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Assessment of Physical Land Suitability for Surface Irrigation by using GIS and RS, In case of Loma District, South Western Ethiopia

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Abstract

This study was initiated with the objective of analyzing the potential physical land suitability for surface irrigation in Loma Woreda, Southwest Ethiopia. Generating geo-referenced map of these resources by using Geographic Information Systems, stream derivation, identification of potential irrigable physical land resources, locating socio-economic factor and climate data were the steps followed to assess this irrigation potential. Results of the derived stream showed seven main basins and belonging streams. To identify potential irrigable land, irrigation suitability factors such as soil type, slope, land cover/use, market accessibility, mean annual temperature and rainfall, and distance from water supply (sources) were taken into account. The weighted overlay analysis of these factors gave potential irrigable area of 770.58ha (0.65%) highly, 46,554.12ha (39.36%) moderately and 67,253.13ha of total area (56.86%) are marginally suitable for surface irrigation. The remained 3,690.09ha (3.12%) of total area were not currently suitable. The finding have shown that, from the total area of 118,267.92ha of Loma Woreda 114,577.83ha (96.8%) are potentially suitable for surface irrigation in the range of highly suitable to marginally suitable. In conclusion, Loma Woreda has a high surface irrigation potential. So that, it is advisable to develop and invest in those potential areas.

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Keywords

Potential, Irrigation, Suitability, Geographic Information System, Remote Sensing.

Introduction

Background of Study

Food cannot be grown without water. In Africa, one in three people suffer from water scarcity and climate change will make things worth. Building on Africa's highly sophisticated indigenous water management could help resolve the growing crisis, but these very systems are being destroyed by large-scale land grabs amidst claims that Africa's water is abundant, under-utilized and ready to be harnessed for export-oriented agriculture (Grain, 2012).

At present in Africa, of the total cultivated area estimated at 143.3 million hectares, about 12.2 million hectares benefit from irrigation. While it is true that considerable potential still exists for future expansion of irrigation, it is also true that water is becoming scarcer in those regions where the need for irrigation is most important (FA0,1995c).The potential of agricultural water management has not yet been tapped in sub-Saharan Africa. In 2000 in Africa, 5.5% of renewable water was withdrawn from natural systems compared to 20% withdrawals in Asia 95% of African land is cultivated by rain fed-agriculture (Molden, 2009). So that, agricultural productivity per caput in sub-Saharan Africa has not kept pace with population increase, and the region is now in a worse position nutritionally than it was 30 years ago: food production has achieved a growth of about 2.5% per year, while population has risen at a rate of over 3% per year (FAO, 1997:1).

According to Seleshi (2010), Ethiopia has abundant rainfall and water resources, its agricultural system does not yet fully benefit from the technologies of water management and irrigation. The majority of rural dwellers in Ethiopia are among the poorest in the country, with limited access to agricultural technology, limited possibilities to diversify agricultural production given underdeveloped rural infrastructure, and little or no access to agricultural markets and to technological innovation. The dominant agricultural system in Ethiopia is small-holder production of cereals under rain fed conditions, with a total area of approximately 10 million hectares. The estimated potential irrigable land in Ethiopia was 3.7 million hectares. But less than 5 percent (about 200,000 hectares) were under irrigation (World Bank, 2006).

In Loma *Woreda*, there are seven perennial rivers: Dola, Yawara, Xingle, Yeguwa, Gindra, Kareta and Ugumane. Despite this large number of rivers, exploitation of their water resources for irrigated agriculture has remained low in the *woreda*. The water resources of these rivers have been serving as sources of water for hydroelectric power (Gilgel Gibe III Hydroelectric Power) and domestic water supply. There are no small or large-scale irrigation schemes in the *woreda*. This might be because of, firstly, the available physical land resources and socio economic factors are not known. Secondly, potential irrigable areas in the *woreda* have not been identified and mapped to encourage the small scale local farmers. Therefore, to overcome these uncertainties, this study was carried out by using GIS as a tool for assessing irrigation potential in Loma *Woreda.* The assessment used input data from soil, digital elevation model (DEM) and satellite image (Landsat ETM+) in order to assess and map the result in the context of surface irrigation development in the study area. Furthermore, the study attempted to identify socio economic factor in the *woreda* and map selected natural resource suitability for potential irrigation development.

Description of the study area

Loma District is located in Dawro administrative zone of Southern Nation Nationality and People's Regional State. Astronomically Loma District extends between $6^0$38"0´- $7^0$4"0´North latitude and $36^0$53"0´up to $37^0$19"0´East longitude. The elevation of the District ranges between 600 and 2600 m.a.s.l. The landform in Loma *District* shows variations in agro-ecology as Highland, Midland (dry and moist) and Lowland. Generally, Highland, Midland and Lowland constitute 12%, 28%, and 60% of the total area (125051ha) of the *District*, respectively.

Minimum and maximum rainfall and temperature range from 1041 mm -1448 mm and 11 Cº - 22Cº, respectively (Loma *District* Agricultural Office, 2016). In the *District* the main food crops and live stocks are: maize, *enset*, sweet potatoes and cattle, sheep and goats respectively.

Method of data collection

The most important data for this study were soil type map, satellite image, Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) DEM, Point data of market location and the mean annual (temperature and rainfall) data. The primary sources of data were satellite image, digitally elevated model ASTER, and ground control truth points. The Landsat 7 ETM^+ of 2016 image and ASTER (DEM) of 2014 were obtained from the website http://www.earthexplorer.usgs.gov/. The secondary sources of data were topographic map from Ethiopian Mapping Agency (EMA), meteorological data (precipitation and temperature) from National Meteorological Agency and soil map from the website of http://www.earthexplorer.usgs.gov/.

The tool that were used in the collection of data are global positioning system (GPS) recorder, Google earth application, and software's like ArcGIS 10.3 and ENVI 4.7.\

Materials and Methods

Method of data analysis

Physical land resources analysis

The stream flow data were derived from the ASTER DEM of 2014 with spatial resolution of 90m. The 90m spatial resolution DEM ASTER was resampled to 30m spatial resolution in order to match with the other map layers used in this study. By using the hydrology tool the stream network and basins were generated. The distances from identified Perennial River to a specific potential irrigation area were measured by multiple ring buffer tool. Finally, the vector format data of river were converted to raster format. The meteorology data were geo-referenced and interpolated to come up with the overall the *woredas* map of temperature and rainfall in terms of their respective mean value. The interpolation technique was processed in ArcGIS with the use of spatial analyst tool an inverse distance weighted technique. To identify suitable potential surface irrigation area the mean annual temperature and rainfall data were reclassified.

Landsat ETM$^+$ of 2016 image was used to prepare land use/ cover map of the study area through ENVI 4.7 image processing software. For the preparations of land use or cover map of the study area the following main steps were followed. The steps are pre-processing of image, land use/cover classification, and accuracy assessment.

The soil suitability class's classifications were based on the soil type of the study area. The soil map has 250m spatial resolution. The map was resampled to 30m spatial resolution. There were six soil types in the study area namely Nitosols, Alisols, Leptosols, Fluvisolls, Luvisols and Histosols. The suitability classes of the soil type classification were based on the production capacity of the soil. To categorize the suitability class of soil types according to its suitability for surface irrigation the previous literature of FAO (1977) was utilized. ASTER satellite image was used to derive slope map of the study area. And then the slope map was reclassified to achieve the required slope status. The slope map was reclassified to suitability classes of surface irrigation according to Global Agro Ecological Zone (2012).

Socio economic data analysis

The market is essentially a place where products are sold (Lothore and Delmas, 2009). It is important to assess the accessibility of market in the vicinity of potential irrigation area. The major village markets of Loma Woreda were identified by using GPS based survey. The 16 major village markets were identified and mapped. It used as one of input layer for the identification of potential surface irrigation area. To measure the distance from respective market to specific potential surface irrigation area multiple ring buffer tool was used.

Weighted overlay analysis

In this study seven study map layers were prepared. Each of seven layers of maps was reclassified to decided suitability classes. The suitability class maps were added to weighted overlay tools. The percentage influence and rating of suitability class were performed with the participation of study area experts namely; Natural Resource Manager and Development and Plan expert. The reclassified and weighted factor suitability maps were computed by the weighted overlay tool of ArcGIS Spatial Analyst Toolbox.

Results and Discussions

Land use / cover suitability evaluation

From the land cover or use classes of the study area the cultivated land and shrub grassland were classified as highly and moderately suitable for surface irrigation respectively. This is because of the assumption that the cultivated land will be used to irrigation without limitation and shrub grassland will be used with less limitation. The forested area and water body were classified as marginally and not suitable for surface irrigation respectively. This is because of the forested area may be a choice when the cultivated and shrub grass land no more avail in the study area. From the total land of Loma District cultivated shrub grassland and forested area covers 45.15, 28.12 and 24% respectively. This shows that 73.27% was highly suitable for surface irrigation and 26.73% was moderately suitable for surface irrigation.

Slope suitability evaluation

Slope has been considered as one of the evaluation parameters in surface irrigation suitability analysis. Depending on GAEZ (2010), the slope was reclassified in to four suitability classes. Its suitability classes range from highly suitable to not suitable classes as presented in the figure below.

Hydrology modeling and suitability evaluation

The DEM data was filled a sink before any hydrological calculations. The filled DEM was used to derive the flow direction of the study area through the use of "hydrology" tool in ArcMap. As it is shown in Figure 1Loma *Woreda* has mainly seven basins namely Yawara, Xingle, Yeguwa, Dola, Ugumane, Kareta and Gindare.

Distance to water sources to be the variable most likely to influence the site location surface irrigation (Westcott and Brandon, 2000). Therefore, the map was made by creating a buffer area of a specified distance to water.

Very small channels or cell counts of less than 350 were removed from the layer and multiple polygon were constructed for the remaining streams through proximity analysis tool of multiple ring buffer tool. The vector format of buffered stream polygon converted to raster format. The distance and cell count threshold determination was done with the participation of natural resource expert of Loma *Woreda*. The suitability class of stream flow were categorized in distance of 1 kilo meter, 3 kilo meter, 4 kilo meter and 5 kilo meter with suitability range of highly suitable, moderately suitable, marginally suitable and not currently suitable respectively.

Soil types suitability evaluation

The suitability of soil types for surface irrigation was evaluated through its suitability potential for agricultural crop production. Among the six soil types in the study area, Nitosols were classified as highly suitable for irrigation. Fluvisols are classified as moderately suitable, Luvisols and Leptosols are classified as marginally suitable and Histosols and Alisols are currently not suitable FAO (1977).

Climate data suitability evaluation

Depending on agro ecological zone classification of Ethiopia the mean annual temperature and rainfall classified in to belonging class. The higher the temperature and less rain fall distribution area were classified as highly suitable for surface irrigation. This is because the crops in such area were mainly vulnerable to moisture deficiency, as a result of high temperature and low amount of rain fall. The following table shows the classification range of mean annual temperature and rainfall.

Market accessibility suitability evaluation

Market is a key derive in intensifying the agricultural product in Ethiopia (Heady et.al, 2013). To analyze available market for irrigational agricultural product exchange the distance from specific potential surface irrigation area to market were measured by using multiple ring buffer tool of "proximity analysis". The market suitability was categorized according to its proximity in terms of distance. As a result, distance radius of 5000 meters (5km) is classified as highly suitable for the exchange of the irrigation agricultural products. Distance ranges from 5-8km, 8-10 and >10 were classified as moderately, marginally and not suitable market location for irrigation agriculture product exchange respectively. Categorization of the different distance bands considered walking, and use of pack animals as major means of transport. This is because, as explained by the expert of Economy and Finance Development office of Loma *Woreda*, the rural small scale farmers use largely their heads and back of donkeys in order to sell their agricultural products.

Multi criteria decision making (mlcd) and weighted overlay analysis

To identify potential surface irrigation area in Loma *woreda*, a multi criteria decision making approach were used. The main physical land resources criteria were soil type, slope, mean annual temperature and precipitation, land use /cover and streams maps of Loma *Woreda*. From socio economic aspect the market accessibility was analysed.

Table.1 Suitability classes of slope (Own processing)

No.	Slope range	Area Share (ha)	Total area (%)	Code	Suitability classes
1	0-5	20,453.67	17.3	S1	Highly suitable
2	5-8	4986.27	4.21	S2	Moderately suitable
3	8-16	13,619.7	11.5	S3	Marginally suitable
4	>16	79,208.28	67	N	Not suitable
Total		**118267.92**	**100**		-

Table.2 Suitability range classification of temperature and rainfall (Own processing)

No.	Mean annual temperature	Mean Annual Precipitation	Suitability class
1	>25	< 150	S1 (Highly Suitable)
2	22.5 – 25	150-220	S2 (Moderately Suitable)
3	18.5 - 22.5	220-300	S3 (Marginally Suitable)
4	< 18.5	>300	N (Currently Not Suitable)

Table.4.1 Factors weight and rating (Own processing)

No.	Factors	Percentage of its influence	Suitability class Code	Rating
1	Mean annual temperature	10	S1	5
			S2	4
			S3	4
			N	2
2	Mean annual rainfall	10	S1	5
			S2	4
			S3	3
			N	2
3	Soil type	13	S1	5
			S2	4
			S3	3
			N	2
4	Slope class	30	S1	5
			S2	4
			S3	3
			N	2
5	Land use/cover	13	S1	5
			S2	4
			S3	3
			N	restricted
6	Streams	14	S1	5
			S2	4
			S3	3
			N	2
7	Market accesssibility	10	S1	5
			S2	4
			S3	3
			N	2
	Total	100		

Table 4.1: The potential surface irrigation area coverage and suitability class (own processing)

No.	Suitability class	Area (ha)	Percent (%)
1	Highly suitable	770.58	0.65
2	Moderately suitable	46554.12	39.36
3	Marginally suitable	67253.13	56.86
4	Not suitable	3690.09	3.12
	Total area	118,267.92	100

Table 4.2: Highly suitable potential surface irrigation area coverage (own processing)

No.	Kebeles Name	Area Sum (ha)	Maximum (ha)	Minimum (ha)	Percent (%)	Geographically located
1	ArgaBacho	3.37	1.18	1.02	0.44	South
2	BeroYamala	20.97	5.21	1.15	2.7	North and West
3	DisaKera	12	1.03	4.14	1.5	Concentrated at Center
4	Fulasa Bale	1.62	-	-	0.21	North West
5	GenddoWalcha	40.3	5.7	1.01	5.2	North and North West
6	Kai Gerera	31.95	5.87	1.6	0.21	South
7	KoyshaGado	1.71	-	-	0.22	West
8	Loma Shambi	1.91			0.25	West
9	Loma Zadali	1.01	-	-	0.13	South
10	ShotaMantut	6.73	2.1	1.06	0.87	North East
11	ShotaChawla	1.1	-	-	0.14	West
12	ShaotaChawla and ShotaMantut	5.69	-	-	0.74	West of ShotaChawlaKebele
13	SuboTulema	1.47	-	-	0.19	Center
14	WasaraTalo	6.21	3.56	2.65	0.81	East
Total		**136.05**	**24.65**	**12.63**	**17.65**	**-**
15	Others (less than 1ha)	634.53	-	-	82.34	-
Grand Total		**770.58**	**24.65**	**12.63**	**100**	-

Table 4.3: Moderately suitable potential surface irrigation area coverage (Own processing)

No.	Kebeles Name	Area Coverage (ha)	Percent (%)
1	YaloWorbati		
	SuboTulema		
	OloWoyde		
	ElaBacho		
	GumerKocho	7,145.67	15.34
2	KoyshaGado		
	KoyshaGorta		
	Gedo Buna	1,155.65	2.5
3	BeroYamala		
	GenddoWalcha		
	Fulasa Bale		
	Loma Shambi		
	Loma Zadali		
	MidaZalo		
	KoyshaGado		
	MalditMashuncha	11,277.38	24.22
4	DisaKera		
	MogatiKosa	2,803.95	
	MaldiitMashuncha		6.02
5	Wasera Talo		
	Kai Gerera		
	Hla Bacho		
	Shota Mantuti		
	Shota Chawla		
	Afuki Woyro	12,177.04	26.16
6	Koysha Gorta	233.33	0.5
7	Dod Angela	112.44	0.24
8	Gessa Chare	190.6	0.41
9	Shota Mantuti	243.29	0.52
10	Yeli Chawla	509.4	1.1
11	Maldit Mashuncha	159.9	0.34
12	Mogati Kosa	92.84	0.2
13	Sayki Boho	50.7	0.11
14	Hala Bacho	71.3	0.15
Total		**36,223.49**	**77.89**
15	Others	10,330.63	22.19
Grand Total		**46,554.12**	**100**

Figure.2 Location of the study area

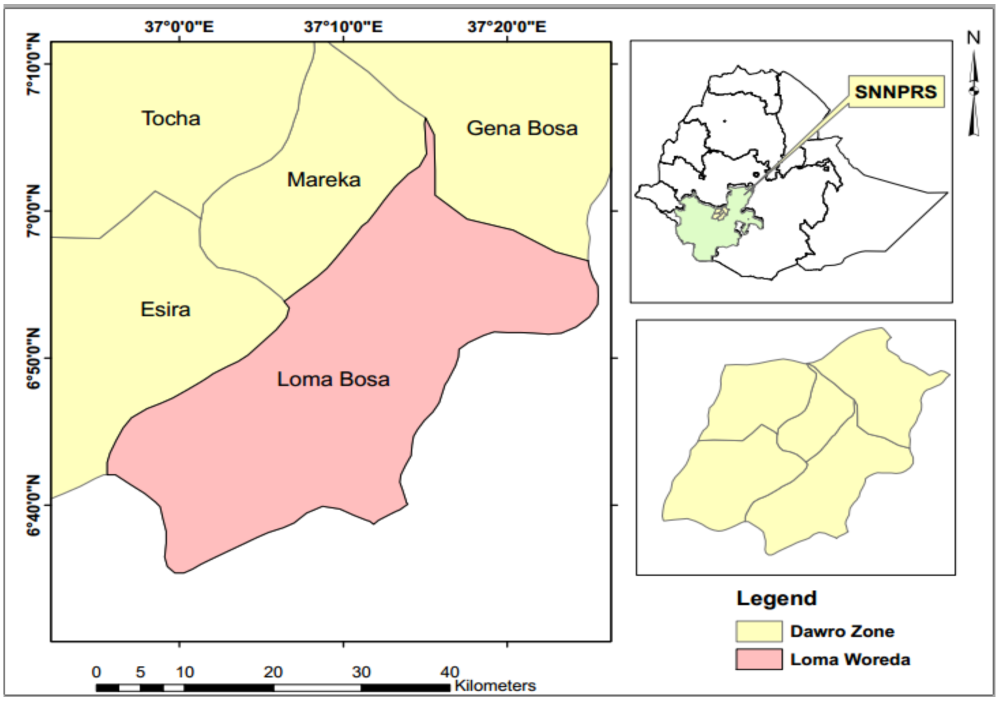


Figure.2 Potential surface irrigation suitability classes based on land use/cover factor

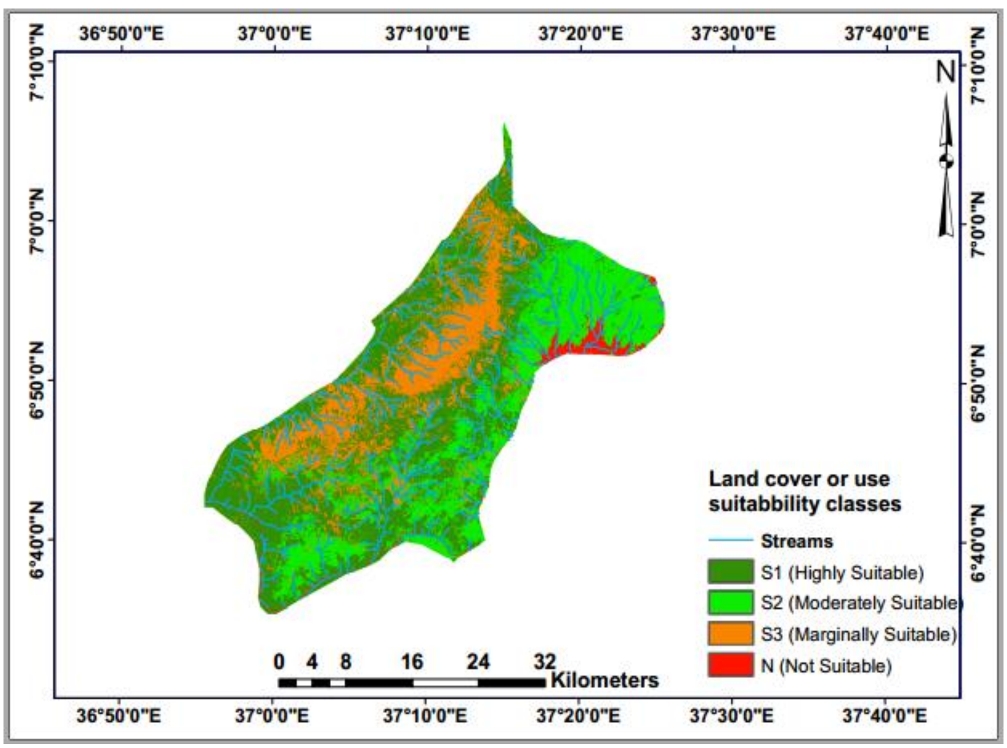


Figure.3 The suitable slope class map of Loma *Woreda*

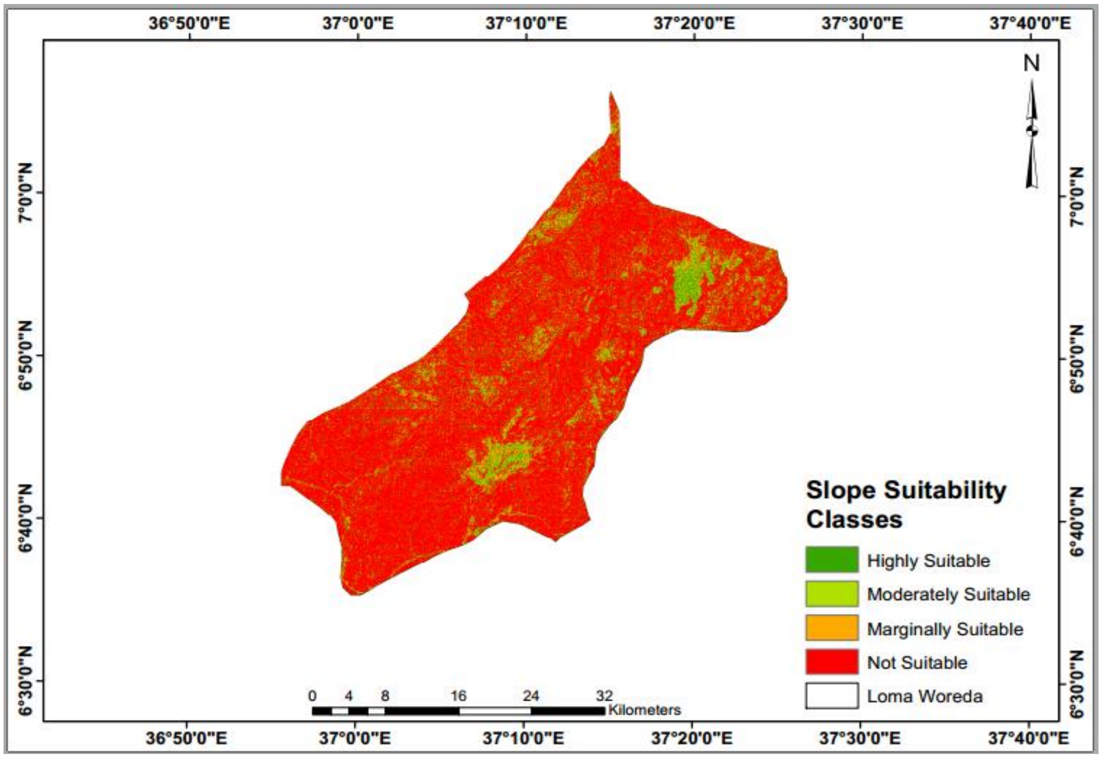


Figure.4 The suitability class map of streams

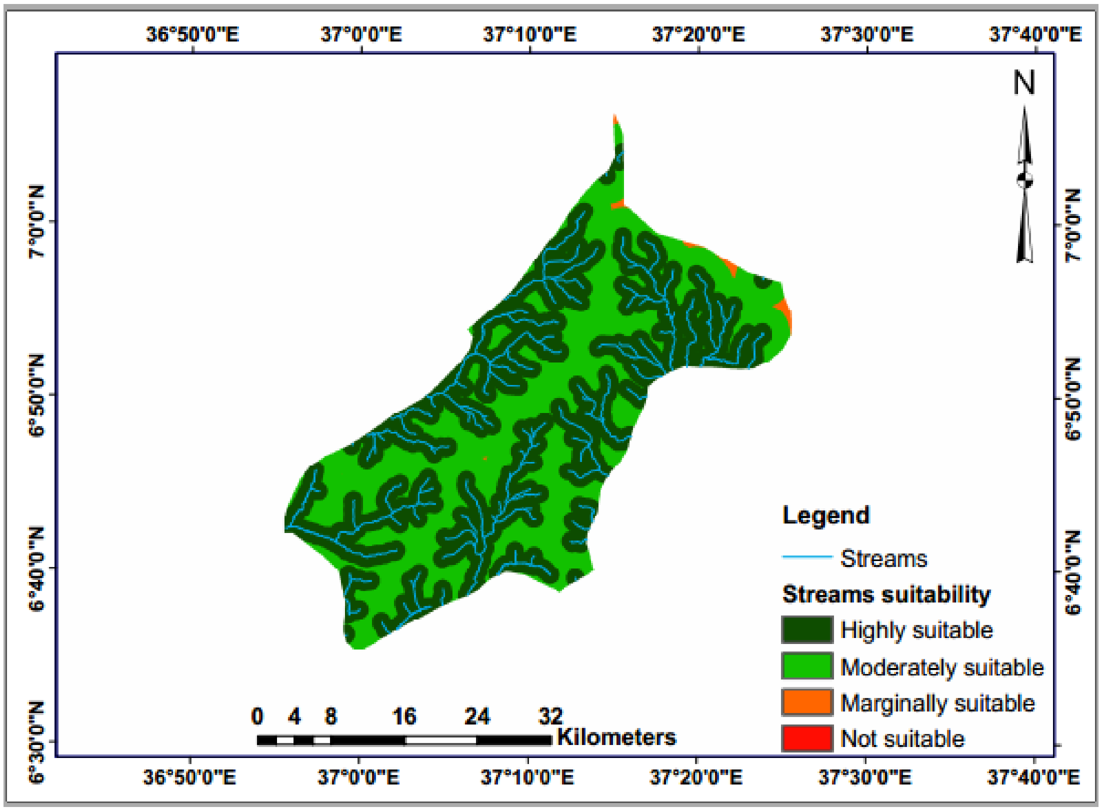


Figure.5 The suitable map of the soil type

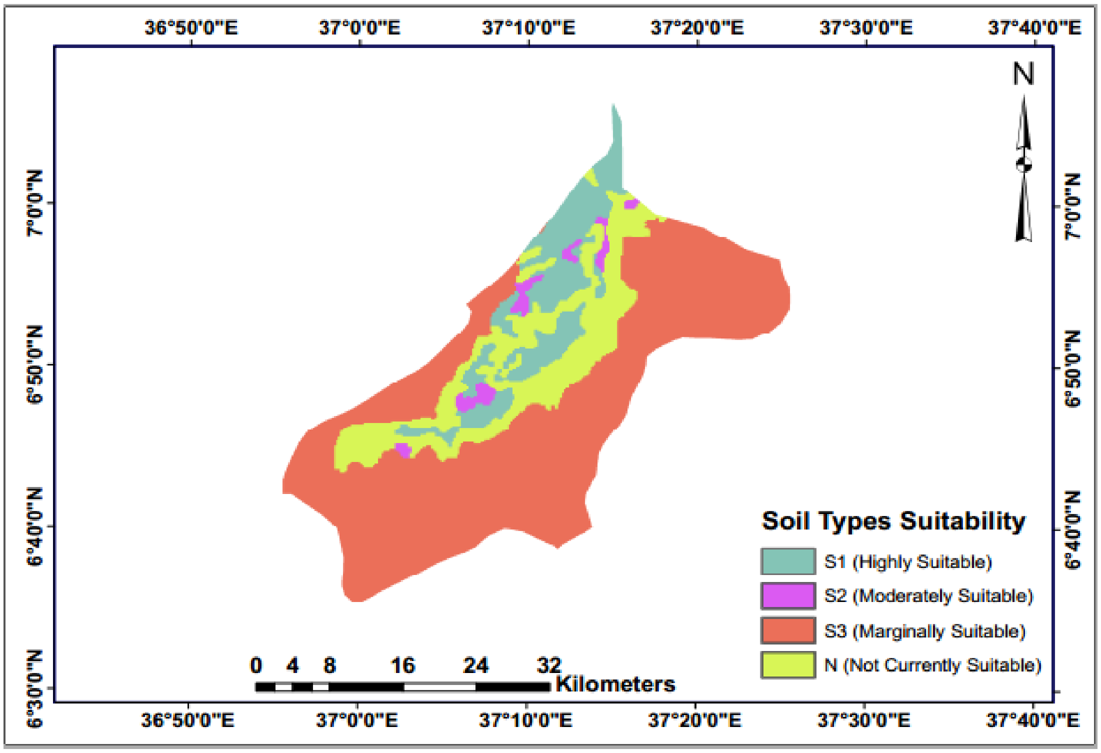


Figure.6 The suitability class map of mean annual temperature (a) and rainfall (b)

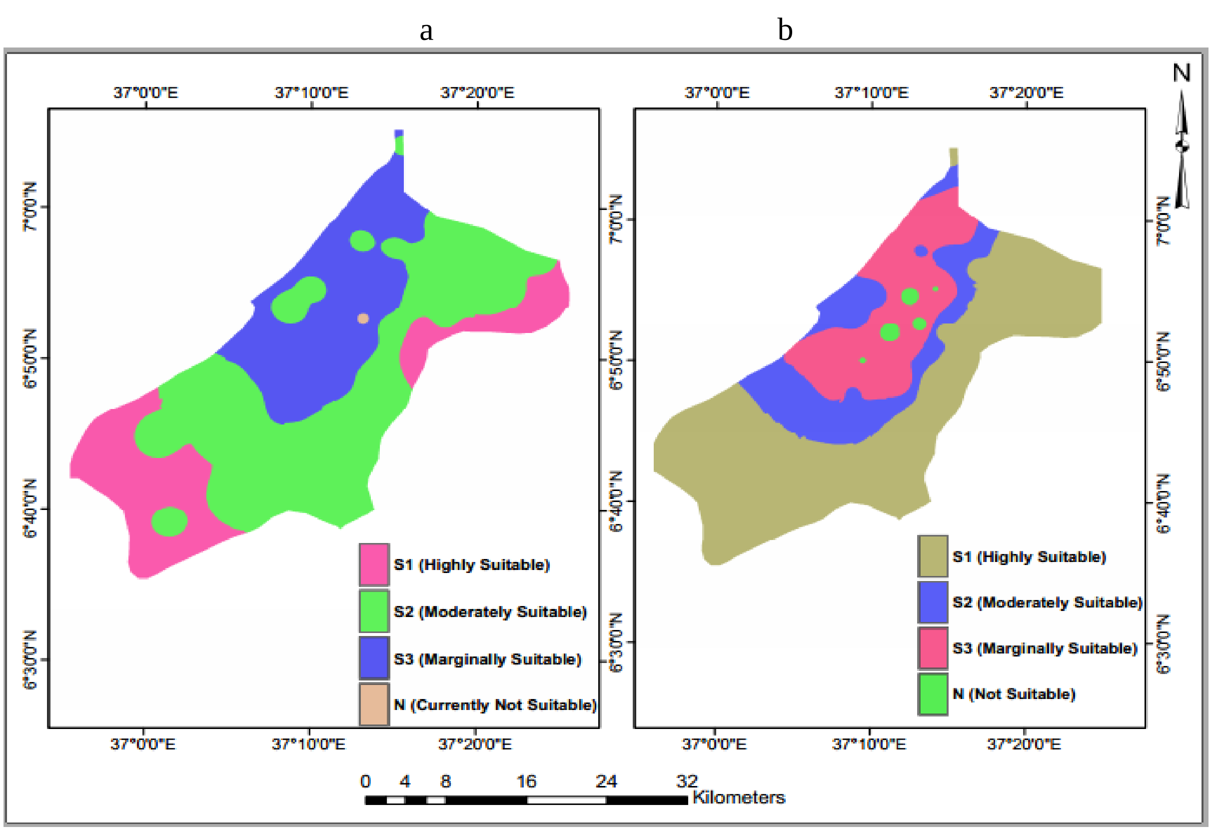


Figure.7 Potential surface irrigation suitability classes based on accessibility to market

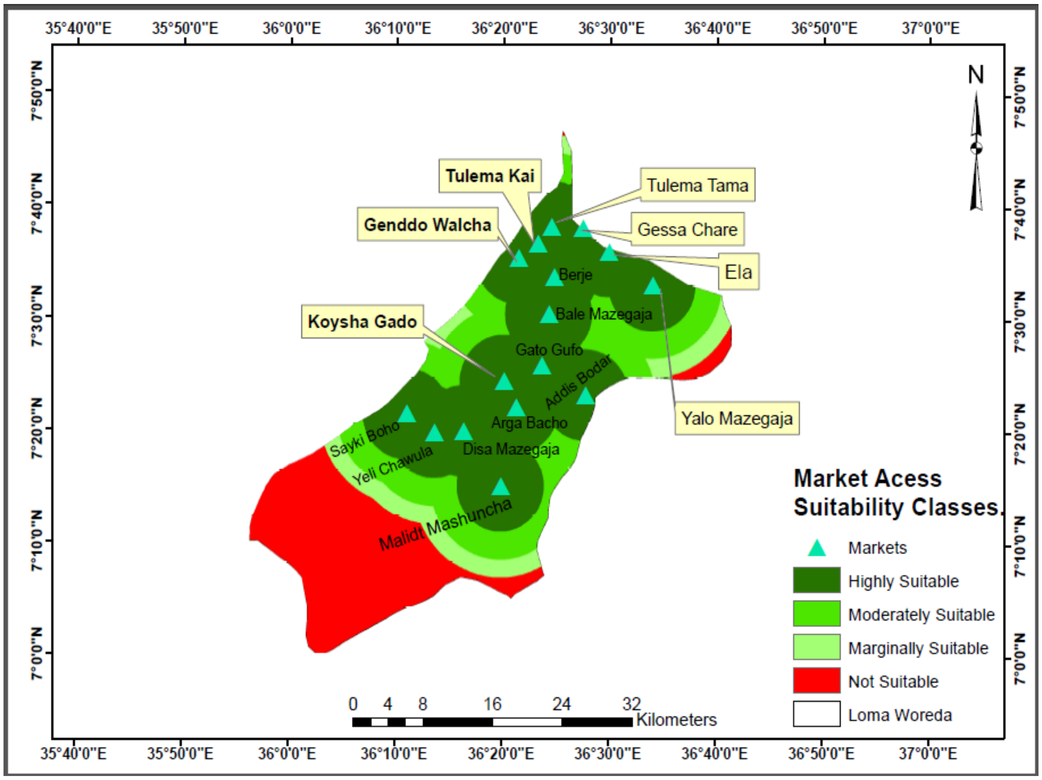
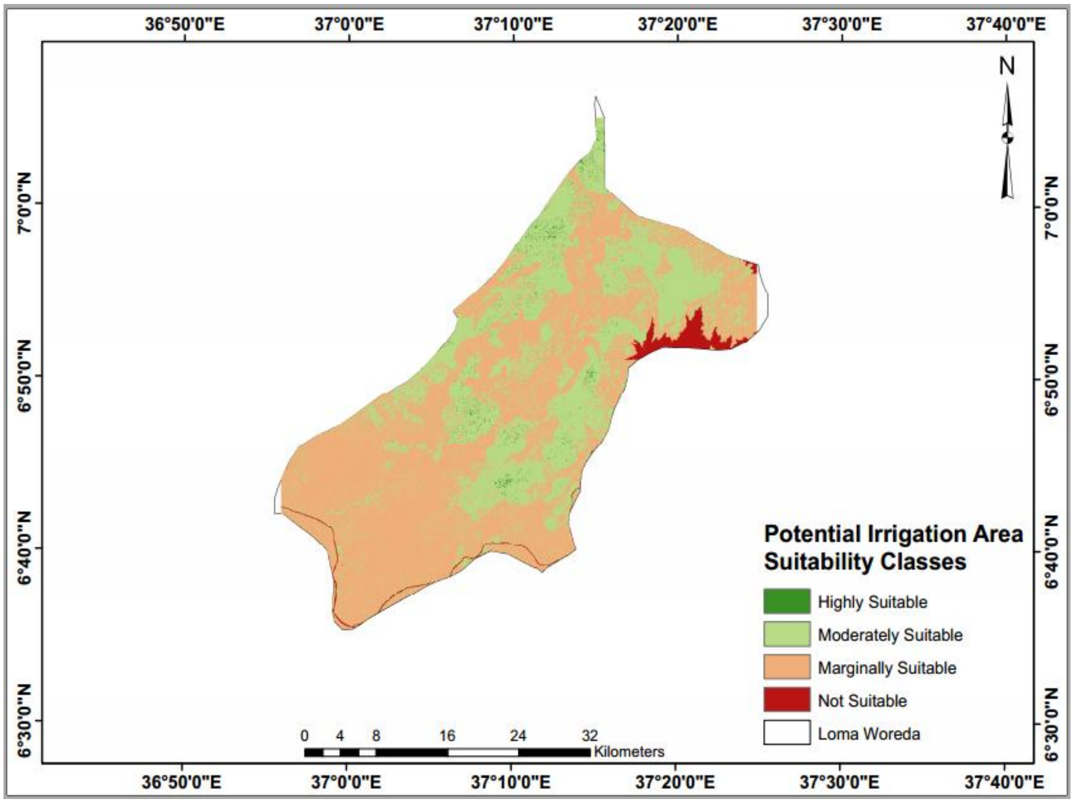


Figure.8 Potential surface irrigation area map of Loma Woreda



All the vector format data were converted to raster format of 30m*30m cell size. Each of the criteria were reclassified to common scale or suitable class in ArcGIS enviroment. The reclassified raster format suitable map of each were added to weighted overlay tool. The final suitable area determination for surface potential irrigation area were achieved by multiplying the cell value of each input reclassified raster by the raster weight of importance and adding up the result cell value to come up with final suitable surface potential irrigation area.

The final map of the study area was revealed that the *woreda* has a high potential of surface irrigation.

From the total area of 118,267.92ha of Loma *Woreda*, 770.58ha (0.65%) was highly suitable for surface irrigation development. This was largely located in GenddoWalcha, BeroYamala, DisaKera, WasaraTalo, Kai Gerera and Shota Mantut *kebeles*

Summary and Conclusion of the study are as follows:

This study assessed the irrigation potential of physical land resources and socio economic factor such as soil, slope, temperature and precipitation, market accessibility, land use or land cover and streams of Loma *Woreda*.

The physical land suitability factors such as slope and stream map were generated from DEM of ASTER 30m resolution. The climate data were computed as mean annual temperature and rainfall. The computed climate data were geo referenced with the help of positional data. The soil type map was obtained from reputed website. The land use/cover map of the area was prepared from Landsat ETM+ of 2015 with the help of envi 4.7 digital image processing software. The markets of study area were identified and mapped by collecting the positional data of respective market locations.

The surface irrigation suitability of the area indicate that 95,795.01ha (80%) of soil, 39,059.64ha (33%) of slope, 118,267ha (99%) of streams, 114,719.88ha (97.7%) of land use/cover, 91,899.9 ha (77.1%) of mean annual temperature, 116,222ha (98%) mean annual precipitation and 75,297ha (33%) of market location are in the suitable range of highly suitable to marginally suitable. In terms of land use or land cover the water body of GilgelGibeⅢ reservoir was restricted from surface irrigation development. The physical land resources and socio economic layer of the study map were reclassified to common scale. The reclassified suitability map layers were added and combined by the weighted overlay tool. The result of weighted overlay tool shown that 770.58 (0.65%) ha, 46,554.12(39.36%) ha and 67,253.13(56.86%) hectares of areas were highly, moderately and marginally suitable for surface irrigation respectively. The remained 3690.09ha (3.12%) of total area were not currently suitable. The study woreda has a high potential of surface irrigation. So that, Loma *Woreda* is suitable and preferable for surface irrigation development.

In conclusion, the research was intended to assess potential available suitable irrigation area in Loma*Woreda* by assessing physical land resources and socio economic factor. The study has also sought that GIS is effective and helpful in identifying the potential area in the study.

The main empirical findings of the study were presented in chapter four of result and discussions. The finding shown that, 118,267.92ha of total area of Loma*Woreda114,577.83ha (96.8%)* are potential suitable for surface irrigation in the range of highly suitable to marginally suitable. As it was shown in the final suitability map of the surface potential irrigation areas were evenly distributed across the *woreda*. But in the west end part of *woreda* there is no potential area for surface irrigation. This indicates that, the higher the potential of irrigation area are located in Northern, North Eastern and Eastern *kebeles* of Loma *Woreda*. This is because most of the physical land resources and market accessibility were suitable for surface irrigation. The result can be simply visualized and understood through by observing the final map of potential suitable surface irrigation area map (Fig. 4.13)

The finding of the study can assist policy decision during development of irrigation project in Loma *Woreda.*

The data generated for this study such as land use/cover map, soil map, streams map and identified basin, slope map, mean annual temperature and precipitation and market accessibility map of the study area can assist local or regional planners to facilitate preliminary survey and prepare irrigation projects in the study area.

Future Research: This study to be continued to include the following main points for the future.

The surface irrigation was assessed by using the physical land resources namely soil, stream, slope, temperature and precipitation and land use or land cover data and with the only one socio economic factors of market accessibility factors.

But the effect of the factors such as moisture of soil, texture class and depth suitability, specific crop based analysis, economic and social terms should be assessed to get sound and reliable result. Surface irrigation land suitability analyse result indicates that 96.8% of the study area were suitable for surface irrigation. Crop based suitability analysis should be carried out to precisely and effectively use the potential area for the further.

In this research the accessibility of market in terms of distance was carried out. But the future research should integrate and analyze potentially profitable crops and potential area of irrigation. The application of remote sensing and GIS was found helpful in assessing surface irrigation potential in this study. It is there for hopped that, future irrigation development activities will exploit these resources more than the present study for the better assessment of physical land resources in the study area and elsewhere.

References

Aklilu Kahssay and Mishera, Sanjay (2013). Community Development Through Hydroelectric Project: A Case Study of Gilgel Gibe Ⅲ Hydroelectric Power Project in Ethiopia, Journal of International Community Development, 1(1).

Anne Lothoré and Patrick Delmas (2009). Market Access and Agricultural Product Marketing Promoting Farmer Initiatives. Retrieved fromwww.inter-reseaux.org on 16 March, 2016.

CSA (2008).Summary and Statistical Report of the 2007, Population and Housing Census Population Size by age and sex. Addis Ababa: UNFPA.

Demers, Michael N. (2009). GIS for Dummies**.** Indiana: Wiley Publishing, Inc

Eastman, Ronald. J (2001). Guide to GIS and Image processing. USA: IDRIS.

Enderle, Donald I.M and Jr., Robert C. Weigh (2005).Integrating Supervised and Unsupervised Classification Methods to Develop a More Accurate Land Cover Classification. Journal of the Arkansas Academy of Science, 59.

FAO (1985). Guidelines Land Evaluation for Irrigated Agriculture. FAO Soils Bull 55, Rome.

FAO (2007). Irrigation Potential in Ethiopia A Basin Approach. FAO Land and Water Development Division: Rome

FAO (1990).Watershed Management Field Manual Watershed Survey and Planning. Rome: FAO.

FAO (1976). A Frame Work for Land Evaluation .Rome: FAO.

FAO (1995C). Assessment of Irrigation Potential in Africa ArcInfo: A Tool for Computation of the Irrigation Water Requirements At Continental Level. Rome: FAO.

Fischer, Nachtergade, Freddyb O., PridersylviaTeixera, Edmar, TothGeza, Harrijuan, Verelst. Luc and Wiberg, Dania (2012). Global Agro Ecological Zones (GAEZ v3.0)-Model Document. Rome: FAO.

Grain(2012).Squeezing Africa Dry: Behind Every Land Grab is a Water Grab. Retrieved from *www.grain.org/e/4516* On 14 Decmber 2015.

Gebremedhin Gebremeskel Haile and AsfawKebedeKasa (2015). Irrigation in Ethiopia:A review in Journal of Agricultural research ,3(10).

GizachewAyalew (2014). Land Suitability Evaluation for Surface and Sprinkler Irrigation Using Geographic Information System (GIS) in Guang Watershed, Highland of Ethiopia. In Journal of Environment and Earth Science, 22(4).

Huisman, Otto and De Buy, Rolf A/Eds/ (2009). Principles of Geographic Information Systems An Introductory Text Books, Netherland: The International Institute for Geo Information Science and Earth Observation.

KebedeGanole (2010). GIS-Based Surface Irrigation Potential Assessment of River Cachment for Irrigation Development in Dale *Woreda*, Sidama zone, SNNP. Published master's thesis, University of Harmaya, Harmaya, Oromia Regional State.

Loma Woreda Agricultural Office (2016).Soil and Water Conservation Strategy, Annual Report.

Levin, Noam(1999).Fundamentals of Remote Sensing. Israel: The Society for the Protection of Nature in Israel.

Melaku Yirga Wolde (2003). Assessment of Irrigation Potential in the Roxo Dam Area (Portugal) for Strategic Planning Using GIS/RS. Netherland. International Institute for Geo information Science and Earth Observation: Ensched Press.

Meron Tariku Ayne (2007). Surface Irrigation Suitability Analysis of Southern Abbay Basin by Implementing Gis Techniques (A Case Study In Dedessa Sub-Basin).Addis Ababa: Addis Ababa University.

Ministry of Agriculture And Rural Development (2010). Ethiopia's Agricultural Sector Policy and Investment Framework (Pif) 2010-2020.Retrieved from https://encrypted.google.com/#q=ministry+of+agric

ulture+and+natural+resources+ethiopia+annual+report on March 2, 2016.
Molden, David (2009). Water Security for Food Security: Findings of the Comprehensive Assessment for Sub Saharan Africa. Retrieved from www.iwmi.org/assessment On 13 December 2015.
Navalgund, Ranganath R., Jayaraman, V., and Roy, P.S. (2007). Remote Sensing Applications: An Overview, Journal of Current Science, 93 (1,225).
NegashWagesho(2004).GIS Based Suitability Analysis(A case study of Abaya-Chamo basin. Southern Rift valley of Ethiopia. Arbaminchi: Arbaminchi University, Institute of Water Technology.
Parimala, M and Hopez, Daphne (2005). Decision Making in Agriculture Based on Land Suitability Spatial Data Analysis Approach. In Journal of Theoretical and Applied Information Technology, 46 (1).
Parmenter, Barbara and Melcher, Jack (2012). Watershed and Drainage Delineation by Pour Pointin Arcmap 10.Retrieved from http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html//009z0000005m00000.htm on 25 December 2015.
Riad, Peter H.S., Billib, Max, Hassana,Ahmed A., Salam, Maha Abdel and Eldin, Mohamed Nur (2011). Application of the Overlay Weighted Model and Boolean Logic to Determine the Best Location for Artificial Recharge of Ground Water .In Journal of Urban and Environmental Engineering, 2(2).
Ritung, Sofyan, Whayunto, Agus, Fahmudin and Hidayet, Happid (2007). Land Suitability Evaluation With A Case Map of Ach Baret District. Indonesia Soil Research Institute and World Agro forestry Center, Bogore: Indonesia, Pp: 1.
Richards, John A. and Jia, Xiuping (2006). Remote Sensing Digital Image Analysis. German: Springer.
Seleshi Bekele (2001). Investigation of Water Resources Aimed at Multi Objective Development With Respect to Limited Data Situations The Case of Abaya-ChamoBasin, Ethiopia. Ph.D Thesis Technische Universitat Dresden Institute Fur Wasserbaw und Technische Hydromechanik D-01062 Dresden.
Seleshi Bekele (2010). Irrigational Potential in Ethiopia Constraints and Opportunities for Enhancing the System. International Water Management
Seleshi Bekele Awulachew, Aster Denekew Yilma, Mekonnen Lulsegd, Loiskandl, Willibald, Mekonnen Ayana and Tena Alamirew (2007). Water Resources and Irrigation Development in Ethiopia. International Water Institute: Austria.
Slehak Melak (2007). Land capability, Irrigation Potential and crop suitability analysis using GIS and Remote Sensing in Upper Kesem (Awash Basin). Unpublished M.Sc thesis.
Smith, Michael J de, Goodchild, Michael F, A Longley, Paul (2015). Geospatial Analysis A Comprehensive Guide to Principles, Techniques and Software Tools. Winchelsea, UK: Winchelsea Press.
Wale, Abeyou, Collick, Amys, Rossiter, David G., Langon, Simon and Stenhuis, Tammo S. (2003). Realistic Assessment of Irrigational Potential in the Lake Tana Basin, Ethiopia. In Journal of Rainwater Management for Resilient Livelihood in Ethiopia. Nairobi: International Livestock Research Institute.

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