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ASSESSMENT OF AVAILABLE LAND RESOURCE FOR SURFACE IRRIGATION DEVELOPMENT FOR EYANDA RIVER BASIN, GIDOLE SOUTHERN ETHIOPIA

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ABSTRACT

Land and water resources assessment for irrigation wasimportant for decision makers and planner for sustainable natural resources. This research was to assess availability of irrigation inEyanda river watershed. Based on multi criteria evaluation method on suitable land for surface irrigation was evaluated based on soil physical properties, land cover type and slope. Watershed delineation was first completed, then suitable parameter for evaluating surface irrigation potential was characterized finally water potential assessment was done. After that each parameters for suitability assessment was reclassified and mapped according to suitability classification for determination irrigation development to reduce poverty. Then all parameters are overlaid and show that 71.4 % of the total lands were found between highly to slightly suitable for agriculture, whereas 28.6 % was unsuitable class due to slope, type of land cover in and soil physical properties soil suitability inEyanda watershed. The performance efficiency indicators were evaluated and the result was 0.84 for R^2, RVE which was -8 and NSE was 0.5 for calibration and R2 was 0.76, NSE value was 0.87 and RVE value was -9 % for model validation of stream flow analysis and it shows that the parameter falls within the acceptable range. Crop water requirement was evaluated for sorghum, maize and pepper and Available water was calculated at 85 % consistent discharge abstracted from the ArcSWAT. The outcome designates that designates that water available in river was more than amount of water needed by crop.

KEYWORDS: *Irrigation Potential, Water Management, Watershed, Suitability Factors, Arcgis, Arcswat2012, Land Resource, Water Availability*

Article History

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INTRODUCTION

Mainly, for particulardeveloping and least industrializednations irrigation expansion and use is a pillar to the degree that it is accountable for the countries'good and nourishing the vast majority of their population. According to International Fund for Agricultural Development [20] only 20 % of the world's total croplands are irrigated.

Ethiopia location was at 3°3' and 14°50'N latitude and 32°42' and 48°12' E longitude and was second populated country in "horn of Africa". More than 85 % of the population was rained agricultural dependent and located in rural areas. 80 % of occupation effort force and 50 % of GDP was from agriculture. It covers an area of 1.127 million square kilo meter out of that 1.119683 million square kilo meters was land surface and 7444 kilo meter square was water body. In Ethiopia farming was based on rain fall which affects incomes and farming system due to hydrology and climate changeability that are revealed as droughts, floods and dry spells [1].

Using irrigation for farming system was crucial for reduction of poverty and development of justifiable irrigation system [14].It has been recognized as akey apparatus towards encouraging profitability and community in ruralarea and measured as a root of national safety and eradicating the deficiency of food in developing countries [26]. According to Hagos et al 2009 the role of irrigation to the Ethiopian economyand gross margin from irrigation is 219.7 % that washigher than the gross margin from rain fed agriculture.Therefore, irrigation development supplies additionalirrigation water to agriculture areas, so irrigation users can obtain more incomes than that of users without irrigation [26].Ethiopia has enough amounts of land resources that was potentially irrigable and also have surplus water available for surface irrigation development, but, only 4 to 5 % out of 3.35 million hectare of land was under irrigation and the rest of land potentially irrigable land which does not under irrigation which needs irrigation development [40]. Irrigation enlargement also playing a great role in familiarizing to weather change for achieving food safety and improving household incomes. But, due to technical, financial, management and other problems the country hasn't utilized its potential very well up to today. However, there has been concern regarding the improvement of irrigation expansion and management of existing irrigation schemes but the result is not much satisfactory[26]. So assessing irrigation potential development was very essential and necessary to utilize thus uncultivated land resource and available of water in different parts of the country.

In generally assessing suitability of surface irrigation was also significant for provision and decision makers to make sustainable use of natural resource (Berhe et al., 2013, Mandal et al., 2018). This irrigation potential assessment was based on land use type, slope water availability and soil type by weight overlay principle on ArcGIS (Negash 2004, Y. Chen, J. Yu, and S. Khan 2010). In Ethiopia suitable land resource utilization and management for agricultural system has been reliant on rain fed agriculture and doesn't yet fully beneficiary for the community. The country has adequate water resource and land potential for irrigation development but, it was little developed and need more assessment throughout the country to find suitable areas that does not assessed before**.** Assessing land resource and available water was very essential in order to relate land resource with the available waterresource potential at river basin level [26]. But, information based on land resource related to water availability for Irrigation development was not well known for different river basins. So, there was deficiency of updated evidence on existing resources potential, systematic potential assessment, and matching of the available water resources potential. Therefore, research does not be conducted at Eyanda watershed related to possible land for irrigation system and this study assesses irrigation possible in Eyanda River basin. So, the aim of the research was to assess possibility of irrigation by ArcGIS at Eyanda watershed to increase socioeconomic development through the reasonable use of natural resource and benefits from the river water and land resource development that was miss used before. The Specific objectives were: (1) to identify suitable land for surface irrigation in terms of soil, slope, land cover type and drainage density (2) to assess irrigation water demand or supply for dominant crop and 3). To provide maps based on the suitability parameters for the analyzed irrigable lands.

METHODS AND MATERIAL OF THE STUDY AREA

Location and Explanation of the Eyanda Watershed

Eyanda River was located in southern nation's nationality peoples and representative of Ethiopia in Derashewored at about 56km from Arba Minch. The river catchment was located Eyanda River basin. It was located within 37^{o}23'66''East and 5^{o}33'58.73''Nourth. it covers total area of 111.75749 killo meter squire in which drainage water was collected from it. The area has an annual rainfall ranging from 601 up to 1600mm/year which is found in bimodal climatic zone. Temperature ranges from 15.1 up to 27.5^{o}c [1].

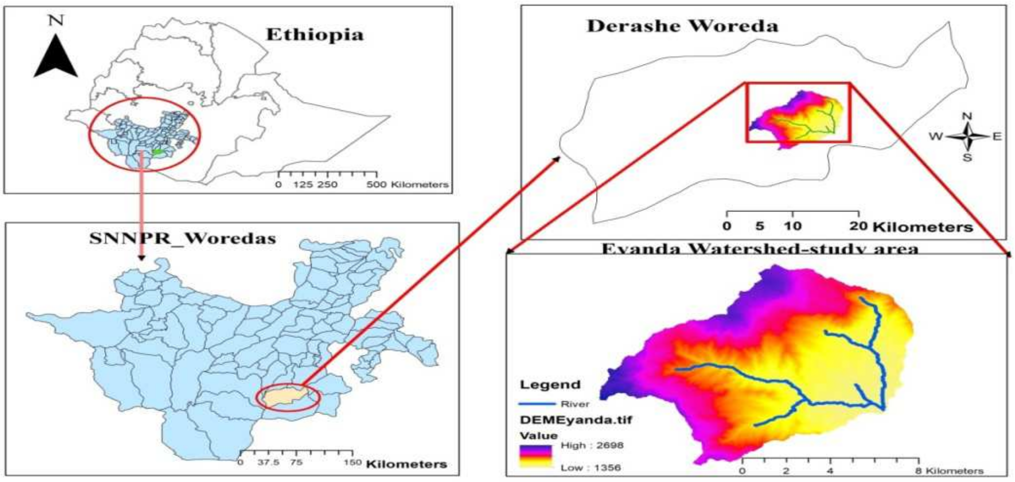

Figure 1: Map of Study Area.

Flow Discharge

A gauging site is situated approximately at the end part of the watershed below diversion head work at Gattokebele from which daily stream flow was collected from. For the year 2001 up to 2014. The collected data was cheeked its goodness, outliers and missing for recorded data. The gauging point of the watershed is included below which was manually added outlet.

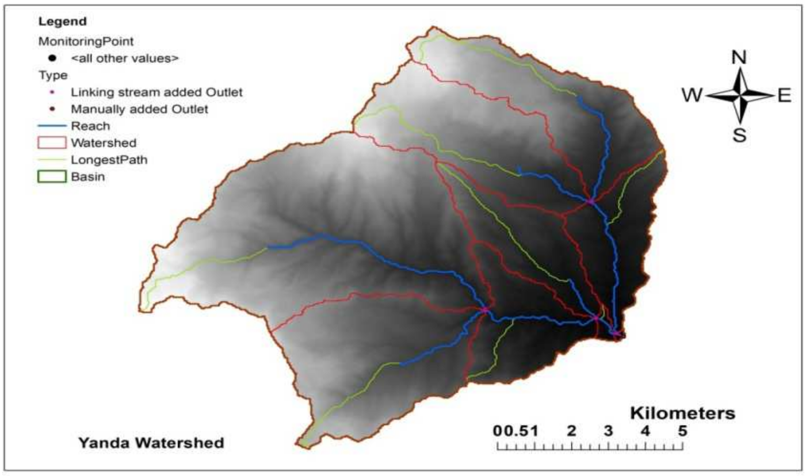

Figure 2: Location of Gauging Station.

Material and Methods

Assessing the study area, by gathering available data's from different ministers and organization related water resource and farming system, Natural Resource, Irrigation and Electricity and Ethiopian National Meteorological Agencies. After gathering, thenecessary data for the research and then filling of missed data and quality checking havebeen done carefully. An Arc SWAT model for assessing surface water potential at theoutlet of the watershed and GIS software for determining resource fitness for irrigation by considering soil physical properties, slope and land cover were implemented.Method of the research has been summarized below the following conceptual framework Figure 3.

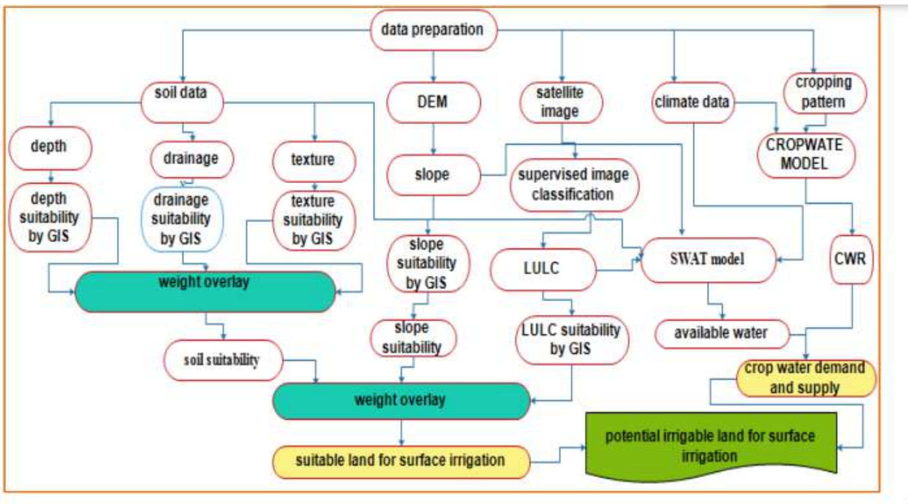

Figure 3: Frame Works for Surface Irrigation Potential Assessments.

Data Collection and Analysis

Different types of data are needed for the modeling framework presented in this research. One of thus data was stream discharge fromGatto River Gauging Station. The series of monthly discharge of the period from 2001 up to 2014 were obtained for stream gage station. The stream gage was located at Gattokebele below diversion weir. The second data needed for this research was weather data which includes precipitation, wind speed, solar radiation, min and max temperature and relative humidity. This weather data was in the form of text format. Two weather stations were found within the watershed downloaded from SWAT weather databases from 2001 up to 2014 and used for run SWAT model to assess surface water availability in the watershed. The third data required for this study was digital elevation model (Palazon L., 2016). 30mx30m spatial resolution of DEM was used for this study. This DEM was downloaded from USGS EarthExplorer (WWW.earthexplorer.usgs.gov) and extracted at watershed level. The fourth data needed for this research was soil data which have also 30x30 spatial resolutions and downloaded from FAO digital soil map of the world (DSMW). Finally the land use land cover data was used for this study. This data was downloaded from European Space Agency GlobCover portal. Cropwat 8.0 was used to calculate crop water requirement of dominant crop. The water requirement was directly related to surrounding climatic condition and crop coefficient.

Method of Data Analysis

By using weighted overlay method using ArcGIS 10.3 software potentially irrigable land which was suitable for surface irrigation was estimated. For this irrigation potential assessment a key factors are considered for developing and accessing suitable land for irrigation potential evaluation. This key factor considered under this study was soil depth, soil texture; slope and cover condition of land and prepared and ready for data examination. Then the prepared data was reclassified according to suitable weighted factor for surface irrigation. After that by using weighted overlay which was found in spatial analysis tool box of ArcGIS the prepared data was analyzed and suitable land for surface irrigation development was calculated. Finally suitable land surface map for irrigation development was created from weighted overlay analysis

Digital Elevation Model (DEM) Data Preparation and Watershed Delineation

The digital elevation model was downloaded from USGS and basically used for delineating the watershed moderately which pronounces the real feature,arrangement, elevation of the natural and artificial physical features of the area. Digital elevation model were extracted from thismosaicked data using Arc GIS 10.3. The DEM were used to delineate the watershed, toextract information about the topography or elevation of research area and calculate drainageoutlines of the area. In addition to this stream network and slopes were also derived by using DEM. The following illustration shows that the x-ices of theEyanda River having 1352 up to 2898 meter amsl.

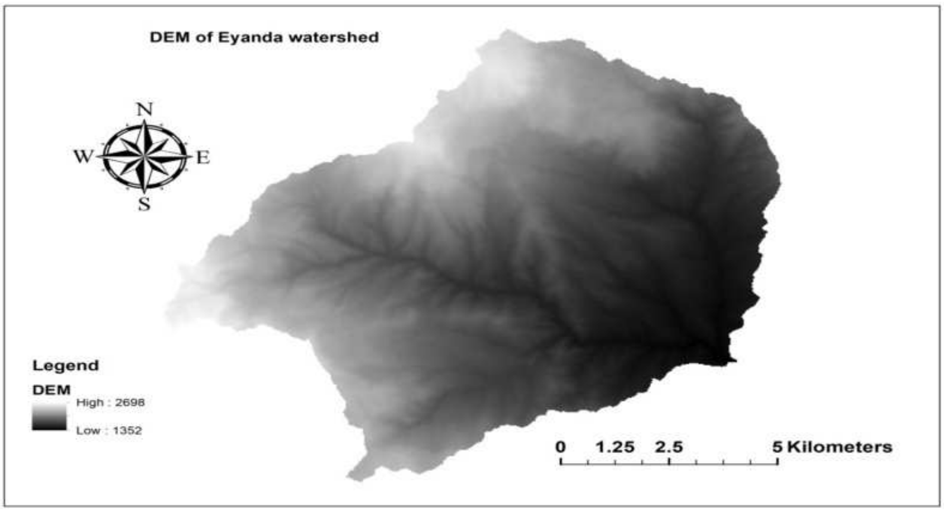

Figure 4: Digital Elevation Model (DEM) Of the EyandaWatershed.

Watershed Delineation

For watershed delineation DEM was the most important data. It was point elevation data which was stored digital computer files having x,y and z coordinate variables. High resolution having 30mx30m was used from the SRTM. From SRTM the gross area was analyzed and exported in digital elevation model format. ArcGIS 10.3 with Arc SWAT2012 interface was used for Wozeka watershed delineation. To delineate watershed of Eyanda River the following steps were used.Firstthe exported DEM of the watershed was projected by using data management tool to project and transform map from geographic coordinat system in to UTM Coordinate system for ArcSWAT.Then flow direction and flow accumulation was formulated by ArcSWAT flow direction and flow accumulation too for individual cells. This ArcSWAT flow direction and flow accumulation tool calculates the flow direction and flow accumulation. After that an outlet point or pour point was set out by ArcSWAT outlet selection tool to fix the bounder of the watershed at which discharge point was concentrated above. Finally by ArcSWAT watershed delineation tool in ArcGIS the main watershed was delineated according to the outlet generated above by automatic process. To compute sub-basin extra outlet was required tand well-defined then creating somenodules and peakswas well-defined in the sub-basin along the stream the same process was followed and watershed delineation for Eyanda watershed was completed.

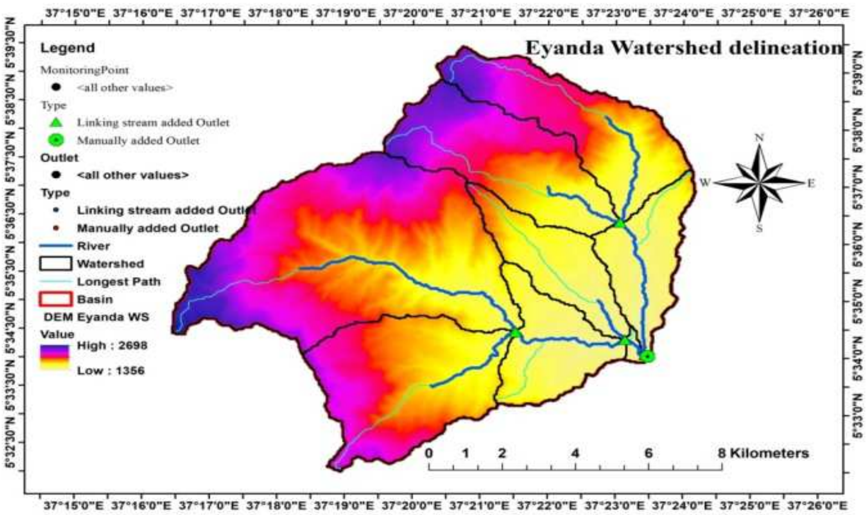

Figure 5: Watershed Delineation of Eyanda River Basin.

Evaluating Suitable Land for Irrigation Development Based on Selected Factors

Physical land factors such as soil physical properties, land cover type and slope class and water resource availability was used to find possiblesites for farm land water supply (Nasir., 2019). Separately all parameters was calculated for farm land water supply based on possibility of the factors and overlaid to find possible site for irrigation.

Calculation of Possible Slope

DEM clipped from SRTM having 30x30m resolution masked to watershed bounder was used to generate slope fitness. By using ArcGIS 10.3 the slope map of the Eyanda watershed was calculated by using Spatial Analysis tool from the masked DEM. Then the slope calculated from DEM was classified according to FAO, 1996 classification system and reclassified by using reclassification tool to generate attribute in ArcGIS. The suitable slope for surface irrigation was grouped into four classes such as S1 which range from 0 to 2 %, S2 was range from 2 to 5 %, S3 which ranges from 5 to 8 % and N which was more than 8 % [7][9]. Then the reclassified slope was converted in to feature data layers by ArcGIS conversation tool. Finally area for each class of the slope was calculated from shape file.

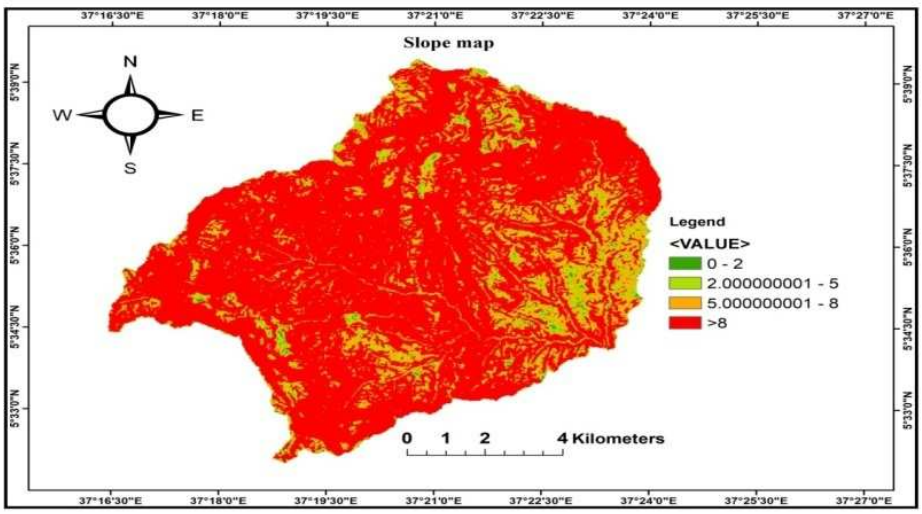

Figure 6: Slope Class of Eyanda Watershed.

Soil Suitability Assessment

The soil map was clipped for the watershed of Eyanda River. There was one soil type named To6-2bc found in the watershed. According to FAO 1997 and FAO 1991 the suitable class of the soil depth was suitable (s1) for surface irrigation is S1>120 cm for clay soil, S2 range between 100 to 120cm for silt clay loam and clay loam and course sand, S3 ranges from 50 to 100cm for silt loam and N was less than 50cm for Corse sand [13]. The soil shape file was converted into raster layer by using ArcGIS conversion tool and reclassified based on soil physical properties which was essential for surface irrigation assessment. The suitability of the soil was analyzed based on weighted overlay of the soil texture, soil depth and drayage class.Then the new value for surface irrigation potential development was created according to common evaluation scale from 1 to 5 from weighted overlay. Then the new result creates for soil suitability was converted into feature class for calculation of suitable area for each class.

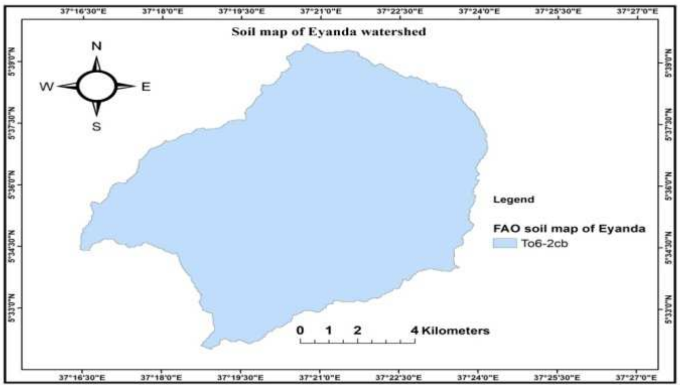

Figure 7: Soil map of Eyanda River Basin.

Finding Land Cover Type Possible for Irrigation

LULC was clipped from the downloaded Globcover map of the world. According to its suitability classes for irrigation potential assessment, land leveling for cultivation and site clearing costs, working efficiency and environmental impacts of irrigation project the land use land cover of the Eyanda watershed was ranked. Based on these suitability classes, LULC map of the watershedwas rasterized and used in the evaluation process to categorize potentially suitable sites forsurface irrigation system. To calculate the area for created land cover map it was converted into feature classes by conversion tool in ArcGIS.

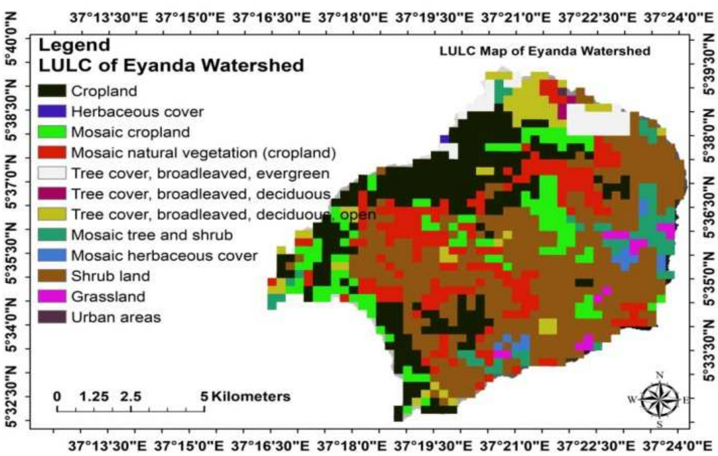

Figure 8: Map for Eyanda River Land Cover Type.

Surface Water Availability Calculation

SWAT was the most important tools used to evaluate flow discharge, sediment yield transport, land management technique, nutrient cycling and other parameter. After watershed delineation LULC and Soil data was prepared for ArcSWAT input data cod was created on text file for LULC and Soil data and slope was generated from DEM used for watershed delineation[36]. Then HRU was created after loading all required data for HRU development. After that from prepared weather data for weather station all input data was loaded in the model. Then edit required data then finally the model was run and Available surface waters of the catchments were evaluated.

Flow Rate Calculation for Un Gauged Area

Investigation of precipitation outcomes, for flow rate from gauged area was needed to find discharge for un gauged area of watershed. Subsequently farm land water supply continuing rivers was used for this research and average discharge rate for many year from gauged area was used to calculate flow rate at un gauged area[15][5][7]. Mean monthly flow rate for un gauged area from measured site having similar watershed x-cs and less than 50km distance between them for at least 10 years average monthly stream flow should be present for gauged area and used for un gauged area by using equation below [15].

$$Qs = \left(\frac{DAs}{DAg}\right) n * Qg \tag{1}$$

Qs is flow rate at which flow rate calculation required in m^3/s

Qg is fflow rate at measured area in m^3/s DAg is area of drainage at measured location in km^2

DAs is area of drainage at which flow rate calculation required in km^2 and n was constant value range from 0.6 up to 1.2 used as an exponent.

For DAs 20 % of DAg that means 0.6 less than or equal to DA area of interst over DA area of gauged less than or equal to 1.2 then for n 1 is used but for other 0.6 was used for n

Weather Data Definition

All meteorological stations were having both temperature and precipitation data, but only Gumayde stations were synoptic stations (having all types of climatic data) used for generating remaining weather data for others (weather generator). Then Filling WXGEN of weather data and lost data was completed by lost data finder as NA for ArcSWAT model.

Simulation, Sensivity Evaluation, Calibration and Validation of Arcswat

All data was loading and run the model and read monthly stream flow of the area. It was adjusted the model to run the simulation for 14 years (2001- 2014) years of data. The model performance for the computed outcome was obtained according to white and chaubey 2005.

- **Evaluating Sensitivity Parameter**

It was essential for obtaining important factors and factors accurately obligatory for standardization. Factors which are more kindliness were selected by attention since less difference by model result and so, it was significant to show factor importance was estimated with great possibility. Factors having less kindliness were not needed for checkup but, little effect in their values was not affect result of the model [39].

- **Calibration**

Calibration was done with the pre-defined parameters that have been identified as most sensitive parameters. The factor standards were adapted extra similar with model performance for river basin. SWAT model was calibrated and checked for NSE, RVE and R^2 result to standardize at least till the smallest suggested standards are comprised for model which was R^2 greater than 0.6, NSE was greater than 0.5 and RVE was less than ±15[34].

- **Validation**

Validation is the final step for steam flow. Model authentication was procedure for representing assumed place definite model was accomplished of production adequately correct simulations, while "sufficiently accurate" differ grounded on development aims[32]. The authentication procedure contains consecutively a model by means of factors obtained from adjustment procedure, and linking with forecasts to detected facts which does not needed for calibration.

- **Model Performance Efficiency**

For calibration and validation time coefficient of regression, relative volume error was used for goodness of fit measure. For those factor R2=1 which shows good value and 0 shows poor value[29].

Nash-Sutcliffe Efficiency, NSE

According to [28] recommended for monthly time steps that NSE values between 0.75 and 1 is very good and NSE-value between 0.65 and 0.75 is good.

$$NSE = 1 - \frac{\sum_{i=1}^{n}(Qi - Pi)2}{\sum_{i=1}^{n}(Qi - Qm)2} \qquad (2)$$

Where

$Q_i$is observed flow at ith period, $P_i$is simulated flow at the ith period and Qmismean of the observed flow.

Calculation of R2

R2is stated as the square off ratio amongcovariance and the multiplied standard deviations of the detected and forecast values for demarcated as the squared value of the coefficient of correlation.

$$R2 = \left[\frac{\left[\sum_{i=1}^{n}(Qs - Qsm)(Qo - Qom)\right]2}{\left[\sum_{i=1}^{n}(Qs - Qsm)\right]2\left[\sum_{i=1}^{n}(Qo - Qom)\right]2}\right] \qquad (3)$$

Qo= observed flow rate in m^3/se

Qs= simulated flow rate in m^3/se

Qom = mean of observed flow rate in m^3/se

Qsm= mean of simulated discharge in m^3/se and n was No of observed data

R^2 was indicates the correlation of simulated and observed flow. Its result was 0 up to 1. If the simulation is accurate, R2 is equal to one. An efficiency of R2 is equal to zero shows accurate model prediction [30]. According to [28] recommended monthly period steps that R2 values between 0.75 and 1 is very good and R2-value between 0.65 and 0.75 is good.

Relative Volume Error (RVE)

Processes the regular tendency of the simulated data to be higher or lesser than their observed complements. The optimal value of RVE was nothing, through little size values showing exact model simulation. Constructive result show model underestimation bias, and destructive values shows model above estimate bias[16] and calculated by equation next.

$$RVE = \frac{\sum_{i=0}^{n}(Qob - Qzsi)}{\sum_{i=0}^{n}(Qob)}(100) \tag{4}$$

Where

RVE = Relative Volume Error (%).

Qob= observed discharge in m^3/seand Qsi= simulated discharge in m^3/se and n is the No of observed data.

Computing Irrigation Water Requirement of Crops

The water demand of a crop depends on the climatic conditions. Under the same condition different crops need different amount of water and the quantities of water used by particular crop vary with its growth stage.

$$ETC = ETO * Kc \tag{5}$$

Where

ETo was reference evaporation from

Kc is the crop coefficient

Hargraves Methods of Calculating ETO.

The supposition that high temperature was a pointer for evaporative power of the atmosphere was the origin for temperature-based approaches, such as the Hargreaves-Samani. These approaches were valuable if there was no weather data. But, certain journalists [25][21] reflect that the result were normally fewer consistent which was considered for other climatic factors. There are different methods to compute ETo, but Hargreaves technique is deliberated for assessing ETo, however temperature data only meanwhile, there are no full weather data in the area. [18]model was one of the further exemplify varieties of one of the elder evapotranspiration models [22]. Form this model accessible by [17] was shown below.

$$ETO = 0.0023Ra(Tav + 17.8)(Tmx - Tmn)0.5 \tag{6}$$

Wherever ETo is evapotranspiration from reference crop in mm per day, Ra was extraterrestrial solar radiation in mm per day, Tav was average air temperature by ^{o}C, Tmx was daily maximum temperature and Tmn was daily minimum temperature by ^{o}C.

$$Ra = RS\left(Kr\left(Tmx - Tmn\right)0.5\right) \tag{7}$$

From the equation; Rs was in units of wer evaporation by mm per day and found from table [33]/ estimated [2]. Experimental coefficient, Kt is primarily fixed for semi-arid and lake having salt at 0.17 and then [19] suggested 0.162 for land mass area and 0.19 for the use of 0.162 for interior regions where land mass dominates, and 0.190 for beaches.

ETc was calculated using FAO CROPWAT version 8.0 and Kc values presents connection with reference ETo and crop evapotranspiration. The values of Kc are varying per the crop types, its climatic condition.

$$NIR = ETC - Pef \tag{8}$$

From the equation above NIR was water demand for crop except Pef which was effective rainfall.Then, gross irrigation water requirement was computed using the following formula[4];

$$GIR = \frac{1}{E} * NIR \tag{9}$$

Where

GIWR is the gross irrigation requirement of crops and E represents the Efficiency of the irrigation.

The Outcome and Elaboration of the Research

Calculation of Slope Possibility

Possible map was generated in percent for the entire area on Arc GIS using DEM of the area as input data. The slope map created was reclassified into four classes. The reclassified raster is changed to a polygon (feature) using the conversion tool on Arc GIS 10.3 and area of each polygon was calculated based on the scale measured slope. According to FAO guidelines, slope map of the watershed was classified into four suitability classes. The classification was based on criteria for slope possibility for farm land water supply. The outcome for slope calculation was shown in Figure 9 below

Figure 9 shows the slope suitability indicates that 31.5 % of area was highly suitable, 35.51 were moderately suitable 23.05 % was marginally suitable and 9.94 was not suitable for irrigation development.

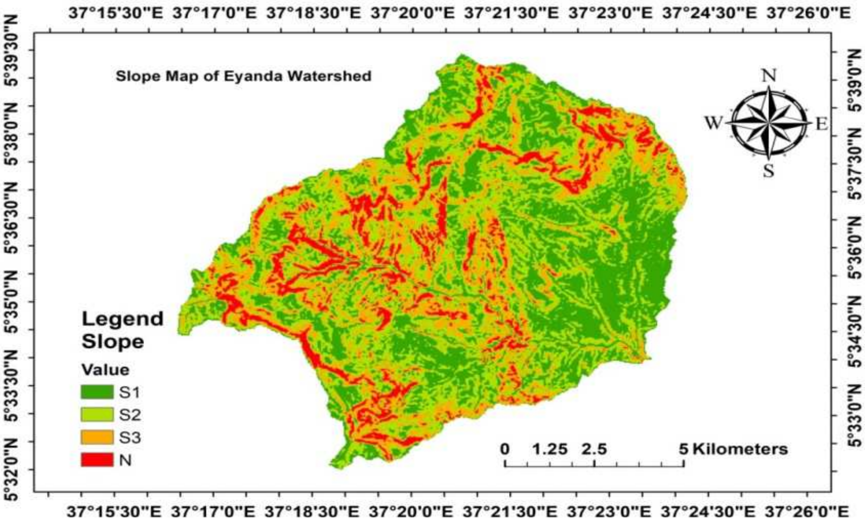

Figure 9 Slope Map of Eyanda Watershed.

Evaluation of Land Use Land Covers Suitability for Irrigation Potential Development

From data prepared fitted farm land water development is calculated using suitability parameters. There was different land cover type in the watershed in which rank was given for major land cover type. So, the major land cover type among the basin was Cropland, Shrub land cultivation, Mosaic cropland and grazing. After rank was given for the LULC types, reclassified map of the Eyanda watershed was developed. By reclassifying land cover type in to possible group and ranked from 1 up to 4. Thus 1 shows highly suitable, 2 suitable, 3 marginally suitable and 4 unsuitable according to [13].

Figure 10 possible land cover type for Eyanda river basin Land cover type was grouped as cropland, mosaic cropland, mosaic natural vegetation, grass land; mosaic tree and shrub were grouped as more too moderately important for agriculture to supply water for the crop. From Table 2 and 3 the outcome shows that 90.51061 % of watershed with in more to moderately possible for irrigation. But, herbaceous, broad leaved, evergreen, tree cover and urban lands were grouped in to unsuitable for agricultural farm land. So, the result shows 9.48938 % of the total area was not necessary for agriculture by surface water supply.

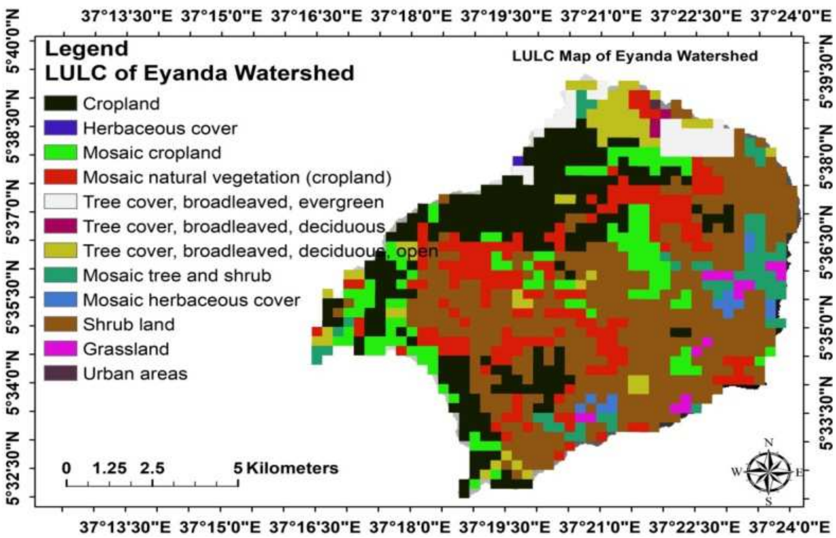

Figure 10

Drainage Suitability of the Soil

Soil drainage is one among very important parameter of evaluation of the area for surface irrigation. The highly drained field was important irrigation. For this research, according to soil survey document group of three evaluation criteria for drainage group were used[10]. Well drained soils of the area were associated to areas with high slope percent.

The drainage suitability map of the area shows the well-drained area which covers a higher percentage area of 7.525867 % which indicates a well suitable class and 20.47294 % of the area covered by moderately suitable and very few unsuitable class or un drained area whichoccupies 36.28142 % that was not suitable for surface irrigation.

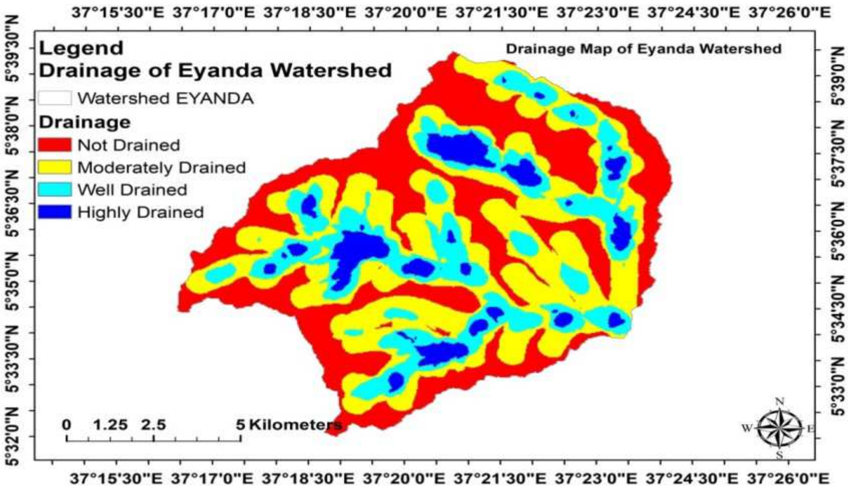

Figure 11: Drainage Class of the Watershed.

Texture Suitability of Soil

Soil texture is one important physical characteristic of the soil. The watershed was dominated by fine textured soils. Texture of a given soil affects infiltration capacity and water retention capacity. As Soil textural classes of investigating soils in the study area vary from fine to course, i.e. clay to sandy loam. Soil textural class suitability analysis for surface irrigation development of the area revealed that 43.80729 % of the soils in the area were under highly suitable and about 20.47294 % of the area's soil were categorized under moderately suitable class and 35.71977 % of the soil textural class in the area were categorized under unsuitable class.

The Over All Suitability of Soil

By weighted overlay the suitability of the soil was calculated

Table 1: Suitablity of the Soil For Irrigation Development

No	Soil Type	Soil Texture	Soil Depth (Mm)	Drainage Density	Texture Suit	Depth Suit	Drainage Suit	Overlaid Soil Suit	Area in M^2	% Age of the Area
1	To6-2bc	Clay soil	400	well drained	N	N	S2	N	2664.9	23.83309
2	To6-2bc	Clay loam	1000	Moderately	S3	S2	S3	S3	74.21	0.6637
3	To6-2bc	Silt soil	1250	Not drained	S2	S1	N	S3	830	7.423
4	To6-2bc	Silt loam	1100	Well	S2	S2	S2	S2	4668.5	41.752
5	To6-2bc	Loam soil	800	Highly	S1	S3	S1	S1	2943.9	26.3283

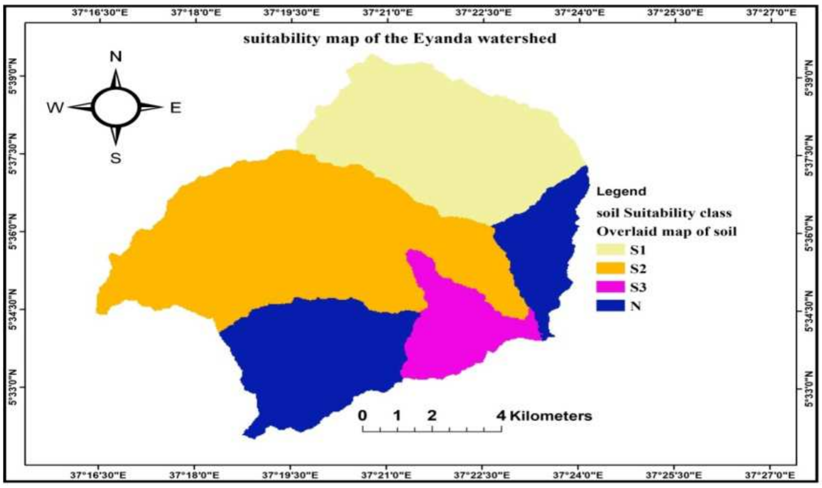

Figure 12: Suitablity Class of Soil Map.

SWAT Model Evaluation

The water availability calculation understands the potential of irrigation water supply in each sub basins obtained from the SWAT simulated outputs and comparing with the irrigation water demand for dominant crops of the watershed.

Stream Flow Sensitivity Analysis

From January 1, 2001 up to July 31, 2014 fourteen years flow sensitivity for flow rate was calculated having two year for preparation time. Sixteen constraints are stated as sensitive in diverse grade of effects on flow rate at the outflow of the river basin. Out of sixteen constraints eight constraints were grouped under a high sensitivity range.

The T_stat gives the degree effect on flow rate which shows large value of total standards were highly affect model whereas the P_value determined the importance of effectiveness. When the rate of P was zero indicates a higher importance. According to [35] the degrees of sensitivity were ranged from: 0<mean relative sensitivity <0.05 means small; 0.05<mean<0.6 means medium; 0.6<mean<1 means High and mean>=1 means very high.

Table 2 shows the result of SWAT sensitivity determination shows out of sixteen constraints eight of the constraints were obtained having maximum effect on the flow rate and ranked in order at table 2. The next table indicates the best fitted values of the model parameters occurred from the swat cup sensitivity analysis of the output.

Table 2: Model Sensitivity Calculation of Eyanda River Basin

No	Name of the Parameter	Description of the Parameter	Value of T-Test	Value of P	Sensitivity of The Parameter
1	IRR_No	Irrigation source location	-3.2	0.000019	1
2	GWHT	Initial ground water height in meter	-2.9	0.00023	2
3	SOL_ZMX	Max rooting depth of soil	-2.4	0.00092	3
4	DIVMAX	Maximum daily irrigation diversion from the reach	-1.2	0.001	4
5	ALPHA_BF	Alpha factor for base flow	-0.86	0.0011	5
6	IRR_AMT	Irrigation depth of water applied on HRU	-0.82	0.03	6
7	IRR_MX	Applied irrigation watsr each time to targeted crop in mm	0.65	0.049	7
8	IRR_ASQ	Surface runoff fraction	0.24	0.0047	8

Table 3: Lists of Best Fitted Constraint for Calibrated Flow Rate

No	Parameter	Explanation of the Parameter	Lower Limit	Upper Limit	Fitted Value
1	IRR_No	Irrigation source location	0	400	1
2	GWHT	Initial ground water height in meter	0	25	10
3	SOL_ZMX	Max rooting depth of soil	0	3500	500
4	DIVMAX	Maximum daily irrigation diversion from the reach	0	150	95
5	ALPHA_BF	Base flow alpha factor in days	0	1	0.85
6	IRR_AMT	Depth of irrigation water applied on HRU	0	100	64
7	IRR_MX	Applied Irrigation water for targeted crop in mm per each time	0	100	80
8	IRR_ASQ	Surface runoff fraction	0	1	0.78

Model Standardization and Authentication After

From January 1, 2001 up to July 31, 2014 for fourteen years flow standardization is calculated with two year model initialization. Therefore, for the model performance in calibration was considered from 2001 to 2014. Due to data availability having less lost data period for standardization was selected. While in conducting calibration auto-calibration was done. Auto-calibration allows the model to change the parameters until both observed and simulated flow data will be in the acceptable range automatically. All parameter was adjusted for model. Then the model blimey of fitting and model performance is obtained. For this study R^2 evaluated which was greater than 0.84 which was with in the acceptable limit which was bigger than 0.68 and NSE which was larger than 0.8 this also within acceptable limit which was greater than 0.5 and RVE was -8 which also within acceptable limit which was less than ±15 [34]. Therefore, it is confirmed that all the values obtained are in the acceptable range and the legend in the graph represents the observed and best estimations or simulated values as the as the next Figure 13

The calibration period of the model presented in Figure 13 shows that it was mostly overestimated or underestimated for some part of the year in a calibration period. From January 1, 2005 up to July 31, 2016 standardization of the model was performed for the river without changing the constraints. Evaluated impartial purposes in model performance were coefficient of determination which was greater, NSE value was 0.87 and RVE value was -9 %. The validation period of the detected and replicated discharge in monthly approximation was below estimations in certain of the year whereas, model shows mostly overestimated in other years.

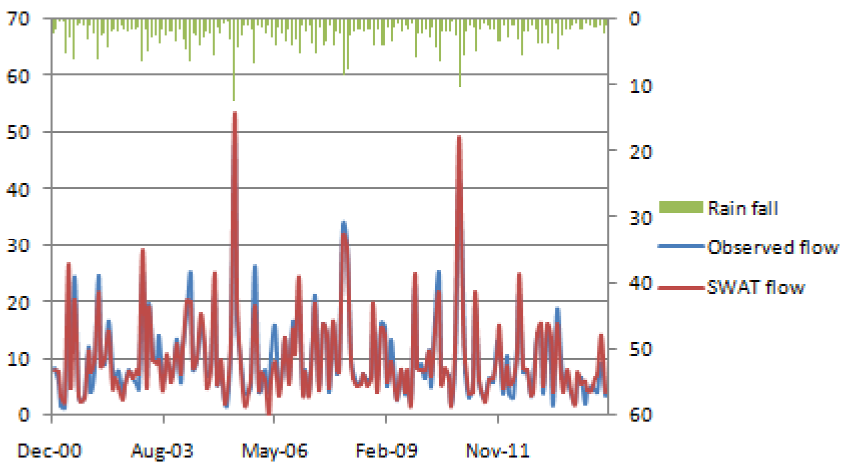

Figure 13: Observed Stream Flow and Simulated Flow Rate for Calibration Time(2001-2014) In M^3/Sec.

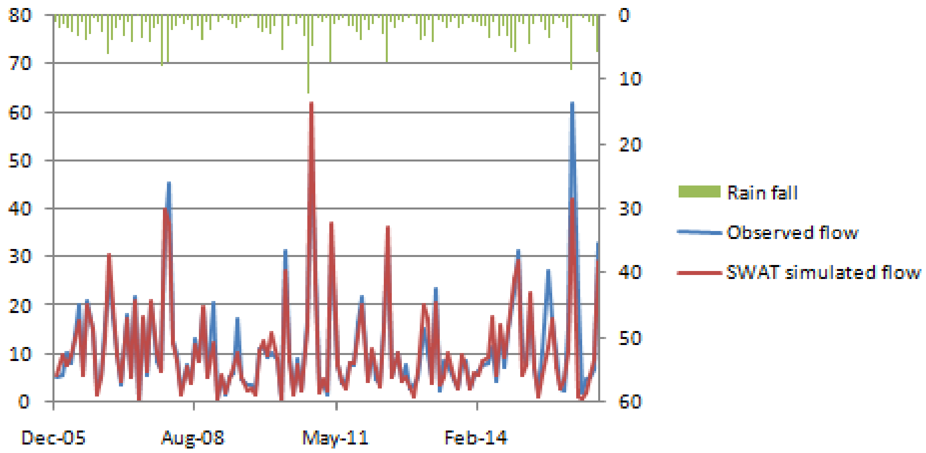

Figure 14: Observed Discharge and Simulated for the Validation Time (2005-2016).

Identification of Potentially Irrigable Sites

Potential irrigable sites were obtained using slope suitability, soil suitability and land use land cover suitability on Arc GIS 10.3 by means of weight overlay analysis of all data sets such as soil physical properties, land cover type and slope. The three suitability parameters identify potentially irrigable sites in the watershed asextremely, temperatelyand inappropriate group for agricultural farm land. In the weighted overlay analysis a high weight of % age influence was given for slope, since it is the determinant factor in the evaluation of the given area of surface irrigation development and the result of weighted overlay analysis of irrigation suitability analysis was shown in the Table 4 below

Figure 15 shows the weighted overlay analysis of surface irrigation suitability revealed that 1.72 % of the total area covers on a highly suitable class, 69.7 % covers moderately suitable class, about 28.6 % of the watershed was covered in notsuitable class. As the result indicated for suitability classes of the watershed suitable site for surface irrigation have a higher coverage due to combined effect of slope, soil and land cover / use.

Table 4: Land Suitability Class of the Study Area

Suitability Group	Symbol for Suitable	Area (Km2)	Area (%)
Highly suitable	S1	3.21	1.718586
Moderately Drained	S2	76.96947	69.67783
Not suitable	N	31.5969	28.60359
Total		**111.7823**	**100**

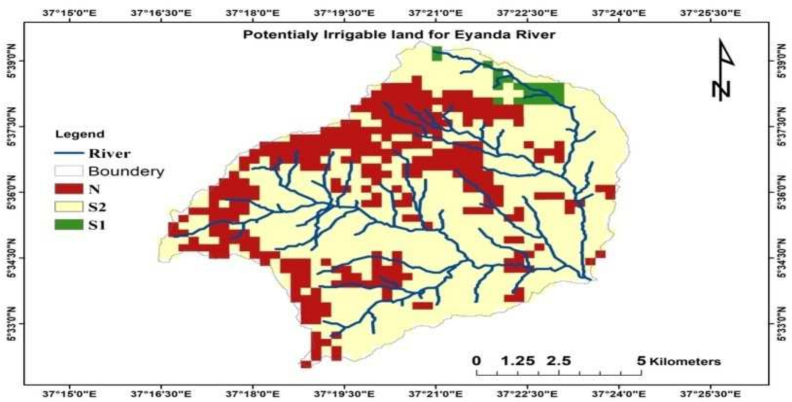

Figure 15

Total Water Demand Calculation for the Watershed

For the river basin the amount of water was calculated by using 85 % reliable discharge rate abstracted from the model. Under surface irrigation methods gross irrigation water requirements of Sorghum, pepper and maize was estimated using climatic data for CROPWAT 8.0 model. Monthly gross water demand for dominant crops of Sorghum, pepper and maize were calculated. The outcome gives an overall indication of monthly crop water requirement for five months of full growth stage of Sorghum, pepper and maize that should be abstracted from the sub basins during the local cropping period.

Table 5 ahows the After potential Irrigation development was identified the water availability for pepper, sorghum and maize production the watershed was calculated. Observing the calculated water demand for selected crop with in identified irrigation development in the watershed and compared with available flow at 85 % of mean monthly flow. The result indicates that the existingregular discharge of the river is more than that of water demand for selected crop in the area.

Table 5: Irrigation Water Demand for Selected Crop

	Gross Irrigation Requirement for Selected (M^3/s)				
Month	**Pepper**	**Sorghum**	**Maize**	**Sum of Gross Irrigation Demand**	**85 % Flow Probability**
January	3.5	1	0	4.5	8.75
February	1.36	0	0	1.36	9.823
March	0.8	1.2	0.85	2.85	12.124
April	0	2.5	1.25	3.75	18.754
May	0	3.5	0.94	4.44	19.22
Jun	0	1.8	0.63	2.43	25
July	0	0.9	0	0.9	18.88
August	0	0	0	0	17.92
September	0	1.5	0.98	2.48	13.670
October	0	2.35	1.5	3.85	11.92
November	1.6	3.68	1.25	6.53	10.267
December	2.5	2.22	0.58	5.3	9.65

CONCLUSIONS

The assessment of surface irrigation potential was carried out through Arc GIS 10.3 technique's in terms of land suitability parameters; land cover type, soil physical properties and slope are calculated in Eyanda watershed.

Land Slope of the area was calculated according to FAO guide line for land identification of surface irrigation development and geographic locations (maps) of suitable sites were also presented on Arc GIS10.3. Lands with under highly suitable slope which covers 31.49782 %, 35.505 was under moderately suitable, Land slope with categorized under marginally suitable class was 23.05143 % and were the rest unsuitable class covers 9.945479 %. Three physical parameters such as soil suitability are textural class, depth and drainage class of the watershed for surface irrigation development were analyzed on Arc GIS10.3 separately. Weighted overlay analysis of the three different parameters was performed using weight overlay analysis on Arc GIS data management tool accordingly, 64.47 % of the soils in the catchment were between largely to slightly possible and an area of about 23.8 % was grouped as non-possible group for farm land due to combined effect of soil texture, depth and drainage class.

In the study used satellite data and geographical information system were integrated with the hydrological model, for ArcSWAT resulting from LULC. Standardization of ArcSWAT was done from 2001 up to 2014 and authentication was performed from 2005 to 2016 on a regular foundation to scrutinize its applicability of simulated and observed flows and comparing through graphical methods. The model results showed in the acceptable range of R^2, ENS and RVE during both the standardization and authentication time. Routine efficiency indicators is calculated and R^2 better than 0.84, RVE which was -8 and NSE which was greater than 0.5. The evaluated objective functions for model performance was coefficient of determination which was greater 0.76, NSE value was 0.87 and RVE value was -9 %. For the performance of model validation of stream flow analysis and it shows that the parameter falls within the acceptable range.

The overall availability of the land for surface irrigation development was assessed with weighted overlay of the three parameters (soil, slope and LU/LC) developed on Arc GIS 10.3. About (71.4 % of) the total lands in the watershed were found between more possible and slightly possible for, whereas (28.6 %) were grouped in unsuitable class due to the constraints in slope, soil and land cover type suitability forEyanda watershed. Water demandfor selected crops was made using climatic data through CROPWAT model 8.0. Available water was calculated by using 85 % reliable discharge abstracted from the model. the outcome shows water available in the river was more than irrigation requirement.

Ethical Approval: This research paper has been conducted in accordance with Arba Minch University water resource research center and approved for publication. Interpretations articulated in this paper article was my explanation and it does not show the opinion of the Institute and approved for publication.

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Data and Materials Available for the Research: For this study the data set formulated during data analysis were available from the corresponding Author on reasonable request.

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