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EVALUATION OF LAND USE LAND COVER CHANGE ON STREAM FLOW: A CASE STUDY OFDEDISSA SUB BASIN, ABAY BASIN, SOUTH WESTERN ETHIOPIA.

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ABSTRACT

Land use land cover change have an impact on hydrology of the watershed on theDedissa sun basin. The study mainly focused on estimating land use change and stream flow under different land use land cover changes of the sub basin. Land use land cove maps of 1986 and 2010 were developed using satellite image throughmaximum likelihood algorithm of supervised classification using ERDAS Imagine 2014. Aphysical-based, semi-distributed hydrological model, SWAT was used to simulate LULCeffects on the hydrological response of Didessa sub-basin.During the study period the land use land cover has changed due to population growth. The cultivatedland increased by 12% and whileforestland decreased by 3.61%. The simulatedStream flow results were utilized to analyze seasonal variability stream flow due to land use and land cover changes. The performance ofthe SWAT model was evaluated through sensitivity analysis, calibration, and validation.Both the calibration and validation result shows good agreement between observed andsimulated stream flow with NSE and R^2 values of 0.7 and 0.79 respectively. Sensitivity analysis using the SWAT modelhas pointed out some crucial parameters that control the stream flow and sediment yieldin the catchment. The result of this study indicated that mean monthly stream flow wereincreased by 29.44m^3/s for wet season and decreased by 4.44m^3/s in dry season over 25 years period.

KEY WORDS: SWAT, ERDAS, Dedissa sub basin, Land use land cover change

INTRODUCTION

BACKGROUND

In Ethiopia where about 85% of the population is engaged primarily in agriculture and depends heavily on available water resources, the assessment and management of available water resources is a matter of prime importance. Surface water flow modeling is an important tool frequently used in studies in surface water system and watershed management [1].
Dedissa sub basin is one of densely populated with an annual growth rate of 2.3 % [2]. This causes various effects on resource bases like deforestation and agricultural land this leads to

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the changes in hydrology of the watershed and sediments deposited in stream channels reduce flood carrying capacity, resulting in more frequently over flows and greater floodwater damage to adjacent properties.

The main objective of this study is to evaluate land use land cover change effects of on stream flow of Dedissasub basin. Moreover this research tried to evaluate the land use land cover changes between 1986 and 2010 and its implication on stream flow. Therefore, this study will enable the knowledge of land use pattern of the sub basin and it could be essential indicator for the resource base analysis and development of effective and appropriate action for sustainable management of natural resources in the country in general and at the study area in particularly.

1. DESCRIPTION OF THE STUDY AREA

Didessa Sub Basin contributes a quarter of the total flow of the Blue Nile as measured at the Sudan border. DidessaRiver is the largest tributary of the Blue Nile in terms of volume of water, which is located in the South Western part of Ethiopia, having a vast number of tributaries that has drainage area of nearly 9979 km^2. The topography or elevation of the watershed ranges from 1274 to 3145m above mean sea level.

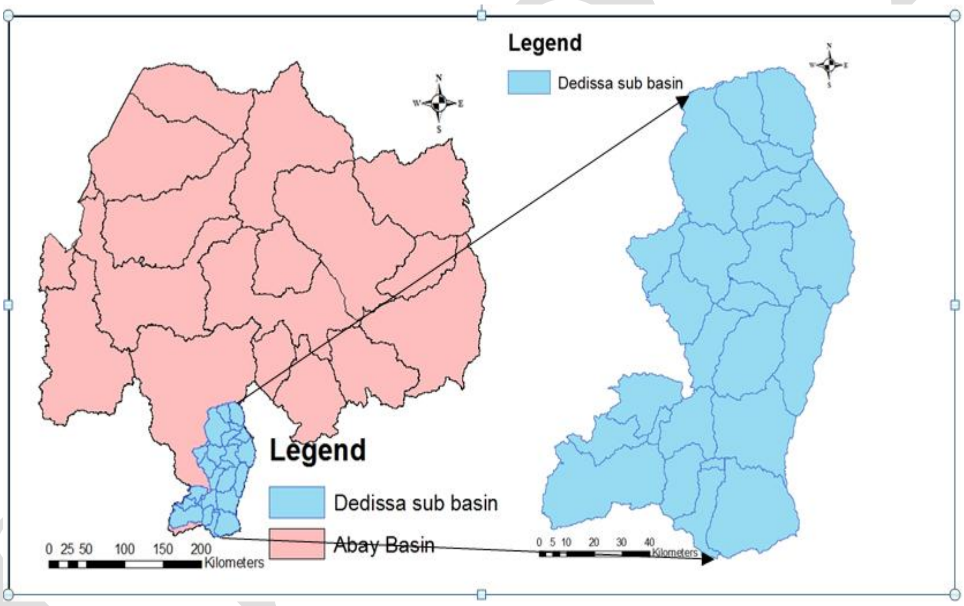

Figure1 Location of study area

Generally the Didessa sub-basin is geographically located between 36^0 02’ and 36^0 46’ East longitude, and between 7^0 43’ and 8^0 13’ North latitude.The majority of the area is characterized by a humid tropical climate with heavy rainfall and most of the total annual rainfall is received during one rainy season called kiremt. The maximum and minimum temperature varies between 21.1 – 36.5^0c and 7.9 -16.8^0c, respectively. The mean annual rainfall in the study area ranges between 1509 mm in the southern to 2322 mm in the northern catchments. The altitude ranges between 1720m and 2088m above sea level.

The sub basin soil is mainly formed from HaplicAlisols, Eutric Vertisols, Halpic Nitisols and Haplic Acrisol type, but the riverbed has a loam and sandy-loam type of soil. From these soils Haplic Alisols covers the largest prtion at about 65.36%, Eutric Vertisols and Haplic Acrisolscovers 12.01% and10.31% respectively and the remaining 12.31% covered with others types of soils.

METHODOLOGY

The methodology mainly focuses on addressing the impact of land use /cover change on stream flow by using ERDAS imagine2014 and arc SWAT models. ERDAS imagine2014 used for image processing by maximum likelihood supervised classification algorism. SWAT is used for stream flow simulation and analysis.

1.1 DESCRIPTION OF SWAT MODEL

Soil and Water Assessment Tool (SWAT) is a model developed by US Department of Agriculture – Agriculture Research Service (USDA-ARS). It is a conceptual, physically based, basin scale, daily time step, semi-distributed model that functions on a continuous time step. Model components include weather, hydrology, erosion/sedimentation, plant growth, nutrients, pesticides, agricultural management, channel routing, and pond/reservoir routing [3]. Among the many advantages of this model are; it has incorporated several environmental processes, it uses readily available inputs, it is user friendly, it is physically based and distributed, and it is computationally efficient to operate on large basins in a reasonable time.
The model calculations are performed on HRU basis and flow and water quality variables are routed from HRU to sub-basin and subsequently to the watershed outlet. The SWAT model simulates hydrology as a two-component system, comprised of land hydrology and channel hydrology. The land portion of the hydrologic cycle is based on a water mass balance. SWAT estimates soil erosion using the Modified Universal Soil Loss Equation [4].

1.2 HYDROLOGICAL COMPONENT OF SWAT

The Simulation of the hydrology of a watershed is done in to two separate divisions. One is the land phase of the hydrological cycle that controls the amount of water, sediment, nutrient and pesticide loadings to the main channel in each sub-basin. The second division is routing phase of the hydrologic cycle that can be defined as the movement of water, sediments, nutrients and organic chemicals through the channel network of the watershed to the outlet. In the land phase of hydrological cycle, SWAT simulates the hydrological cycle based on the water balance equation (equation).

$$SW_t = SW_o + \sum_{i=1}^{t} (R_{day} - Q_{surf} - E_a - w_{seep} - Q_{gw} \qquad (1)$$

In which SWtis the final soil water content (mm), SWo is the initial soil water content on day i (mm), t is the time (days), Rday is the amount of precipitation on day i (mm), Qsurf is the amount of surface runoff on day i (mm), Ea is the amount of evapotranspiration on day i (mm), Wseep is the amount of water entering the vadose zone from the soil profile on day i (mm), and Qgw is the amount of return flow on day i (mm).
Surface runoff occurs whenever the rate of precipitation exceeds the rate of infiltration. SWAT offers two methods for estimating surface runoff: the SCS curve number procedure (USDA-SCS 1972) and the Green &Ampt infiltration method [5]. Using daily or sub daily rainfall, SWAT simulates surface runoff volumes and peak runoff rates for each HRU. In this study, the SCS curve number method was used to estimate surface runoff because of the unavailability of sub daily data for Green &Ampt method.
The SCS curve number equation is:

$$Q_{surf} = [(R_{day} - 0.2S)]\hat{}2/(R_{day} + 0.8S \qquad (2)$$

In which, Qsurf is the accumulated runoff or rainfall excess (mm), Rday is the rainfall depth for the day (mm), S is the retention parameter (mm). The retention parameter is defined by the equation:

$$S = 25.4 * \left[\left(\frac{100}{CN}\right) - 10\right] \qquad (3)$$

1.3 SWAT INPUT DATA

1.3.1 DIGITAL ELEVATION MODEL (DEM)

The topography is defined by DEM, which describes the elevation of any point in a given area at a specific spatial resolution, which is used for watershed delineation. A 30 by 30 meter resolution DEM was taken from Ministry of water, Irrigation and Energy of Ethiopia GIS and remote sensing department, and used for this study.

1.3.2 SOIL DATA

Soil data is one of the major input for SWAT model with inclusive and chemical properties. The soil map of the study area was also obtained from Ministry of Water, Irrigation and Energy of Ethiopia. According to FAO classification, eight major soil groups were identified in the Dedissa sub basin. SWAT model requires soil physical and chemical properties such as soil texture, available water content, hydraulic conductivity, bulk density and organic carbon content for different layers of each soil type. To integrate the soil map with SWAT model, a user soil data base which contains textural and chemical properties of soils was prepared for each soil layers and added to the SWAT user soil data bases.

1.3.3 METEOROLOGICAL DATA

Meteorological data is needed by the SWAT model to simulate the hydrological conditions of the basin. The meteorological data required for this study were collected from National Meteorological Agency of Ethiopia. The meteorological data collected were precipitation, maximum and minimum temperature, relative humidity, and wind speed and sunshine hours for six stations (Nekemt, Jimma, Arjo, Chora, Limugenet and Denbi) from the year 1985 - 2011.

A. FILLING MISSING DATA

Data were missing from a particular gauge site or representative precipitation is necessary at a point of interest. There are different methods for filling the missing data from those methods station average and normal ratio method were used for the rainfall in this study [6].

$$\% \text{ difference} = \left(\frac{N_X - Ni}{N_X}\right) * 100 ------------------------ 4$$

N_x–N_i must be positive. IfN_i>N_x the numerator will become N_i – N_x.Then, the mean of the nearby stations' differences is determined.

$$P_X = \frac{1}{n} * [\left(\frac{N_X}{N_1}\right) * P_1 + \left(\frac{N_X}{N_2}\right) * P_2 + \cdots + \left(\frac{N_X}{N_n}\right) * P_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where $P_X$is the missing data at station x, N_x is the missing data stations normal annual rainfall, N_i is normal annual rainfall at station i, and n is number of nearby gauges

The station-average method for estimating missing data uses n gages from a region to estimate the missing point rainfall, P_X, at another gage:

$$P_x = \frac{1}{n}\sum_{i=1}^{n} p_i - 6$$

In which Pi is the rainfall at gage i(Equation 6) is accurate when the total annual rainfall at any of the n regional gages when the mean of percent difference is less than 10%. This method gives equal weight to the rainfall at each of the regional gages. The value 1/n is the weight given to the rainfall at each gage used to estimate the missing rainfall.

Most of the rainfall recorded from the stations has missing data ranging about 10 %.Therefore before using the data to runoff modeling it was first essential to apply a gap filling techniques. The other station which has greater than 10% is filling by weather generator.

B. CONSISTENCY

Double mass curve (DMC) was used to check the consistency of rainfall for adjustment of inconsistent data. This technique is based on the principle that when each recorded data comes from the same parent sample, they are consistent. A group of 6 base stations in the neighborhood of the station was selected.

A consistent record is one where the characteristics of the record have not changed with time. A double-mass curve is a graph of the cumulative catch at the rain gage of interest versus the cumulative catch of one or more gauges in the region that has been subjected to similar hydro meteorological occurrences and is known to be consistent. If a rainfall record is a consistent estimator of the hydro meteorological occurrences over the period of record, the double-mass curve will have a constant slope. A change in the slope of the double mass curve would suggest that an external factor has caused changes in the character of the measured values. If a change in slope is evident, then either the record needs to be adjusted with the early or the later period of record adjusted.

$$\frac{P_a}{P_d} = \frac{Y}{X} \Big/ \frac{Y_d}{X_D} = \frac{\text{Slope of original line}}{\text{slope of deviated line}} = \text{correction factor} - - - - - - - - 7$$

In which Pa = adjusted amount Pd= deviated amount for the concurrent period for which Pa is desired.

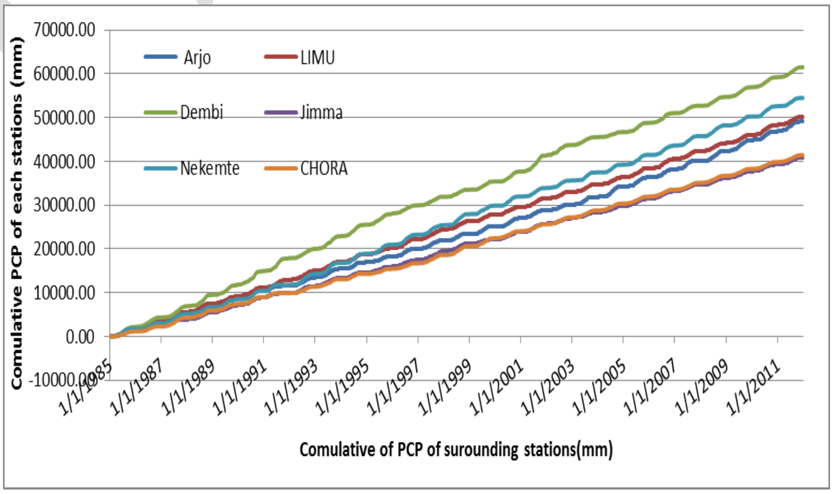

Figure 2. Double mass curve of the selected station

The collected weather data were also arranged as per the requirement of SWAT model. Wgn user weather parameters were developed by using the weather parameter calculator pcpSTAT and dew point temperature calculator DEW02.

1.3.4 FLOW DATA

Flow data was required for performing sensitivity analysis, calibration and validation of the model from 1985 to 2010 for the period of 26 years. The flow data was also collected from Ministry of Water, Irrigation and Energy of Ethiopia. The flow data at Arjo gauged station were collected and arranged as per the requirement of SWAT model. The homogeneity of rainfall and flow data were also checked using RAINBOW (a software package for hydro meteorological frequency analysis and testing the homogeneity of historical data sets). RAINBOW offers a test of homogeneity which is based on the cumulative deviations from the mean. By evaluating the maximum and the range of the cumulative deviations from the mean, the homogeneity of the data of a time series was tested.

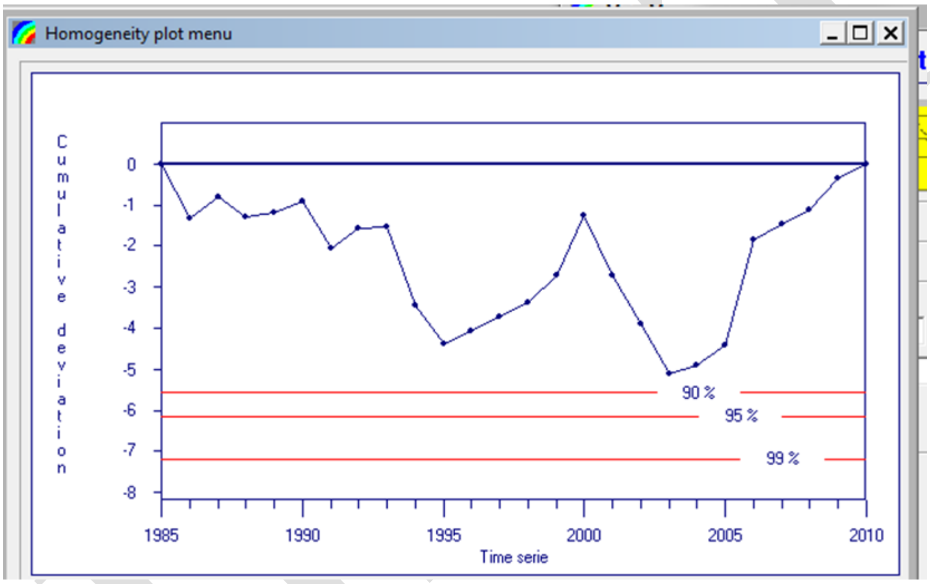

Figure 3. Homogeneity test of flow data

1.3.5 LAND USE LAND COVERS DATA

Land use is also another most important factor that affects runoff, evapo-transpiration and surface erosion in a watershed. The Land use and land cover change studies usually need the development of land cover units before the analysis is started. The two different year's satellite image were downloaded from USGS Glovis website and used for land use change detection of the area.

Table 1. Land use land cover classification of the study area

Land use/land cover	Land use according to SWAT data base	SWAT code
Cultivated land	Agriculture land to grown	AGRC
Forest	Forest mixed	FRST
Shrub land	Range Brush	RNGE
Grass land	Range –grass	RNGB
Water	Water	Water

1.4 LAND USE AND LAND COVER MAPPING

1.4.1 IMAGE PROCESSING

This study was done using Land sat imageries of five bands to identify changes in land use and land cover distribution in the Dedissa sub basin over 25 years period from 1986 to 2010. Land sat ETM+ was selected for the period of 1986 and 2010. To avoid a seasonal variation in vegetation pattern and distribution throughout a year, the selection of dates of the acquired data were made as much as possible in the same annual season of the acquired years. In order to view and discriminate the surface features clearly, all the input satellite images were composed using the false color composition. The images provide complete coverage of Dedissa sub basin.

The image data files were downloaded in zipped files from the United State Geological Survey (USGS) website and extracted to Tiff format files with the path/row of 170/55,170/54 and 169/55,169/54. The resolution of the image was 30 meter with sensor of ETM+ and the acquisition date wereJan 01/1986 and Jan 01/2010.

1.4.2 LAND USE AND LAND COVER CLASSES

The Land use and land cover change studies usually need the development and the definition of homogeneous land use and land cover units before the analysis is started. These have differentiated using the available data source such as remote sensing, any other relevant information and the previous local knowledge. Hence, based on the priori knowledge of the study area and additional information from previous research [7 and 8], six different types of land use and land cover have been identified for the Dedissa sub basin. The identified land use types were agriculture (cultivated land), forest, shrub, grass and water.

1.4.3 LAND COVER CLASSIFICATION

Image classification and enhancement for the study performed using ERDAS imagine 2014.

Image classification involves the process of assigning of pixels of continuous raster image to the predefined land cover classes. A different issue to keep in mind to avoid overlapping features and finish with effective classification lies parallel with the ground truth. The result of the classification is mostly affected by various factors such as classification methods, algorithms, collecting of training sites etc. Usually it needs to acquire ground reference information from a field test site within the image. The sites were representative of the range of land cover types that is found in the area.

There are two approaches of classification, which are unsupervised and supervised classification. For this study, the land cover map produced based on the pixel based maximum likelihood supervised classification through using ground truth (training) points of the area. The training sites were collected from Google Earth by liking to EARDAS imagine 2014 and the analyst done by personal experience and knowledge of the physiographical knowledge of the area.

1.5 MODEL SET UP

Physically based Soil and Water Assessment Tool (SWAT) was used for watershed delineation, HRUs, weather data write up, sensitivity analysis and other watershed characteristic determinations.

Arc SWAT uses Digital Elevation Model (DEM) data to automatically delineate the watershed into several hydrologically connected sub-watersheds. The watershed delineation operation uses and expands ArcGIS and spatial analyst extension functions to perform watershed delineation. The initial stream network and sub-basin outlets were defined based on drainage area threshold approach. Multiple Hydrological response units (HRU) of the watershed were formed using 10%/10%/5%threshold levels of land use, soil and slope classes respectively. After creating multiple HRUs weather write up and simulation of the model follows.

1.5.1 SENSITIVITY ANALYSIS

A model sensitivity analysis can be help full in understanding which model input are the most important. Sensitivity analysis is a method of identifying the most sensitive parameters that significantly affects the model calibration and validation. Sensitivity analysis describes how model output varies over a range of a given input variable [9]. So that twenty-sixflow, parameters were checked for sensitivity. Sensitivity analysis was done using the simulated flow and observed flow data. So that this step simplifies the calibration and validation process.

When a SWAT simulation is taken place there would be discrepancy between measured data and simulated results. So, to minimize this discrepancy, it is necessary to determine the parameters which are affecting the results and the extent of variation. Hence, to check this, sensitivity analysis is one of SWAT model tool to show the rank and the mean relative sensitivity of parameters identification and this step was ordered to analysis. This appreciably eases the overall calibration and validation process as well as reduces the time required for it.

Hence, 26 flow parameters were included for the analysis with default values as recommended by other researchers [10]. Up on the completion of sensitivity analysis, the mean relative sensitivity (MRS) values of the parameters were used to rank the parameters, and their category of classification. The category of sensitivity was defined based on the [11] classification presented in table 2 below.

Table 2. Classification of sensitivity of model

Class	RMS	Sensitivity category
Cass one	0.00≤ MRS <0.05	Small to negligible
Class two	0.05≤ MRS <0.20	Medium
Class three	0.2≤ MRS <1	high
Class four	MRS >1	very high

Based on the above classification, parameter producing MRS values of medium, high and very high were selected for calibration process.

1.5.2 MODEL CALIBRATION

Calibration is the process whereby model parameters are adjusted to make the model output match with the observed data. Therefore, in this study the hydrologic component of the model was calibrated at Arjo gauging station in order to make the simulation result more realistic for independent calibration period. The period from 1991 to 1999was used as a calibration period since the data for this period was with little missing data or representative data.

1.5.3 MODEL VALIDATION

Validation is the comparison of the model outputs with in independent data set without making any adjustment.The purpose of model validation is to check whether the model can predict flow for another range of period.In order to utilize the calibrated model for estimating the effectiveness of future potential management practices, the model was tested against an independent set of measured data. As the model predictive capability was demonstrated as being reasonable in both the calibration and validation phases, the model was used for future predictions under different land use scenarios. The statistical model performance measure would be used in calibration as percent difference between simulated and observed data.The period from 2001 to 2004 was taken as a validation period.

1.5.4 MODEL PERFORMANCE EVALUATION

Model evaluation is an essential measure to verify the robustness of the model. In this study, two model evaluation methods were used, which were Nash-Sutcliffe efficiency (NSE) and coefficient of determination (R^2) [12].

$$NSE = 1 - \frac{\sum_{i=1}^{n} (X_i^{obs} - X_i^{sim})^2}{\sum_{i=1}^{n} (X_I^{obs} - X^{mean})^2} - - - - - - - - - 8$$

where, X_i^{obs} =observed variable (flow in m^3s^{-1}or sediment concentration in mg l^{-1}).
X_i^{sim} = simulated variable (flow in m^3s^{-1}or sediment concentration in mg l^{-1}).
X^{mean} =mean of n values
n=number of observations

The coefficient of determination (R^2) describes the proportion the variance in measured data by the model. It is the magnitude linear relationship between the observed and the simulated values. R^2 ranges from 0 (which indicates the model is poor) to1 (which indicates the model is good), with higher values indicating less error variance, and typical values greater than 0.6 are considered acceptable [13]. The R^2 is calculated using the following equation:

$$R^2 = \frac{\sum[X_i - X_{av}] * [Y_i - Y_{av}]}{\sqrt{\sum[X_i - X_{av}]^2} * \sqrt{\sum[Y_i - Y_{av}]^2}} - - - - - - - - - - 9$$

where, Xi – measured value (m^3/s)
Xav – average measured value (m^3/s)
Yi – simulated value (m^3/s) and
Yav – average simulated value (m^3/s)

RESULT AND DISCUSSION

1.6 LAND USE AND LAND COVER ANALYSIS

The two-land use cover maps of 1986 and 2010 generated from the land sat ETM+ imaginary classification (Figure 4 and 5 respective years). It is easily shown that there is an increase of cultivated land, and decrease of forested areas, shrub land, grassland and water bodies over 25 years. In general, during 25-year period the cultivated land increases at about 12% whereas the forested area decreased by 3.61%. For the individual class area and change statistics for the two periods are summarized as follows (Table 3).

Table 3. Area coverage of different land use class (%)

Land cover types	1986 (%)	2010 (%)	2010-1986 (%)
Agriculture land	36.7	48.6	11.94
Forest	18.25	14.64	-3.61
Grass land	17.87	15.87	-2
Shrub land	25.21	19.75	-5.16
Water	1.76	0.92	-0.86
Urban	0.21	0.22	0.01

The land use land cover map of 1986 (Figure 4) showed that the total cultivated land coverage was about 36.7% of the sub basin and increased rapidlyto 48.64% of the sub basin in 2010 (Table 3 and Figure 4). The reason is mainly the growth of the population that caused the increase in demand for new cultivation land andsettlement, which in turn resulted shrinking of other typesof land use percentage of the sub basin. On the other hand,the total forest coverage in 1986 was about 18.25% and then reduced to 14.64% in 2010. This was due to deforestation activities that have taken place for the purpose of agriculture, firewood and new settlement.

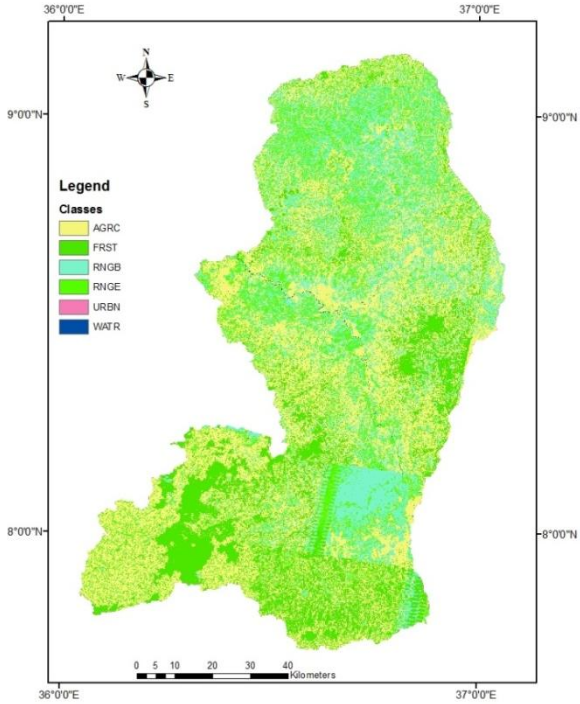

Figure 4. LULC map of dedissa sub basin supervised classification 1986

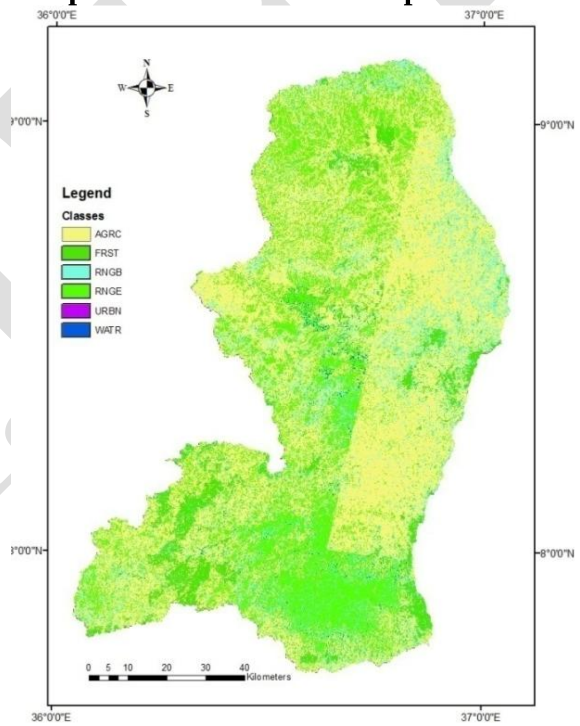

Figure5.LULC map of Dedissa sub basin of supervised classification 2010

Previous studies in other parts of the country alsoshowed similar result. For example, Hurni[14] showed that 99% of the forest covers changed to agriculture and at Dembecha area in the northern part of the country between 1957 to1995. Asmamaw[15]reported that the cultivated land increase by 46% while the forest decrease by 2% in GilgelAbay watershed.

1.7 STREAM FLOW MODELING

1.7.1 SENSITIVITY ANALYSIS

Sensitivity analysis of simulated stream flow for the sub basin was performed using the daily observed flow data for identifying the most sensitive parameter and for further calibration of the simulated stream flow. Twenty-six flow parameters were checked for sensitivity and four of them were found to be highly sensitive (Table 4).

Table 4.Sensitive parameters and their rank with RMS value for stream flow

Parameter name	Parameter value range	RMS	Calibrated value	Sensitivity	Significance
CN2	±25%	0.571	47.08	1	High
ESCO	0 – 1	0.568	0.82	2	High
SOL_AWC	0-1	0.374	1.0	3	High
GWQMN	0 – 5000	0.307	4500	4	High

From those parameters SCS runoff curve number (CN2), Soil evaporation compensation factor (ESCO), Soil available water capacity (SOL_AWC), and Threshold depth of water in the shallow aquifer required for return flow (GWQMN) are sensitive parameters and ranked from 1 up to 4 respectively. The remaining parameters were not considered during model calibration, as the model simulation result was not sensitive to the sub basin.

1.7.2 FLOW CALIBRATION

The simulation of the model with the default value of parameters in Dedissa sub basin showed relatively weak matching between observed and the simulated stream flow. After sensitivity analysis has been done, the calibration of stream flow was done manually. The model was run for the period of 9 years from 1991 to 1999. The result of calibration for the average monthly stream flow showed a good agreement between observed and simulated stream flow (Figure 6)with Nash –Sutcliffe simulation efficiency of 0.76 and coefficient of determination (R^2) of 0.80.

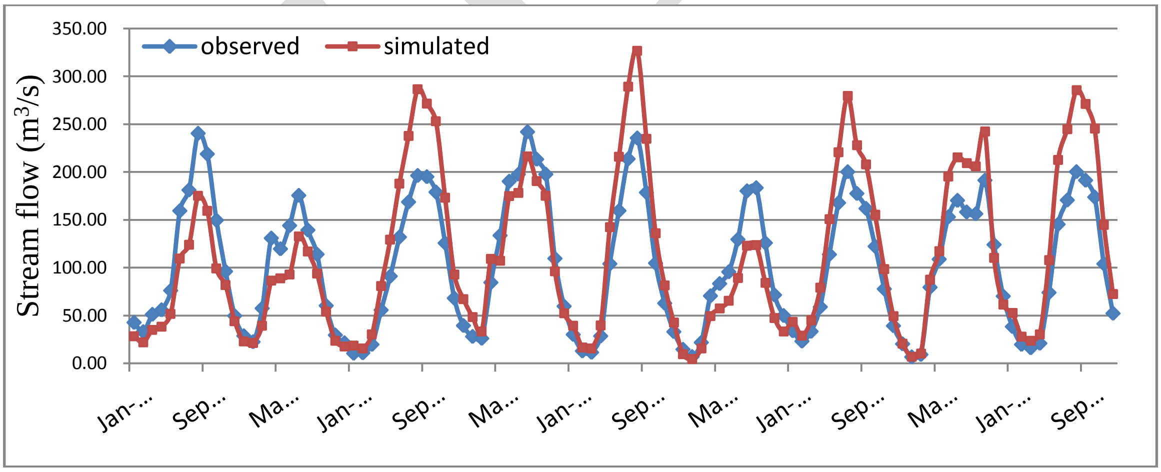

Figure6.Calibrated average monthly stream flow (1991 to 1999)

UNCERTAINTY

It is necessary to consider uncertainties in predicting of hydrology of the watershed. There are different sources of uncertainties, whichlead not completely matching between observed and simulated graphs. Sources of uncertainty are

- Input data uncertainty, errors in meteorological data and hydrological data
- Output uncertainty, errors which is done by the model

- Model structural uncertainty and parametric uncertainty.

Hence, during this study the observed data collected were also having missing and outlier. Land use classifications were not fully accurate and it may have effects on HRU class determination. The other uncertainty is simulation or prediction uncertainty by the model. Therefore, with these uncertainties the model gave appreciable results.

1.7.3 MODEL VALIDATION

After calibration was done manually and getting acceptable values of NSE and R^2, validation of simulated flows for 4 years period from 2001 – 2004 were performed and validation were checked using monthly-observed flows.The model validation also showed a good agreement between simulated and measured monthly flow (Figure 7) with the NSE value of 0.70 and R^2 0.79.

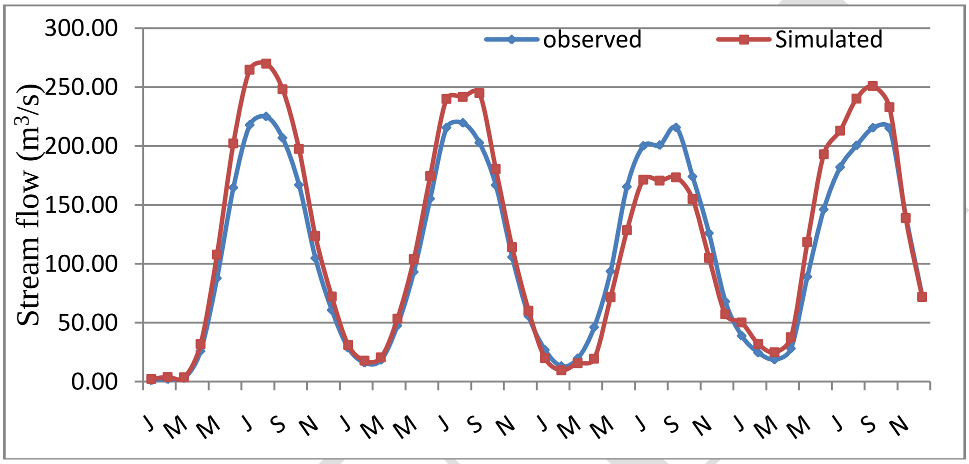

Figure7. Validated average monthly stream flow (2001 to 2004)

The calibrated and validated stream flow result shows a good agreement between observed and simulated stream flow. Therefore, the results of stream flows (Table 5) indicate that SWAT model is a good predicator for stream flow of Dedissa sub basin.

Table 5.Average monthly stream flow for calibration and validation

Period	Average monthly flow(m^3/s)		R^2	ENS
	Observed	simulated		
Calibration (1991-1999)	101.53	110.42	0.80	0.760
Validation (2001-2004)	110.77	114.63	0.79	0.70

Different studies that were conducted in the upper Blue Nile basin also showedsimilar result. For example, Asres and Awulachew (2010) as cited in Asmamaw[15]reported that SWAT model showed a good match between measured and simulated flow of Gumara watershed both in calibration and validation periods with (ENS = 0.76 and R^2= 0.87) and (ENS =0.68 and R^2= 0.83), respectively. Through modeling of the Lake Tana basin, Shimelis G.*et al* [16] indicated that the average monthly flow simulated with SWAT model were reasonably accurate with ENS =0.81and R^2=0.85 for calibration and ENS = 0.79 and R^2 = 0.80 for validation periods. This indicates that SWAT can give sufficiently reasonable result in the upper Blue Nile basin and hence the modelcan be used in this similar watershed.
The following figure shows that the scatter plots of observed and simulated value for both calibration and validation (Figure 8 and 9). This shows good linear correlation between observed and simulated values.

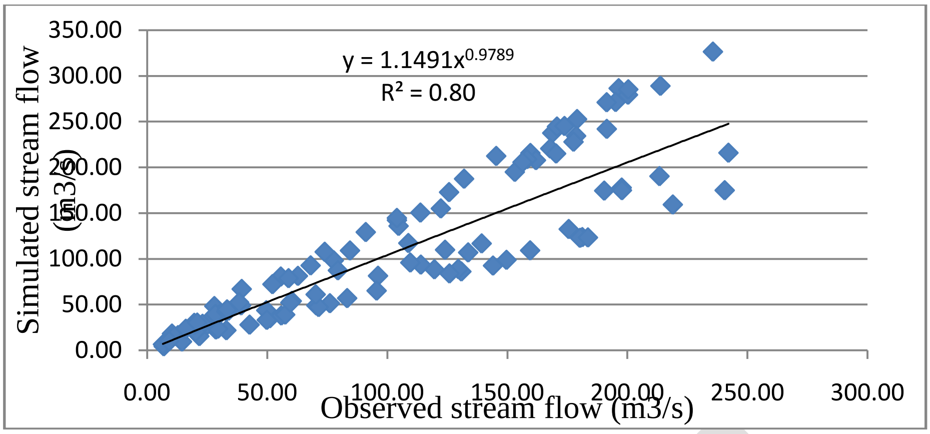

Figure8. Fitted line between observed and simulated stream flow for calibration

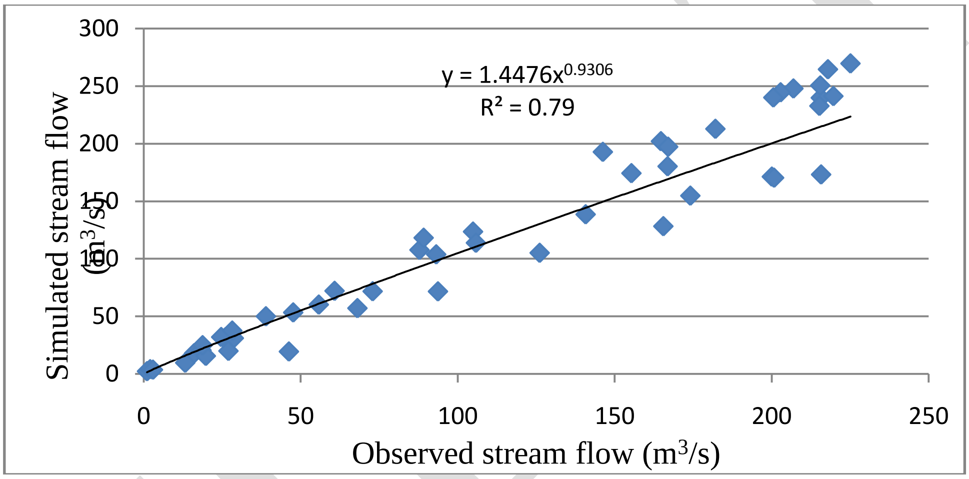

Figure9. Fitted line between observed and simulated stream flow for validation

1.7.4 CHANGE IN SEASONAL STREAM FLOWS

According to Land use land cover change detection of the two different year's satellite image results showed an effect on stream flow of the sub basin. After calibration and validation of the model using two land use land cover maps, the model was run keeping the other parameters constant for both simulations to quantify the variability of stream flow and to see the effect of land use land cover change.

Table 6.Mean annual stream flow results for calibration and validation

Years	1986	2010	change detection
	Simulated	Simulated	1986-2010
Calibration	110.42	118.90	8.48
Validation	114.63	121.73	7.10

The stream flow results under different year were compared based on the validated value. Generally the stream flow has increased throughout the study period over 25 years by

$7.10m^3/s$.The change of stream flow was due to land use land cover change (mainly due to a crease of agricultural land).

Table 7.Seasonalvariation of stream flow 1986 and 2010

Year	1986	2010	change
Wet season	175.12	205.81	+30.69
Dry season	23.53	18.25	-5.28

Considering wet season of the stream flow by taking June, July and August and dry season stream flow taken as January, February and March for detecting the change of stream flow. Mean monthly stream flow for wet months has increased by $30.69m^3/s$ for the period of (1986- 2010) due to due to agricultural land by almost 48% which implies that agricultural lands increased surface runoff. On the other hand, the stream flow had showed a decrease trend for the whole study period with the magnitude of $5.28m^3/s$which has reflected that base flow has decreased with an intense agricultural expansion. Different studies shows in different parts of the country to evaluate the effect of land use land cover change on stream flow. Study on a Hare watershed, in Southern Ethiopia, Tadele [17] reported that due to the replacement of natural forest in to farm land and settlements, the mean monthly discharge for wet months had increased while in the dry season decreased. In the study of Chemoga watershed, in Blue Nile basin, Abebe [7] reported that large volume of surface runoff occurs during the storm events since the area under forest cover decreased.

CONCLUSION AND RECOMMENDATION

1.8 CONCLUSION

During this study the impact of land use cover changes on Dedissa sub basin for over 25 years period were detected using Land sat satellite images from USGS earth explorer and GLOVIS. The land use classification performed using ERDAS Imagine 2014 and integrated with other GIS data to estimate its effect on stream flow of the watershed using SWAT model.

The model was used to explore the likely impacts of deforestation on basin water balance components inDedissa basin. Much of the original forest in the Dedissabasin has already been converted to agricultural lands. These changes would exacerbate already serious problems related to water scarcity in dry periods and hill slope erosion during wet periods. Generally during 25 year period the cultivation land increase almost about 12%, forest land decreased by 3.61%, the grass land decreased by 2%, the shrub land also decreased by 5.16% and the water body decreased by 0.86% of the sub basin. The reason is mainly due to the population growth. This might be due to the population pressure has caused a high demand for additional land result shortage of cultivated land is the major problem for farmers in the study area.

The model evaluation statistics for stream flow gave a good result since NSE >0.5 and R^2>0.5. The change in land use land cover resulted in stream flow, in which the expansion of agriculture results an increase of surface run off while the lateral flow decreased due to the expansion of agriculture. The significant changes of stream flow were occurred in wet periods than dry periods. During the wet season, the mean monthly stream flow was increased by $30.69m^3/s$ while the mean monthly flow decreased by $5.28m^3/s$ during the dry season.

The spatial and temporal variability of sediment source areas was identified and mapped using GIS as a result sub watershed of 1, 3 and 7 were identified as more potential sediment source areas. These sub watersheds indicated that, it requires attention for best management practices in the sub basin.The temporal variability of sediment yield at the outlet was done using the calibrated sediment yield; hence the highest amount of sediments was occurred during wet months.

1.9 RECOMMENDATION

Generally,based on the resultsof the study the following recommendations were made:

- Due to significant land use land cover change, it needs effective participatory integrated watershed management.
- In order to improve the performance of the model the additional weather stations could be improved both in quality and quantity.
- Changes of land use land cover in Dedissa sub basin are mainly caused by population growth. Reforestation of shrub lands, steep slope lands and some parts of agricultural lands mainly at upper parts of the watershed with other soil conservation measures should have to be implemented for further development of the hydrology.
- Further researches like sedimentation effects on Dedissa sub basin with reservoirs including development of BMPs with detail land use survey shall have to be done

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