). Surface suitability mapping, integrating Geographic Information Systems (GIS) and Analytical Hierarchy Process (AHP), represents a cutting-edge approach to land assessment and resource management. This innovative methodology plays a pivotal role in identifying the most suitable areas for surface irrigation, offering a systematic and data-driven solution to optimize land use. By harnessing the power of GIS and the analytical capabilities of AHP, this approach aims to enhance precision, efficiency, and sustainability in surface irrigation planning.

## 1.1 Background

Water is the single most important natural resource underpinning Nepal's economy and livelihoods. Inclusive, sustainable management of water resources depends on strengthening community resilience and protecting healthy, biodiverse ecosystems in the face of both development and climate change. Irrigation is a key factor for sustainable improvement and poverty reduction. Irrigation water can be obtained from a river or pumped from a well. Most significant were the generous contributions of time, thoughtful attention, and ideas of members of many community forest user groups (CFUGs), cooperatives, water user groups, and, especially, the communities dependent on aquatic biodiversity and local water management. Leaders of Jorayal, Chure, Badikedar, and Mohanyal rural municipalities and the newly elected local government bodies engaged deeply in the assessment and prioritization and committed themselves to collaborate and integrate the priority agenda into local planning processes. This watershed profile provides critical baseline information for local governments, communities, civil society within the kapagad Watershed to strengthen water resource management in a way that benefits human development and protects the natural resource base upon which well-being depends. This profile also helps local stakeholders to design and test interventions to strengthen community resilience and conserve freshwater biodiversity, for which additional resources are available through the Paani local grants program. The practical development of soil suitability assessment will significantly improve community livelihoods. In fact, mapping surface irrigation potential has a significant impact on improving the long-term management of surface water resources and increasing crop production in both the study area and the country overall. Overall, we find decreasing river discharge during pre-monsoon, monsoon, and post-monsoon, but an increasing trend during winter (0.1 m3/s year). Precipitation has decreased in this watershed while temperatures have increased, and it is believed these are the two main drivers of the decreasing river discharge, while increasing winter rains have fueled that increase. As a result, a thorough investigation was conducted to determine the soil's suitability for surface irrigation for better use. As a result, by defining land suitability zones using remote sensing techniques and GIS tools, help to achieve proper management and sustainable use of surface irrigation for crop production in the sub-basin. The study took into account five determining factors: slope, soil, LULC, proximity to a watercourse, and proximity to a road.

### 1.1.1 Multiple Criteria Decision Analysis

Multi-criteria decision-making (MCDM) is one of the main decision-making problems which aims to determine the best alternative by considering more than one criterion in the selection process. MCDM has methods that can be applied in different fields from finance to every engineering project. Multi-criteria decision analysis provides a set of strategies, procedures and calculation for organizing choice issues, planning process, assessing, prioritizing from the multiple set of alternatives. Example: For the goal of selecting a appropriate location of irrigation in doti district with watershed and rivers, roads, LULC, elevations could be the criteria and selection of best suitable zone across the districts are the alternatives.

### 1.1.2 Analytical Hierarchy Process

AHP is one of the multiple criteria decision-making method that was developed by Prof. Thomas L. Saaty (1977). It provides measures of judgment consistency, derives priorities among criteria and alternatives and simplifies preference rating among decision criteria using pair wise comparisons. Decompose the decision-making problem into a hierarchy. Make pair wise comparisons and establish priorities among the elements in the hierarchy. Synthesis judgments and evaluate and check the consistency of judgments. The basic procedure is to develop the ratings for each decision alternative for each criteria, develop the weights for the criteria and calculate the weight average ratings for each decision alternatives.

## 1.2 Problem Statement

Despite the critical importance of surface irrigation in ensuring food security and sustainable agriculture, the lack of a systematic and integrated approach for identifying suitable areas hampers efficient implementation. Traditional methods often fall short in providing a comprehensive assessment, considering the dynamic interplay of various factors influencing surface irrigation suitability. As a result, there is a pressing need for a robust methodology that leverages advanced spatial analysis tools, such as ArcGIS, and incorporates a structured decision-making framework like the Analytical Hierarchy Process (AHP).

## 1.3 Objectives

1 The primary objective of this report is:

- To select the suitable irrigation surfaces with multiple watershed in doti District.
- Generate a Surface Irrigation Suitability Map that prioritizes areas with the highest potential for successful implementation of surface irrigation practices.

2. The secondary objective of this report is:

- To comprehensively describe current technologies, strategic innovations and monitoring tools. Contribute to the advancement of knowledge in the field of irrigation planning and management.
- Promote sustainable agricultural practices by facilitating optimized resource allocation, reducing environmental impact, and enhancing the overall efficiency of surface irrigation systems.

### 1.4 Scope

This study aims to identify the suitable irrigation surface in doti District and provide valuable results that can guide decision-makers in the municipality and Village Development Committees (VDCs) in making informed decisions regarding the selection of an appropriate. The analysis considers essential factors such as road network, water network, land-use, and soil texture and slope, which play a crucial role in determining the ideal location of irrigation to make the watershed. The study will assess the scalability and adaptability of the proposed methodology for application in different geographic contexts. This involves evaluating the transferability of the approach to diverse regions with varying climatic, soil, and land use conditions.

## 2. LITERATURE REVIEW

The USAID Paani Program facilitated the preparation of this profile, in close coordination with the Government of Nepal (GON) and local stakeholders and with support from the United States Agency for International Development (USAID). Paani aims to increase the knowledge, engagement, and benefits of local water users in target river basins to build local water resource management capacity. This watershed profile provides critical baseline information for local governments, communities, civil society, and private sector stakeholders within the Thuligaad Watershed to strengthen water resource management in a way that benefits human development and protects the natural resource base upon which well-being depends. This profile also helps local stakeholders to design and test interventions to strengthen community resilience and conserve freshwater biodiversity, for which additional resources are available through the Paani local grants program. The Thuligaad watershed is located within the Karnali River Basin that belongs to parts of Doti and Kailali districts. The watershed stretches across the Jorayal and Badikedar rural municipalities of Doti, and Mohanyal in Kailali. The total drainage density of this watershed is 935 m/km3 and the total area of the watershed is 850 $km^2$. Altogether 17 streams and 156 tributaries in this watershed flow into the Karnali River. Water drains from the north between the Karnaso Gaad of Doti through to the Khimadi near Mohanyal in the south from where it eventually flows into Karnali River. It should be noted here that the research for this watershed profile, and the other profiles under the Paani initiative, was conducted before and after the country elected to move to a federal system of government. This change means that former governmental units, such as village development committees (VDCs), will be gradually superseded by new units such as the municipality (nagar palika), rural municipality (gaun palika) and province. Watersheds as a unit of analysis do not align with past or current administrative units; however, as our research began and ended after this change, you will note references to both the new and old forms – VDC, gaun palika (GP) and nagar palika (NP). When we refer to liaising with or providing support to local governments, we are making reference to the units as assigned by the new federal system.

Irrigation is a key factor for sustainable improvement and poverty reduction. Irrigation water can be obtained from a river or pumped from a well (FAO, 2000). The annual groundwater potential is 40 Gm-3 a-1 and the total annual runoff is 122 Gm3 a-1 (Awulachew et al., 2007). There are twelve major river basins in Ethiopia, 9 of which are wet and 3 are dry. The Blue Nile basin in the Ethiopian Highlands provides over 80% of the water used in Sudan and Ethiopia across the Nile. Despite this abundance of water, Ethiopia sustains food resources for only about 10% of the population (Makombe et al., 2007) as the surface water supply is spatially and temporally variable and little is available at the end of the dry monsoon phase (Worqlul et al., 2015). Today, irrigated farmlands provide around 40% of the world's food. However, irrigated agriculture's ability to provide enough food to feed the world's rapidly expanding population is failing (Bagherzadeh & Paymard, 2015). Only 4% of the 6 million hectares of cultivated land in sub-Saharan Africa, as noted in (Teshome et al., 2013), is irrigated. In Ethiopia, the irrigation subsector only uses roughly 3% of the total water supply (Teshome et al. 2017). Land suitability resources are scarce, especially in the lower Bedessa Basin of the Rift Valley Basin (an area of around 16,076.64 km2), where accessible areas are mostly employed for domestic usage and irrigation and have not undergone enough research. The surface irrigation planning process must integrate information about soil suitability, water resource availability and water needs for irrigable land at a given time and place (FAO, 2007). Assessing the suitability of land for surface irrigation requires a thorough assessment of the soil characteristics and topography (slope) of the land within the field (Fasina et al., 2008). Use of GIS and Remote Sensing (RS) technology applications have now become commonplace for utilities, land surface intelligence and planning. GIS can be a powerful tool to identify suitable irrigable land and to map suitable land for irrigation.

# 3. METHODOLOGY

## 3.1 Study Area

The kapagaad watershed is one watershed located in the seti river basin. The seti is one of river basins in Nepal and flows through Doti and bajhang. The watershed lies in the Seti River Basin and belongs to parts of Doti districts in southwestern Nepal. The watershed stretches across the Jorayal and Baddikedar rural municipalities (in Doti). District Doti district is located in the southwestern part of sudurpaschim Province and it extends from 29.2006° N, 80.8987° E. The altitude of the study area ranges from 936 to 2757 m from sea level. The headquarter of doti is Dipayal due to which the centralization of various facilities such as education, medical, governance, economy, and other productive activities has led to rapid population growth. According to census 2021, The total population of doti district is 204,831 with a 0.32% annual population change and a 101.2/km $^2$ population density.

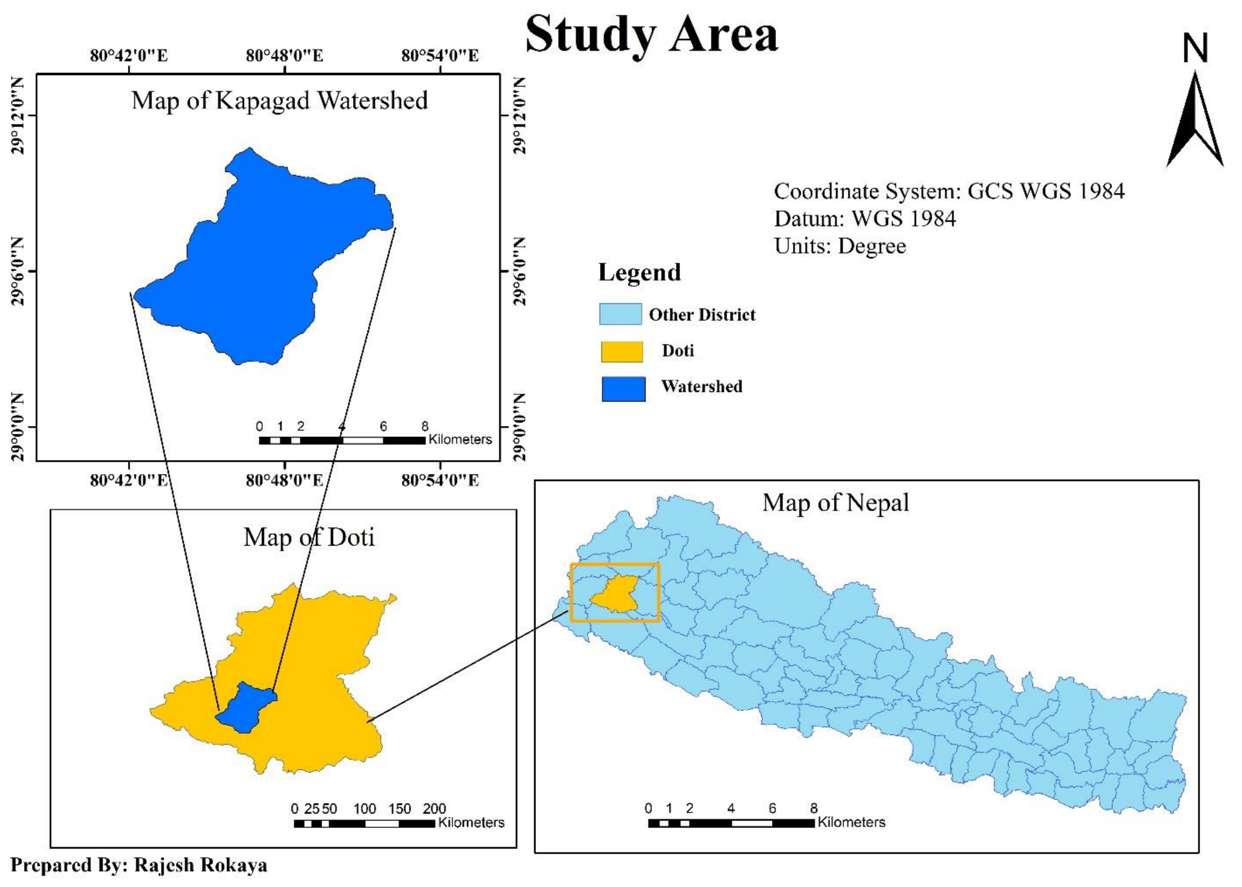


Figure 1: Study Area map of kapagaad watershed

### 3.2 Material Used

#### 3.2.1 Data Used

Mainly we have two type of data vector and raster. The most common raster file types include JPG, GIF, PNG, TIF, BMP, and PSD. The most common vector file types are AI, CDR, and SVG. Both rasters and vectors can be rendered in EPS and PDF format. The data type found for our project is given below in the table.

Table 1: Data Type used

| S.N | Parameter Used | Data Type |
|---|---|---|
| 1 | DEM data | Raster(tif file) |
| 2 | LULC | Raster |
| 3 | Network of Road | Vector |
| 4 | Network of River | Vector |
| 5 | Soil Texture | Vector |

#### 3.2.2 Software Used

For Gis-based research, the software utilized in this study is Esri ArcGIS 10.7.1. An excel sheet is used to determine the weightage for each criterion on a pairwise comparison basis. It is one of the simple and easy method.

**Block Diagram:**

Creating a visual block diagram using text can be challenging, but I'll attempt to provide a simplified textual representation. Each box corresponds to a major step or process within the ArcGIS Model Builder workflow. The diagram is shown below:

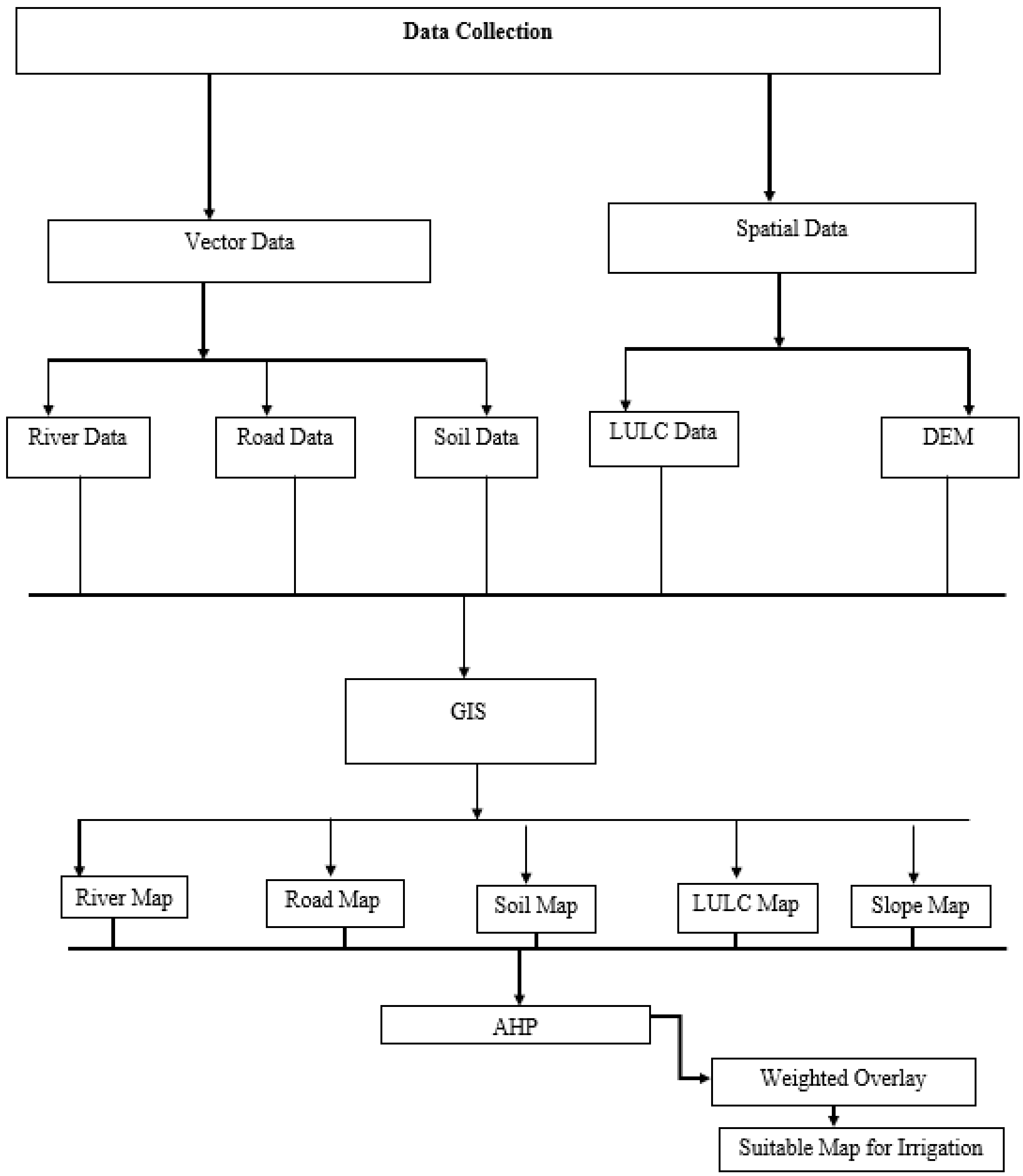


Figure 2: Conceptual framework of land suitability for surface irrigation map

### 3.3 Flow Work

Analyzing and visualizing the gathered data involves following the below mentioned flow chart. Developing an effective integrated irrigation watershed is a challenging and time-consuming task.

The reclassified data is subsequently employed in weighted overlay through the utilization of the Model Builder tool within ArcGIS. Model Builder is a visual programming language for building geoprocessing workflows. Geoprocessing models automate and document your spatial analysis and data management processes. You create and modify geoprocessing models in Model Builder, where a model is represented as a diagram that chains together sequences of processes and geoprocessing tools. This flow provides a general outline, and the specifics will depend on the complexity of your project and the datasets involved. Ensure that you customize each step based on the requirements of your study area and the available data.

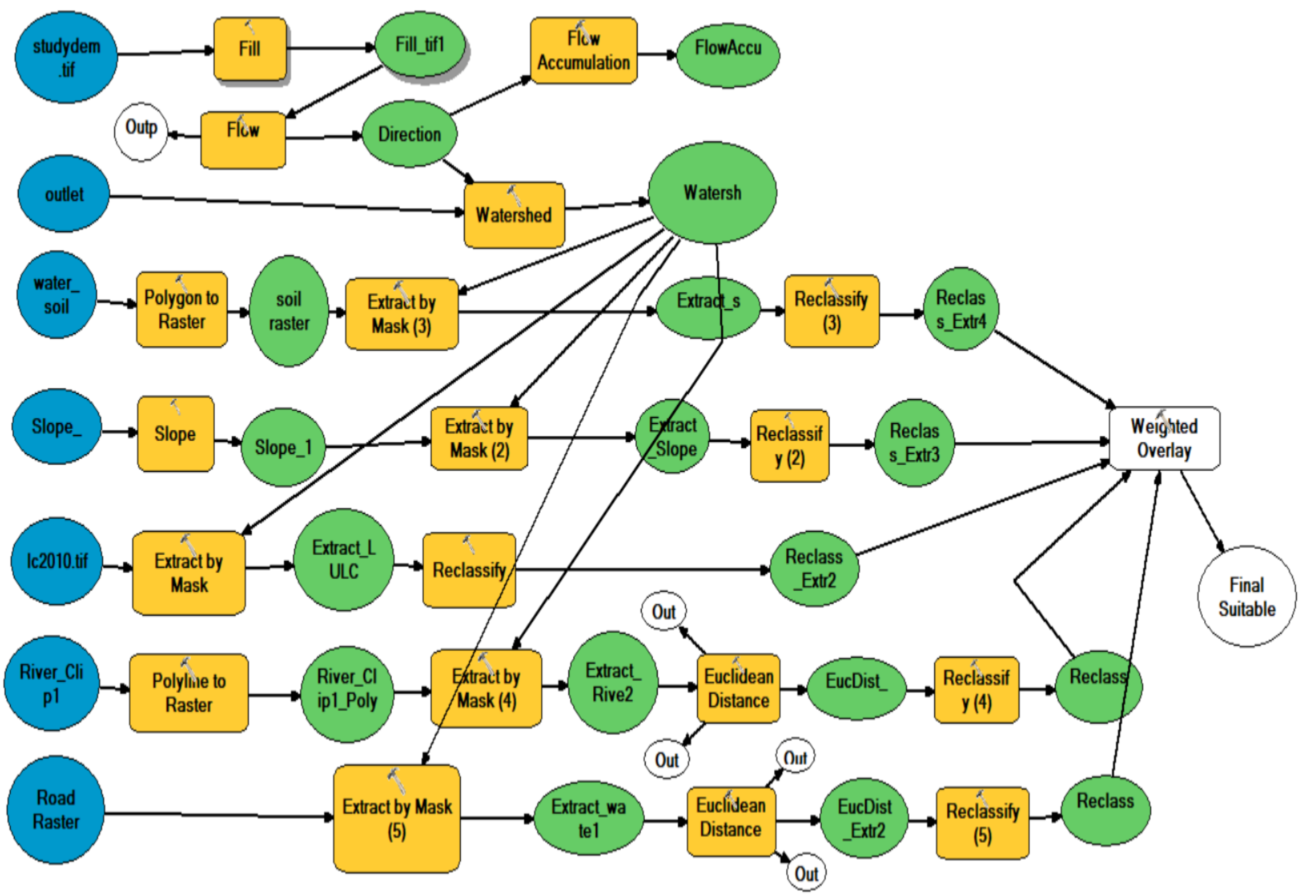


Figure 3 : Model Builder Prototype

## 3.4 Data preparation

The first step involved establishing the criteria for identifying potential irrigation land surfaces. This was accomplished by examining previous research on surface irrigation suitability mapping selection criteria. The criteria encompassed factors such as slope, land use, water bodies, roads, soil texture, and the specific data layers needed for analysis. To ensure consistency, the data was transformed into the same projection system and then limited to a defined area of interest, namely Doti district with kapagaad watershed. To streamline the data, irrelevant attributes were eliminated.

## 3.5 Data Visualization

For visualization each of the parameter were Prepared Euclidean distance, slope rise percentage, land use, and reclassify map.

## 3.6 Data Analysis

### 3.6.1 Criteria Allocation

Firstly, the evaluation criteria for selecting a surface irrigation in doti district were determined. Only five parameters is taken into account for this study namely, slope, roads, land use, soli texture, and river. 4 Class intervals is created where 4 represent the most suitable area, 3 represents the more suitable area, 2 represent marginally suitable and 1 represent not suitable on a map for irrigation. Rating were performed on Road, Settlement, River, Slope and Land Use data. The following things were assumed while taking these factors into account:

Table 2 : Criteria Allocation

| **S.N** | **Suitability score (ranks)** | **Suitability** |
|---|---|---|
| 1 | 4 | Most Suitable |
| 2 | 3 | More suitable |
| 3 | 2 | Marginally suitable |
| 4 | 1 | Not Suitable |

#### 3.6.1.1 Slope Gradient

Slope is the incline or gradient of a surface and is commonly expressed in percent. Slope is important for soil formation and management because of its influence on runoff, drainage, erosion and choice of crops. The slope gradient of the land has great influence on the length of the irrigation run, crop adaptability, erosion control practices and irrigation method. With surface irrigation, the following adverse effects occurs as the gradient increases: erosion hazards increases, water control becomes more difficult, the practical length of irrigation runs decreases, and crop selection becomes more limited. Slope is the key factors for determining irrigation method. This factor intensify as the gradient increases. Steep gradient usually result in lower productivity and higher costs of production. According to FAO standards guidelines for the elevation of slope gradient, slopes, which are less than 2% are most suitable for surface irrigation but slopes, which are greater than 8% are not recommend (FAO, 1999).

#### 3.6.1.2 Soil Type

There are only two types of soil observed in kapagaad watershed those are (Bd34-2bc and Bd 29-3c) dystric Cambisols.The soil type were categorized based on the soli classification and characterization guide for Agricultural Suitability by FAO (Sheng 1990). Similarly we covert the soil type map to raster by using the conversion tool and than reclassify it to know The most part this watershed is covered by Bd 29-3c The criteria weighted of soil in suitable irrigation map is about 14%. Here we found the marginally suitable soil for the irrigation.

#### 3.6.1.3 Distance to The Road and River

In addition to the above factor availability of water near to our study area to minimize cost for canal construction as well as loss of water and the road that helps for market accessibility are the factors that we consider to map suitable to map suitable land for surface irrigation potential. Influence of distance parameters on agricultural land suitability, were estimated by dividing in to almost equal distances, for road 3m and for river 1.5m. The suitability map of spatial proximities to water sources and road were computed using GIS layers, unit on the map is meter. For our overall suitability map the road criteria weighted is 29% and the river is 6%.

#### 3.6.1.4 Land Use Land Cover

Land use land cover is also another factor, which is used to evaluate the land for irrigation suitability. Irrigation can significantly impact land use and land cover. The establishment of irrigation watershed often requires clearing vegetation and altering the natural landscape. The land use area and percentage, for cultivation, forest, Grassland, river/streams and shurb forest was 67 $km^2$ and 19%, 260$km^2$ and 78%, 0.33$km^2$ and <1%, 1.6$km^2$ and 1%and 5$km^2$ and 2% respectively.

### 3.6.2 Rating Model

Each criteria is classified with the purpose of converting all the common attribute to a single scale. For the vector data model of road and river euclidean distance tool is used to calcuate the distance of road and river criteria within the watershed. However slope was classified on the basis of percentage rise, Landuse data and soil data is classified according to the respective class.

#### 3.6.2.1 Slope Criteria Allocation

In this study, we customized and reclassified each raster criteria layer into four categories with associated suitability score of 1–4 (4 = most suitable; 3 = more suitable; 2 = marginally suitable; and 1 = unsuitable). The 'unsuitable' category represents the 'permanently unsuitable' category of FAO. Similar to what is defined as 'currently unsuitable' in the FAO method. Weights for each of the selected criterion were calculated using AHP technique.

Table 3: Slope class for surface irrigation suitability

| Slope Class (%) | Suitability Score |
|---|---|
| 0-2 | 4 |
| 2-5 | 3 |
| 5-8 | 2 |
| >8 | 1 |

#### 3.6.2.2 Road Criteria Allocation

Road is classified with the equal interval of 3km. According to the analysis, the distance within 3km of irrigation is considered most suitable and the distance more than 10 km is considered as unsuitable area for the irrigation.

Table 4: Distance to road influences irrigation land suitability

| **Distance (km)** | **Suitability Score** |
|---|---|
| 0-3 | 4 |
| 3-6 | 3 |
| 6-10 | 2 |
| >10 | 1 |

#### 3.6.2.3 River Criteria Allocation

River is classified with the equal interval of 1.5km. According to the analysis, the distance within 1.5km of irrigation is considered most suitable and the distance more than 5 km is considered as unsuitable area for the irrigation.

Table 5: Distance to river influences irrigation land suitability

| **Distance (km)** | **Suitability Score** |
|---|---|
| 0-1.5 | 4 |
| 1.5-3 | 3 |
| 3-4.5 | 2 |
| >4.5 | 1 |

#### 3.6.2.4 Land use Land cover Criteria Allocation

During the consideration of land use data: Cultivation, forest, grassland, river/streams and shurb forest were taken. Farm village, Intensively cultivated land, Moderately cultivated is most suitable for irrigation. Each data are categorized based on the suitability and unsuitability.

Table 6: Framework of land suitability classification

| Category | Suitability score |
|---|---|
| Farm village/Cultivated | 4 |
| Marginally Cultivated | 3 |
| One grass land/seasonal wet | 2 |
| Dense natural Forest | 1 |

#### 3.6.2.5 Soil Texture Criteria Allocation

Haplic Nitosols, Haplic luvisols, Euntric vertisols are the most suitable soil type for irrigation and haplic Alisols, Euntric regosols is more suitable. The criteria allocation is given below:

Table 7: Soil type characteristics and suitability for irrigation

| Soil Property | Suitability score |
|---|---|
| Loamy soils | 4 |
| haplic Alisols, Euntric regosols | 3 |
| dystric Cambisols ( Bd 29-3c) | 2 |
| dystric Cambisols (Bd34-2bc) | 1 |

### 3.7 Calculation of Weight for Criteria Maps

The analytic hierarchy process (AHP) is used to calculate weights for the criteria maps. It is a structured method for analyzing complex decisions by breaking them into pairwise alternatives of two at a time (Saaty 1988, 2008). An AHP plugin tool for the ArcGIS environment (Marinoni 2009) was used to compute weights for the different criteria layers. Using the pair-wise comparison matrix, the analytic hierarchy process calculates comparative weights for individual criterion layers. It also produces consistency ratio (CR) that serves as a measure of logical inconsistency of expert/user judgments during pairwise criteria comparisons, measured using equation $CR = CI/$

$RI$ Where, CI represents consistency index, and RI represents random index. According to Saaty (1988), if the CR value is much in excess of 0.1, the judgments during pairwise comparison are untrustworthy because they are too close for randomness. A scale from 1 to 9, with 1 indicating that both column and row elements are equally essential.

Table 8: The fundamental scale for pair-wise comparison matrix (Saaty 1988)

| **Scale** | **Degree of Preference** |
|---|---|
| 1 | Equal Importance |
| 3 | Somewhat more important |
| 5 | Much more important |
| 7 | Very much important |
| 9 | Absolutely important |
| 2,4,6 | Values for inverse comparison |

Table 9: The pairwise comparison for irrigation suitability factors

| Criteria | **Soil** | **LULC** | **River** | **Road** | **Slope** |
|---|---|---|---|---|---|
| **Soil** | 1 | 4 | 1/3 | 4 | 1/5 |
| **LULC** | 1/4 | 1 | 1/5 | 1/2 | 1/7 |
| **River** | 3 | 5 | 1 | 6 | 1/2 |
| **Road** | 1/4 | 2 | 1/6 | 1 | 1/7 |
| **Slope** | 5 | 7 | 2 | 7 | 1 |

After normalizing pairwise comparison matrix for multi-criteria decision. Than output is generating by using AHP. The output is shown below:

Table 10: Pairwise comparison matrix output generated by AHP

| Criteria | Soil | LULC | River | Road | Slope | Weight (%) | CI | RI | CR |
|---|---|---|---|---|---|---|---|---|---|
| **Soil** | 1 | 4 | 0.333 | 4 | 0.2 | 14 | 0.589 | 1.12 | 0.0526 |
| **LULC** | 0.25 | 1 | 0.2 | 0.5 | 0.1428 | 5 | 0.589 | 1.12 | 0.0526 |
| **River** | 3 | 5 | 1 | 6 | 0.5 | 29 | 0.589 | 1.12 | 0.0526 |
| **Road** | 0.25 | 2 | 0.1667 | 1 | 0.1428 | 6 | 0.589 | 1.12 | 0.0526 |
| **Slope** | 5 | 7 | 2 | 7 | 1 | 46 | 0.589 | 1.12 | 0.0526 |
| CR | | | | | | | | | 0.052619 |

After the calculation the above Priority table was obtained which shows that the slope is given the highest priority, whereas the LULC factor is given the lowest priority.

# 4. RESULTS AND DISCUSSION

## 4.1 Criteria Of Map

The elevation of topography is low-gradient is most suitable for surface irrigation, normally gental slope having less than 5% is suitable. Loamy soils are often preferred for surface irrigation and high infiltration rates are favorable for efficient water distribution.

Proximity to water sources such as rivers or reservoirs with in a 1500 m and Availability of transportation for equipment and resources within a 3000 m. Presence of vegetation for erosion control and areas designated for agriculture are primary candidates are in land use land cover.

Area coverages of criteria on the basis of their score or ranks is calculated in percentage is shown given below:

Table 11: Area coverages of difference Criteria

| **Parameter** | **Score (4) Most Suitable** | **Score (3) More Suitable** | **Score (2) Marginally Suitable** | **Score (1) Unsuitable** |
|---|---|---|---|---|
| **Distance from Road** | 62% | 25% | 8% | 6% |
| **Distance from River** | 36% | 31% | 22% | 11% |
| **Soil Texture** | - | - | 64% | 36% |
| **LULC** | 0.7% | 0.9% | 7% | 91% |
| **Slope** | 99% | 0.5% | 0.3% | 0.2% |

The reclassify map of the individual criteria is given below:

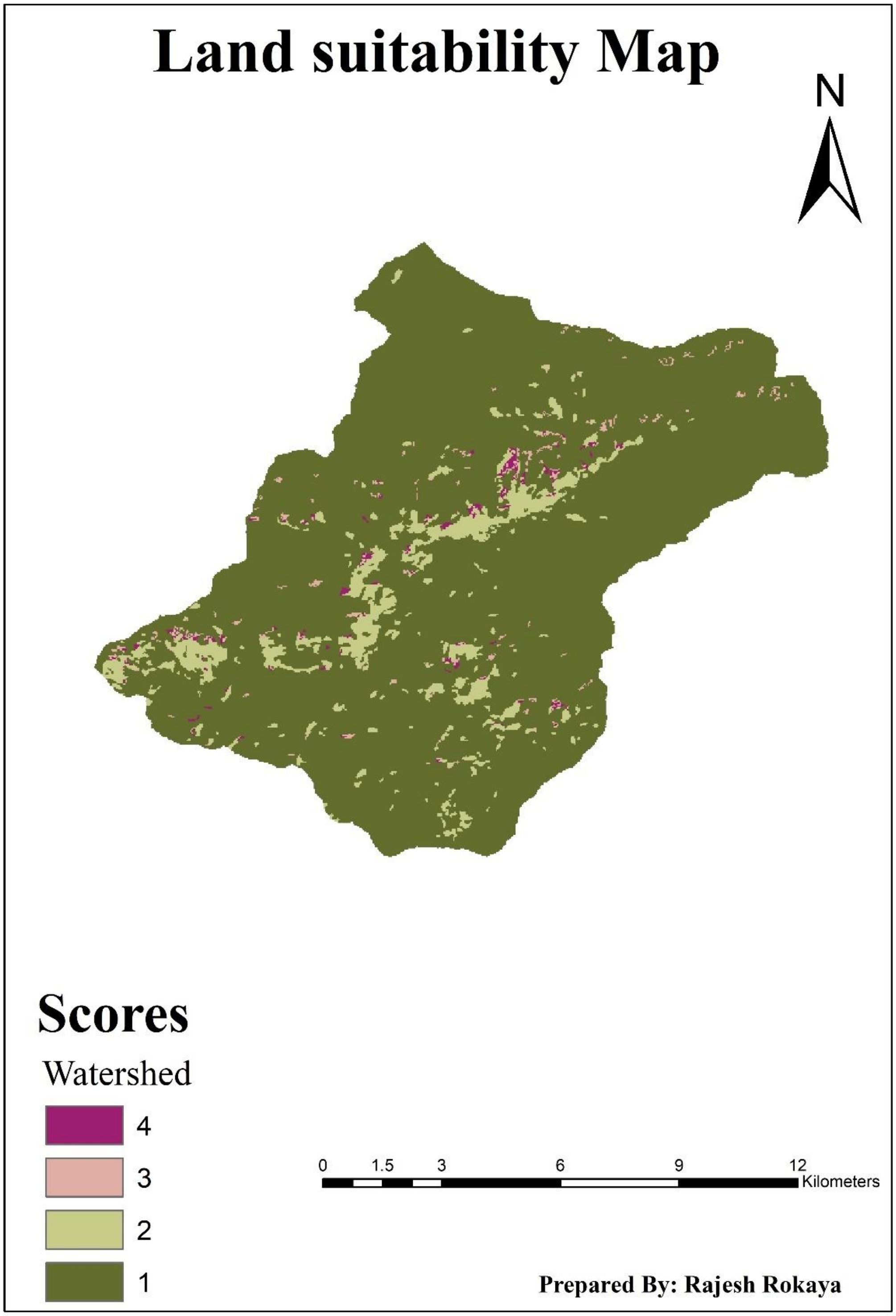


Figure 4: Land use land cover map of kapagad watershed

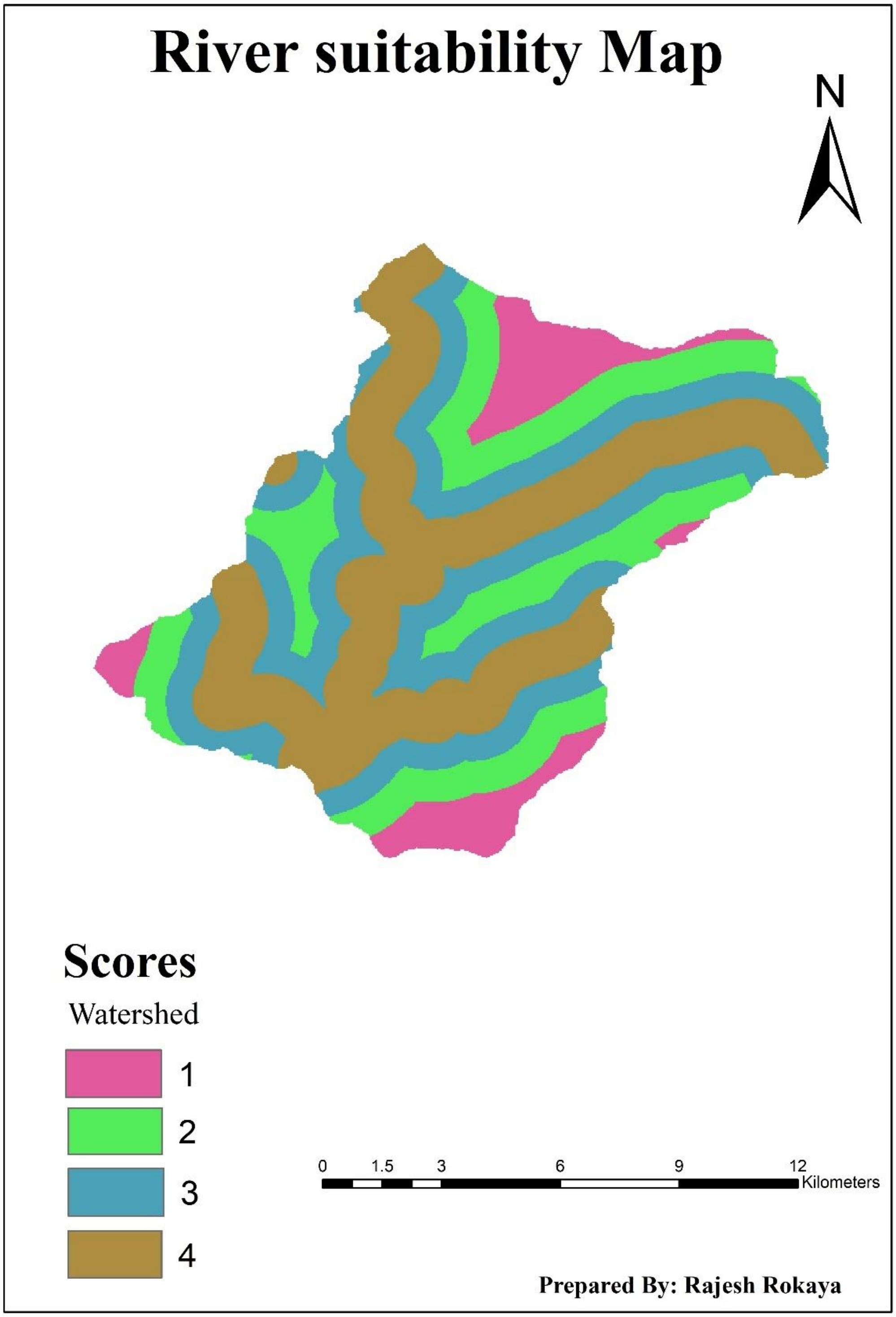


Figure 5: River Suitability map of kapagad watershed

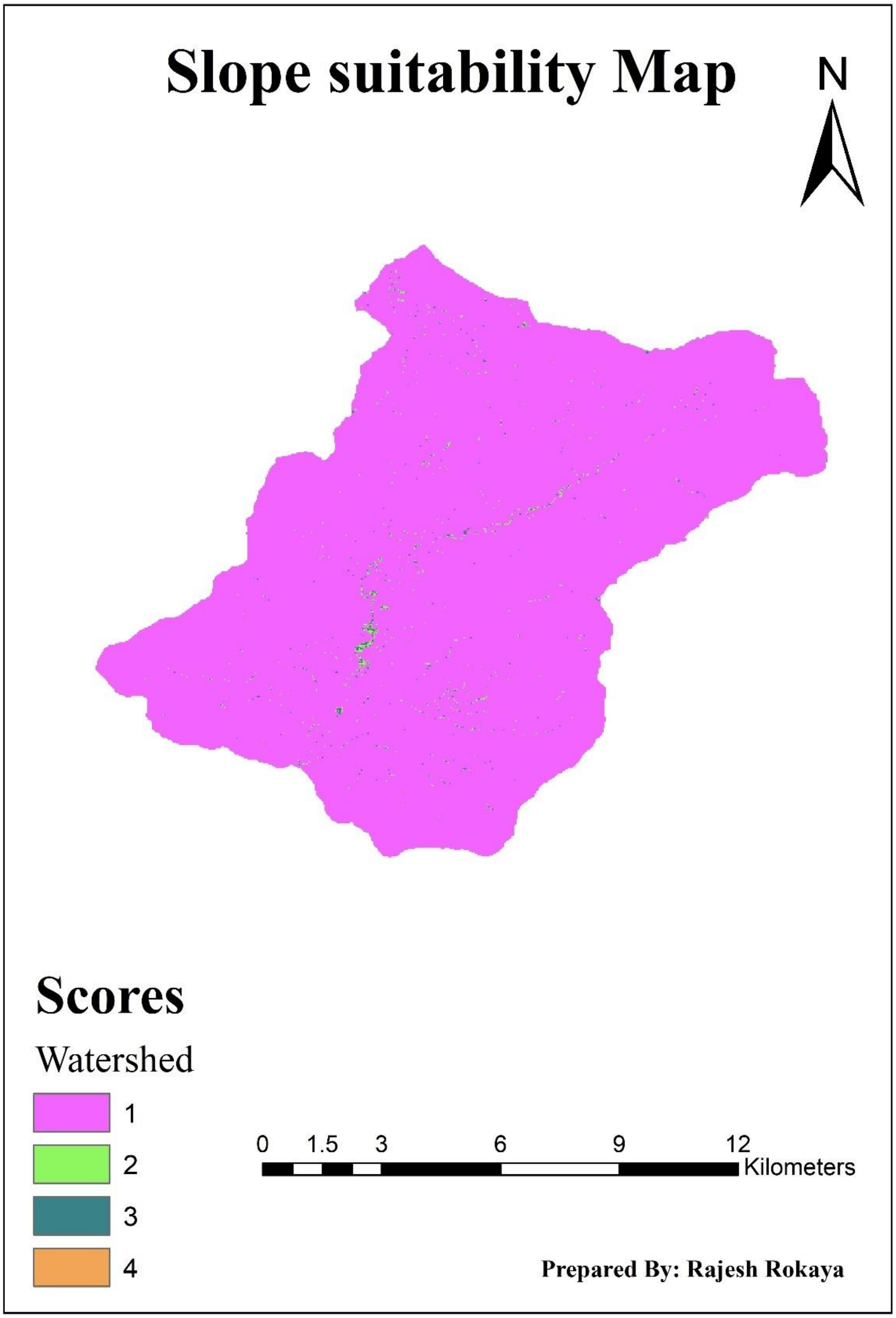


Figure 6: Slope map of kapagad watershed

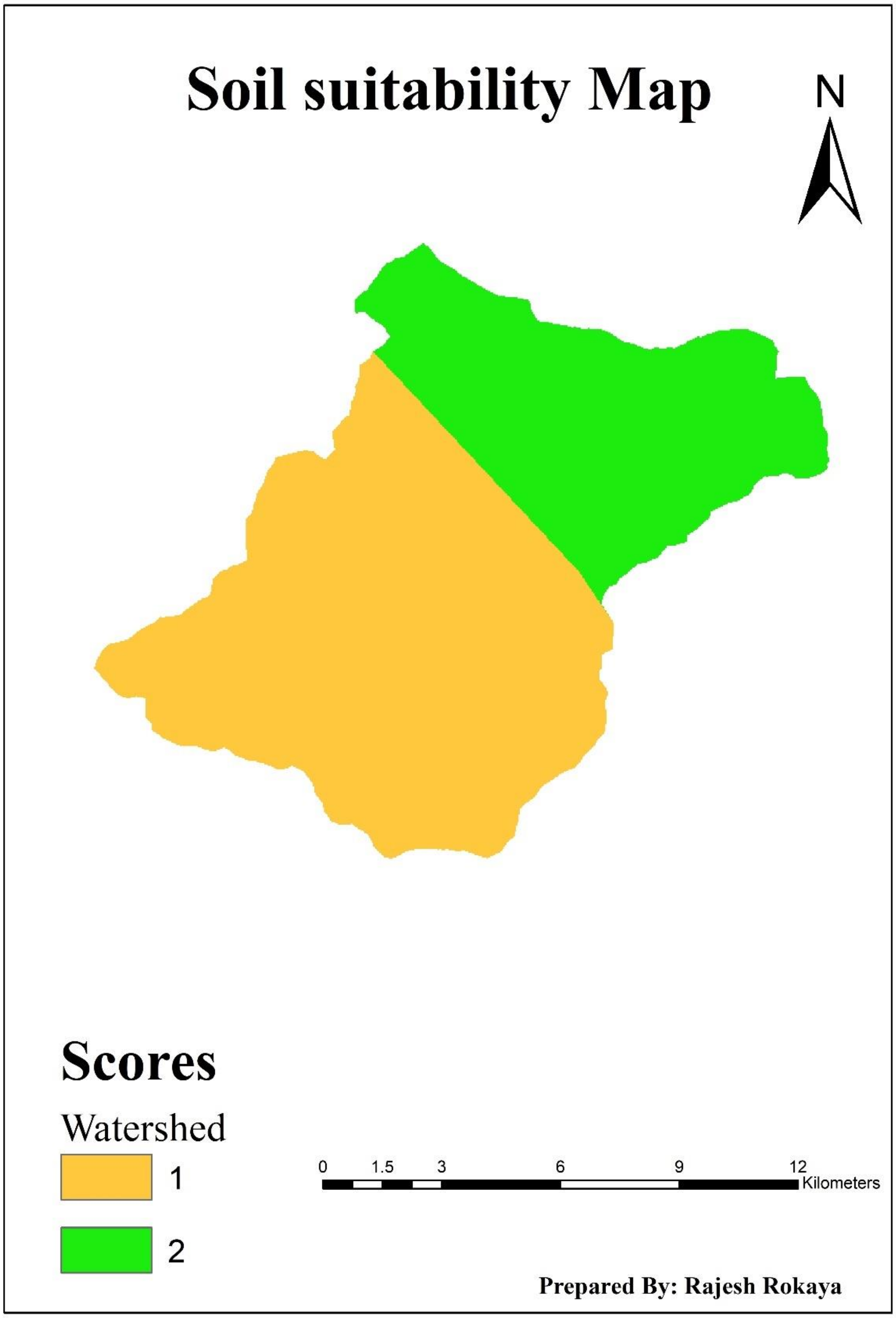


Figure 7: Soil type map of kapagad watershed

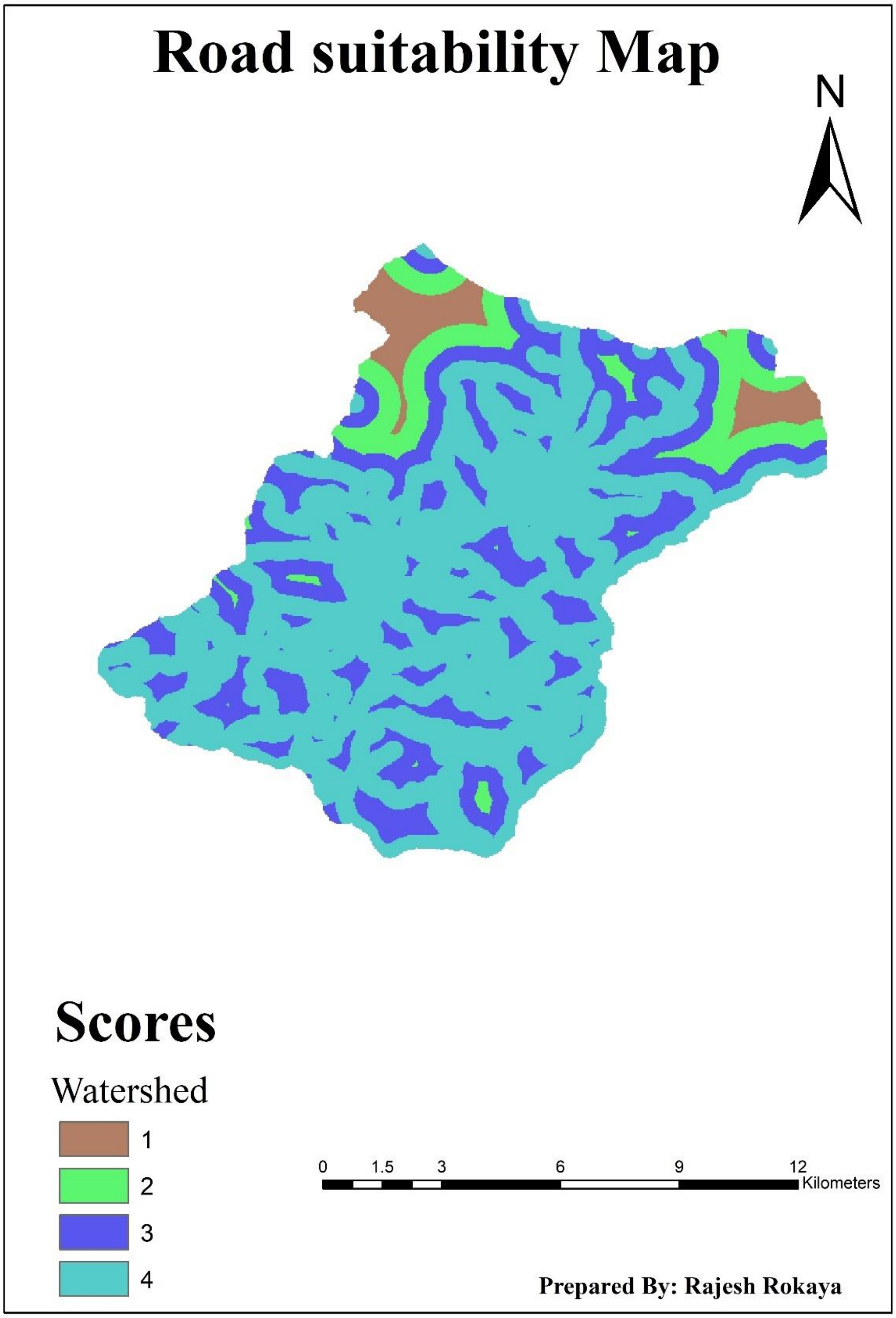


Figure 8: Road Suitability map of kapagad watershed

## 4.2 Final Suitability Map

All five criteria is combined using weighted overlay tool to find the final output that shows the overall maps considering all the conditions. The results shows around 0.01 $km^2$ area is most suitable for selecting of irrigation. And 93 $km^2$ area is unsuitable for this as shown in below.

Table 12: Area coverages for Irrigation in kapagad watershed

| Factors / scores | Area Coverages (%) | Area Coverages ($km^2$) |
|---|---|---|
| Most Suitable/4 | 0.003 | 0.01 |
| More suitable/3 | 0.6 | 2 |
| Marginally Suitable/2 | 75.50 | 301 |
| Unsuitable/1 | 23.90 | 93 |

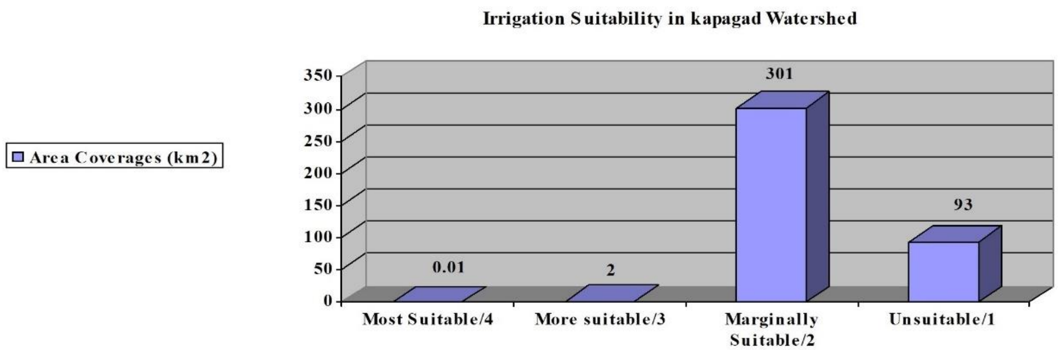


Figure 9: Bar Chart Showing Area Coverage For surface irrigation

The final output overlay map of surface irrigation suitability is given below and about 75 % of overall area is covered by the marginally suitable as shown in figure below.

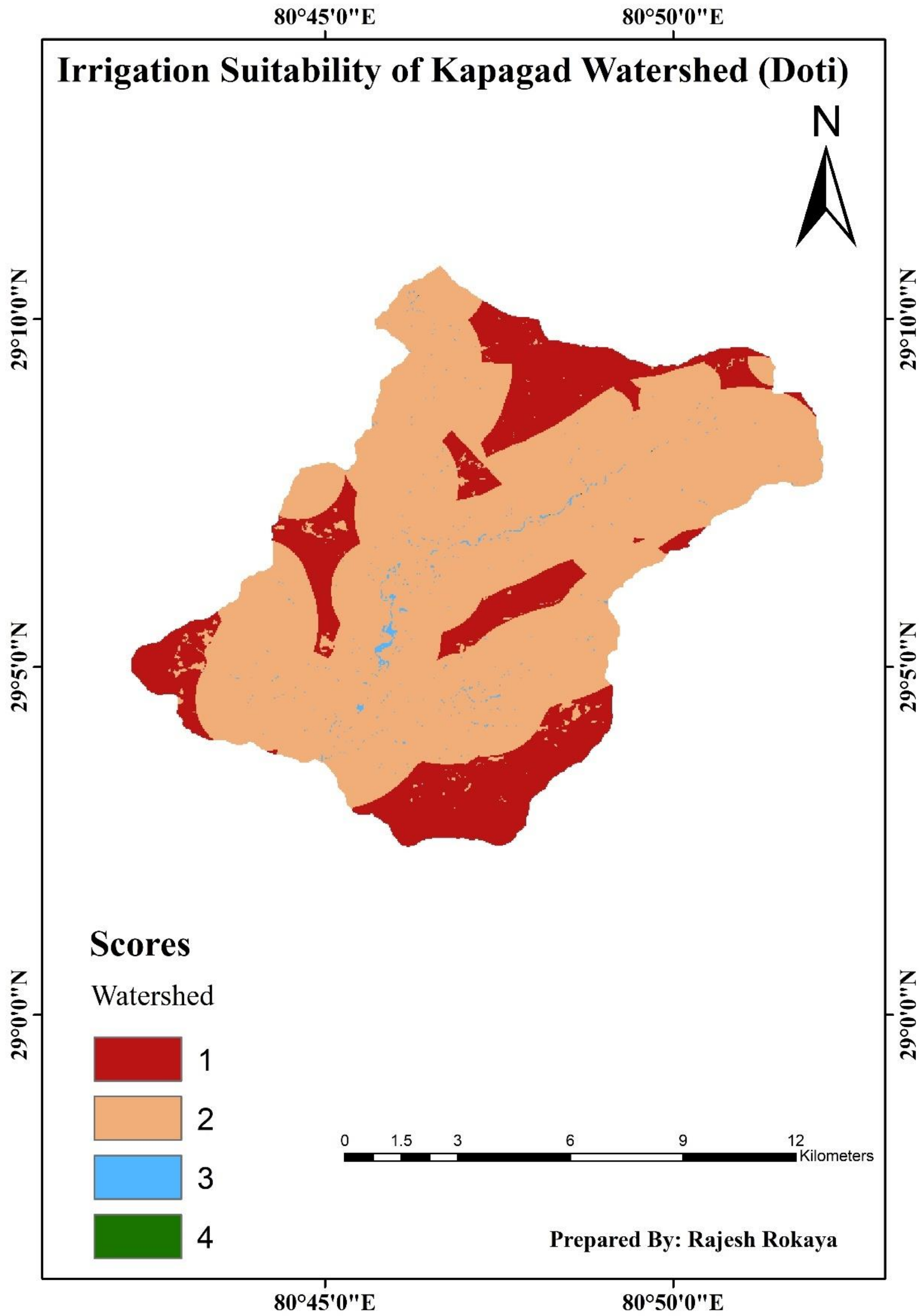


Figure 10: Surface irrigation suitability map of Kapagad watershed

# 5. CONCLUSION

In conclusion, the development of a surface irrigation suitability map using ArcGIS and the Analytical Hierarchy Process (AHP) presents a comprehensive and systematic approach to inform decision-making in agricultural water management. By integrating spatial analysis tools within the ArcGIS platform and manipulate the AHP methodology, this study aimed to address the complex and dynamic nature of surface irrigation suitability assessment. In this study we evaluated surface irrigation suitability in kapagad watershed using weighted overlay analysis in arc GIS environment and analytical hierarchy process (AHP). Five factors like slope, LULC, soil type, and proximity to rivers and roads are considered to prepare irrigation suitability map of kapagad watershed. From the suitability map of kapagad watershed 0.003% is most suitable, 0.6% more suitable, 75.50% marginally suitable and the remaining 23.90% is under unsuitable class from the total area. Future irrigation potential should take into account that runoff river system can only be expanded to a limited degree and that future expansion should involve building of reservoirs or sustainable use of ground water if available.

# 5. REFERANCES

[1.1] *Abyssinia Journal of Science and Technology* Vol. 7, No. 2, 2022, 11-25.

[1.2] Awulachew S.B, Teklu Erkossa and Regassa E, 2010. *Irrigation potential in Ethiopia Constraints and opportunities for enhancing the system*. Namara, editers IWMI (International Water Management Institute).

[1.3] Zolekar RB, Bhagat VS (2015). *Multi-criteria land suitability analysis for agriculture in hilly zone: remote sensing and GIS approach*. Compute Electron Agric 118:300–321.

[1.4] Worqlul, A. A., Jaehak,J., Yihun, T., D., Javier, O., Petra, S., Thomas, G., Srinivasan, R., & Neville, C. (2017). Assessing potential land suitable for surface irrigation using groundwater in Ethiopia. *Journal of applied geography*, 85(1), 1-13.

[1.5] Victor, O. K., & Samson, A. O. (2019). An Application of GIS-Based Multi-Criteria Decision Making Approach for Land Evaluation and Suitability Mapping for Rice Cultivation in OyeEkiti, Nigeria. *Journal of Agriculture and Environmental Sciences*, 8(1), 0–9.

[1.6] https://www.youtube.com/watch?v=nfa8Q8xTRMI

[1.7] https://www.youtube.com/watch?v=Y6JuAZ4S0Jo

[1.8] *https://www.youtube.com/watch?v=XoUY2m2hD8U*