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Impacts of Land Use Land Cover Change in Gidabo Sub-Basin: The Case of Ethiopia Rift Valley Lake Basin

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Abstract

In the past 50 years, there have been tremendous changes in land use pattern which exerted significant influence on land resource of the Ethiopia. This paper comprehensively analysed the primary scientific issues about the impacts of land use and land cover change on the water resource and sedimentation of Gidabo River Basin (Ethiopia. So far LULC change was studied for full basin and, upper parts of the basin from the years 1985 to 2018 by using Landsat TM and Landsat ETM+ and Landsat OLI/TIRS images. As the result, agricultural land and urban settlement is increasing and forest and grassland is decreasing in the basin. The impact of land dynamics on the hydrological response of the basin is studied up the year 2006 and reported as the surface runoff and evapotranspiration increasing staring from the year 1986 to 2006. Sediment yield and hotspot erosion area is identified based on detected land use and available measured sediment data of the basin. In this review, it is analysed that, the detected soil loss rate of the basin is significantly different form study to study and no assessment is done for the last 15 years since the measured stream and sediment flow data is limited at the year 2006. The shortage of such data and empirical estimation of sediment and flow for huge ungauged part of the basin (lower parts) have led for variation of results via analyses. Although a wide watershed interventions activity was held for the last 15 years in the watershed, no study analysed its effect so far. Hence, we would like to recommend to undertake a new study that can alleviate the variation of the previous studies upon land used land cover change, stream and sediment flow, and erosion hot spot area. Since the availability of measured sediment yield of the basin is too low, it is good to developed an empirical model that can substitute the measured sediment by using other watershed parameters.

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Keywords: *Land Use Land Cover; Sediment flow; Erosion hotspot area; Alternative model, Gidabo basin*

1 Introduction

In the twenty-first century, Land use and land cover change is a topic of global concern (Maitima et al. 2009; Luwa et al. 2020). In the past, recognition of the importance of the natural environment for human well-being has been less influential in maintaining sustainable development and poverty alleviation strategies (Agidew and Singh 2017; Demissie et al. 2017; Dibaba et al. 2020; Luwa et al. 2020). However, the natural environment and poverty are highly correlated with sustainability and development. Today, land degradation as a result of undesired land use and land cover change has led to reduction in food production, income, and employment (Luwa et al. 2020).

Land use/land cover change is playing a great role in water resources of the world by controlling the partitioning of water at the land surface. A continuous land use/land cover change can alter the quantity of hydrological flow at a catchment outlet (Aredehey et al., 2020; Tahiru et al., 2020). The higher surface runoff created in the catchment accelerates erosion; reduces water availability and affects the quality of the water (Tahiru et al. 2020). Accelerates erosion governed by change of land use is reducing the storage capacity of the reservoirs and lose of fertile soil from the agricultural land is reducing the production capacity of the land (Aga et al. 2018, 2019). In the river basin, sediment transported from the surrounding environment is affecting the quality of water resources (Tahiru et al. 2020).

Studies have shown that land use/cover change has been intensive in the developing country like Ethiopia (Dibaba et al. 2020). In particular, the expansion of intensive agriculture, urbanization, and extraction of forest products are accelerating over time to meet the requirements of an increasing population in developing countries. Various authors addressed on land use/cover changes of the country Ethiopia (Biazin and Sterk 2013; Teferi et al. 2013, 2016; Desalegn et al. 2014; Hailemariam et al. 2016; Demissie et al. 2017; Tahiru et al. 2020) and reported that as the forest and grassland are declining while the agricultural land is increasing.

For southwestern parts of the country Ethiopia, there are also studies that have reported different trends of land use/cover changes. For example, Alemayehu et al.(2019) has reported that agricultural land declined while the grassland increased in the Somodo watershed, southwestern Ethiopia and for Gelana Sub-Watershed, Northern Highlands of Ethiopia Miheretu and Yimer, (2017) have also reported as there is an expansion of grassland and shrub lands in the sub basin.

Gidabo watershed, the sub basin of Ethiopia rift Valley lake basin is characterized by a very rich diversity of natural resources, including land, vegetation and soil (Belihu et al. 2020a). As the result different land use land cover change detection studies were carried out for the basin. Some of the studies like Aragaw et al., (2021); Belihu et al., (2020); Buruk, (2019); Meshesha, (2017) are published but studies like a rift valley master plans are documented and available in the different governmental offices. Hence, collecting and organizing those studies in one document will increase our knowledge for the basin. Another benefit of this review is, based with the analyzed land use, different authors have detected the average sediment yield of the basin and the hots spot erosion area is identified and mapped. Since all of the studies were used different years landsite images, there result is also different. Hence this will need to collect all the results together and to give an appropriate justification based with the methods used in the study. Therefore, this paper reviewed the history and methods of the relevant researches, and summarized the influence of land use land cover changes on Gidabo basin and to simulate the strategies according to the researches in the recent decades.

2 Materials and methods

2.1 Description of the Study Area

Gidabo river basin is the sub-basin of the Rift Valley Lake Basin and situated in the south western part of Ethiopia. It is located between 6°12’12.4’’ to 6°56’17.4’’ N latitudes and 38°9’30.6’’ to 38°38’34.7’’ E longitudes (Figure 1).

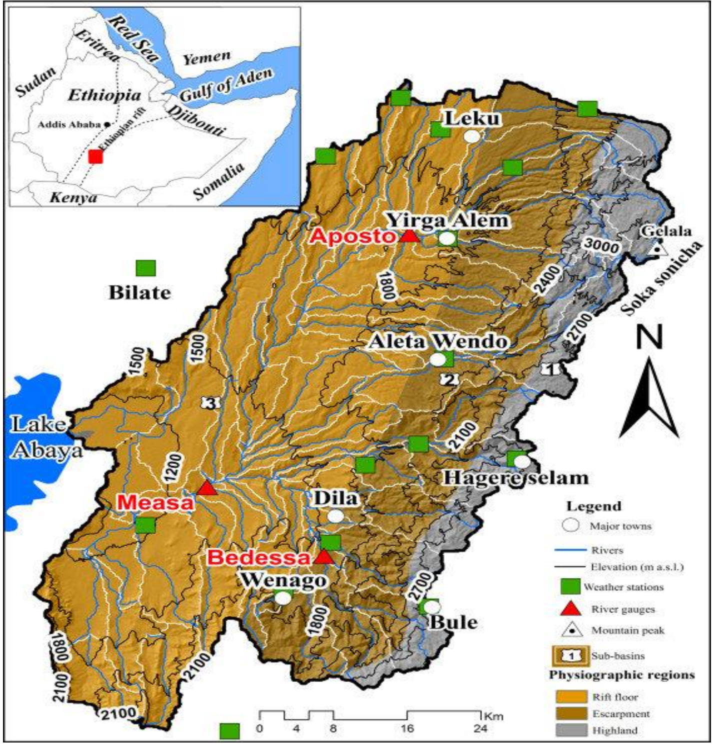

Figure 1: Location of Gidabo River Basin in the country (Source: Mechal et al., 2015)

Gidabo River drains from eastern part of the Lake Abaya-Chamo drainage basin. The total drainage area of the basin is estimated as 3342.5 km2. The elevation of the watershed ranges from 3193 in the northern and 1174 a.m.s.l in the south with a mean elevation of 2183.5meter. Regarding to climate, it ranges from semi-arid in the rift floor to humid in the mountains of the escarpment (Mechal et al. 2015).

3 Results and Discussion

3.1. Effect of land use land cover change on water resources in Gidabo river water shed

A few research studies have been conducted by different scholars on Gidabo river watershed which is located in Rift Valley Lakes Basin situated in the southern part of Ethiopia having geographical location of 60 09’ and 70 N latitude and 370 50’ and 380 38’ E longitudes and covers catchment area of 3302 square kilometres. According to the research findings; Land use and land cover (LULC) changes altering hydrological processes and have the potential to exert a large influence on earth water (Pandit et al. 2020) (Wagner et al. 2013; Kaushal et al. 2017). The changes resulted from Population growth, deforestation and higher demand for farm lands. (Meshesha and Demeku 2017) studied on impact LULC changes on stream flow and sediment yield of the catchment by using data like weather data, soil data, Land Use and Land Cover data, Sediment and stream flow data and Digital Elevation Model (DEM). The weather data (1988–2013) were obtained from Ethiopian National

Meteorological Agency (NMA) for nine stations located in and around the watershed as shown in the table 1 below.

Table 1: Meteorological station names and locations

S.No	Station name	X(meter)	Y(meter)
1	Aletawondo	435670.37	729998.10
2	Billate AgrEstate I	396854.05	746211.12
3	Dilla	422582.84	703793.10
4	Hagere Selam	446925.33	715184.89
5	Kebado	426275.41	711154.25
6	Telamo kentiso	444645.51	756864.15
7	Wonago	418888.22	698266.94
8	Yirga alem	435680.70	744381.95
9	Yirga chefe	412391.02	679929.95

Source : (Meshesha and Demeku 2017)

Soil map of the Catchment was obtained from M OA in shape file format and its physical and chemical properties were obtained from FAO soil data base (FAO 2002) and using SPAW (Saxton and Rawls 2006). Soil texture in %, organic matter content and bulk density were obtained from FAO data base and the rest parameters were calculated using SPAW model. The land use and cover data map Land sat imagery was obtained for the year 1990 and 2013 from Ethiopia Mapping Agency and the land cover map was produced using ERDAS imagine. Stream flow data (1989 – 2006) of the catchment was obtained from Ministry of Water Resources and Energy of the country. The sediment-discharge relationship was obtained from design document of Gidabo irrigation project vol.3 (MOWE 2010). Based on the data availability three stations were selected Gidabo near Aposto, Bedessa near Dilla and Gidabo near Maesso.

Table 2: Flow and sediment stations names and locations

Stream flow and sediment stations	X(meter)	Y(meter)
Bedessa near Dilla	422584.95	705262.99
Gidabo near Aposto	431293.95	746251.04
Gidabo near Maesso*	409875.68	711473.20

*Stream flow only source: (Meshesha and Demeku 2017)

The Digital Elevation Model (DEM) of 30m by 30m was collected from Ethiopian Construction Design and Supervision Works Corporation (ECDSWCo). Software and materials used for data processing were ArcGIS (10.2.2) and SWAT 12. Five different types of land use such as crop land (cultivated land), forest land, Grass land, settlement (impervious land) and wet lands were identified. Two land use for year 1990 and 2013 were used to evaluate LULC change effect on hydrology and sediment flows. The impact of LULC change shown by using three scenarios. Based on this ,53% and 19% of change in forest land to agriculture resulted in (67% & 29%) and (43% and 13%) increase in sediment load and stream flow respectively. Change in 35% of grass land into agricultural land increase the sediment yield by 9% and stream flow by 3%. In general, they estimated the annual sediment load at Gidabo dam site to be 435.26 ton per square kilometre per year (Meshesha and Demeku 2017).

(Belihu et al. 2020b) studied mainly focused on the upper watershed which covers area of 539.6 square km located in eastern highlands part of the main watershed .Their study also envisioned on effects of LULC changes on stream flow . They used data like Digital Elevation Model (DEM) at 30 m resolution, soil, land use (spatial data), and daily climate and hydrologic data. The soil data were collected from MoWR. Land use land cover assessment was classified based on supervised classification by using ancillary data (Google Earth) and field survey. In the process, the images for 1985, 2000, and 2018 were analysed for land use land cover changes. Categorization and differentiation of LULC classes based on the training sites which were defined by using Google Earth images and detailed field cross checking with many ground control points using GPS considering each land-use type for recent image (2018). LULC data considered three periods in different years: Landsat TM of 1985, Landsat ETM+ of 2000, and Landsat OLI/TIRS of 2018 at 30 m resolution obtained from the US Geological Survey Earth Resources Observation and Science Centre. Climate data (1983–2014) collected from Ethiopian NMA and river discharge (1986–2006) from the Ethiopian Ministry of Water and Energy. The satellite images with ground control points (collected using GPS) analysed by using ERDAS IMAGINE 9.2 and ArcMap 10.3 software packages. The research findings identified the major soils types like Pellic Verisol, Ortic Luvisol, Chromic Luvisol, and Eutric Cambisol (MoWR, 2008) of study area. Seven types of land use such as Agriculture(AGRL), Pasture(PAST), Shrub land (SHRB), Urban settlement(URBN), Swampy(SWMP), Forest(FRST), Agroforest(AGRF) were identified. Among them agroforestry is the dominant land use (64%).Land use land cover change analysis of upper Gidabo water shed was conducted for two different periods. The first period is (1985-2000) and the second one is (2000-2018).

The land use change in the first period (1985–2000) showed a magnificent change in agricultural land (82.7%) about 5.5% per annum and the other positive change in urban land use (increased by 3. 4%).The decreasing of forest and grassland was about 38.2% and 29.7% respectively. In the second period (2000-2018) negative change in grassland and agriculture (decreased by 47.9% and 12.5% respectively). General for past three decades' land use change in agriculture and urban settlement (increased by 59.8% and 28.7% respectively) whereas change in grass land and forest (decreased by 63.4% and 31.6% respectively) as shown in the table 3. In the field survey, it was also proved that the growing demand for farmland due to population growth on one side and decreasing of number of animals per household due to the shortening of grazing land (grassland) are the responsible factors for the change (Belihu et al. 2020b).

Table 3: LULCC for upper Gidabo watershed.

Land use land cover change							
LU/LC	SWAT code	(ha) 1985-2000	%	(ha) 2000-2018	%	(ha) 1985-2000	%
Agriculture	CROP	5412.42	82.7	-1496.7	-12.5	3915.72	59.8
Grassland	PAST	-94.74	-29.7	-446.22	-47.9	-840.96	-63.4
Shrub land	SHRUB	-68.58	-33.9	82.89	62.1	14.31	7.1
Urban settlement	URBN	102.24	3.4	752.31	24.5	834.55	28.7
Swampy area	SWMP	-4.86	-18.4	48.87	227.2	44.01	166.9
Forest	FRST	-2510.55	-38.2	432.63	10.7	-2077.92	-31.6
Agroforest	AGRF	-2535.93	-7.0	626.22	1.9	-1909.71	-5.3

Sources: (Belihu et al. 2020b)

To understand LULCC effect on hydrology, peak flow analysis for one and seven-day period was done by Indicators of Hydrologic Alteration (IHA) considering the simulation flows. Accordingly, the extreme flows in the second period (2000–2018) increased by 29% and 19%

in seven and one-day maximum peak respectively as shown in the figure 1. The low flow percentage in the first period (1985–2000) showed a significant decrease in both one and seven-day flow by about 25% (Fig. 1).

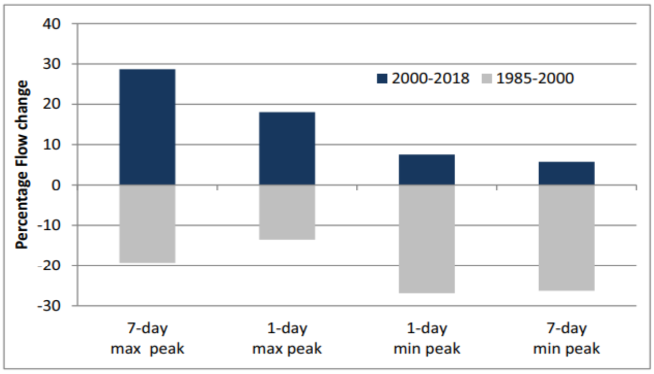

Figure 2:Percentage change of the peak flow distribution for one and seven-day peak and low flows (Belihu et al. 2020b)

In general, the land use change in the first period (1985–2000) resulted increase in agriculture (82.7%) and urban settlement (3.4%) and decrease in forest (38.2%) and grassland (29.7%). This change caused significant change in hydrology by decreasing 25% of flow. Whereas the change in the second period (2000-2018) linked with hydrology by increasing flow by about 25%. LULCC depicted that agricultural land and urban settlement increased by 59.8% and 28.7% respectively at the expense of forest and grassland. The impact of land use dynamics on the hydrological response depicted that an increase in surface runoff and evapotranspiration by 9.2% and 1.7% respectively. (Yared 2019) conducted his thesis study on estimation of sediment yield of Gidabo watershed to reservoir . He used DEM, Soil, Land use/cover, and Meteorological data by collecting them from the same sources by similar methods with the previous studies. SWAT model was used to simulate the sediment yield from the watershed which covered area of 2634 square kilometre. The time series data from 1997 to 2002 was used for model calibration and the time series data from 2003 to 2006 were used to validate the model using the input parameter set for both gauging stations Aposto, Bedassa and Maesso (Yared 2019). In this study, the SWAT model simulates average annual sediment yield of 95.32 tonkm^{-2}year^{-1} at dam outlet (Maesso station). The study also showed that changing 30% of agricultural land to forest mixed reduces 27.2% of sediment volume and he recommended this as best management method. Meshesha and his friend have been reported that significant forest and grass land changed to agriculture occurred in the watershed. They linked the change with sediment and stream flow increases for land use of 1190 and 2013 since 53% forest change to agriculture resulted increase in sediment by 67% and increase in stream flow by 29% (Meshesha and Demeku 2017) .This resulted sediment load of 435.26 tonkm^{-2}year^{-1} to Gidabo dam site (Meshesha and Demeku 2017). However, Belihu and his friends reported the land use land cover change resulted decreased stream flow in period (1985-200) and increased one in (2000-2018) in water shed. Changing 30% of agricultural land to forest mixed reduces 27.2% of sediment volume (Yared 2019) . Meshesha identified only five different types of land use and he didn't consider shrubs and agroforestry which share significant area of the watershed shed since they play a great role in regulation of water and sediment in the catchment (Yared 2019; Belihu et al. 2020b). Different research studies covered different areas like 3302 km^2 (Meshesha and Demeku 2017) , 539.6 km^2 of upper part of the Gidabo catchment (Belihu et al. 2020b) and 2634 km^2 (Yared 2019).But total area of the Gidabo water shed is 3342.5 km^2.This indicates that no studies covered the whole watershed . So far the studies limited on effect of LULC change on sediment yield and stream flow but not linked with climate changes. Therefore, further studies need to link effect of Land use land cover and climate change on the stream flow and sediment yield. Addition to all the previous studies used SWAT model and in further studies other models and approaches should be used.

3.2. Identification of Erosion Hot spot areas

3.2.1. Morphometric analysis for prioritizing sub-watersheds and management planning and practices in Gidabo Basin

This study was conducted by (Abdeta et al. 2020). The study was aimed to prioritizing erosion-prone sub-watersheds using morphometric analysis. Data used for this research were topo sheets with 1:50,000 scale, control points, ASTER_DEM, and Software used was ArcGIS10.3. Advanced space-borne thermal emission and refection radiometer of 30m resolution DEM has used to generate drainage networks and delineation of sub-watersheds using ArcGIS software. The study area has classified into seven interesting sub-watersheds, which have ordered SW1–SW7 as shown in the Figure 2 below.

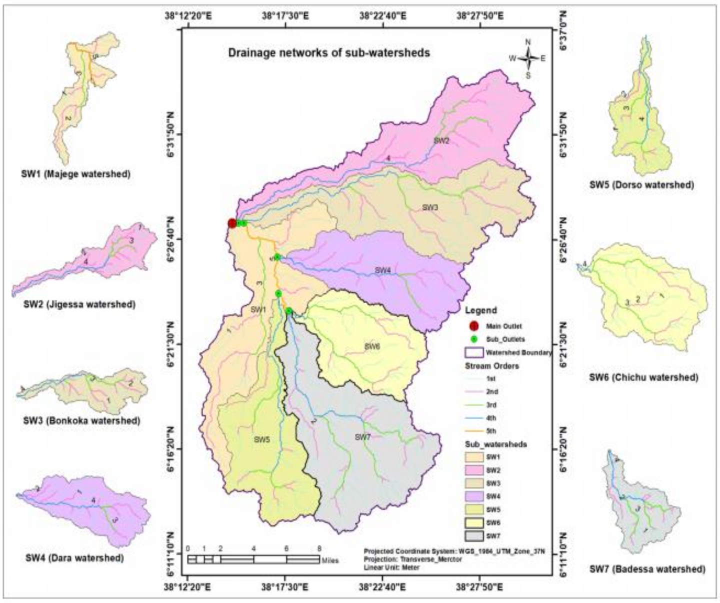

Figure 3:Map of sub-watersheds and drainage networks (Sources :(Abdeta et al. 2020)

Sub-watersheds (SW7, SW3 and SW4) and (SW5, SW6 and SW2) have categorized into higher and medium priorities, whereas sub-watershed (SW1) has assigned at lower priority.

This implied that SW1 is relatively sustainable than others, on the contrary, SW7 is relatively affected sub-watershed by runoff and soil erosion that needs first priority for management practices. The final priority map of sub-watersheds. SW7, SW3 and SW4 are relatively the most susceptible to land degradation being prone to soil erosion, respectively as shown figure 3.

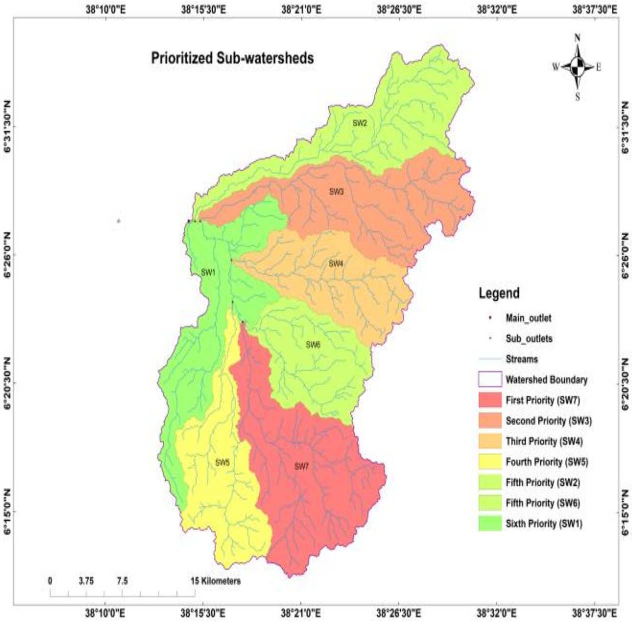

Figure 4: Map of prioritized sub-watersheds through morphometric parameters

(source:(Abdeta et al. 2020)

Analysing watershed morphometry is not enough for characterizing and prioritizing of sub-watersheds, but it has required other an integrated approach, which includes land use and land cover changes, estimation of runoff and sediment yield (Abdeta et al. 2020). Another research study conducted in Gidabo water shed on Estimation of Catchment Sediment Yield using SWAT (Yared 2019). He showed spatial distribution of sediment yield in Gidabo catchment as shown in the figure 5 below.

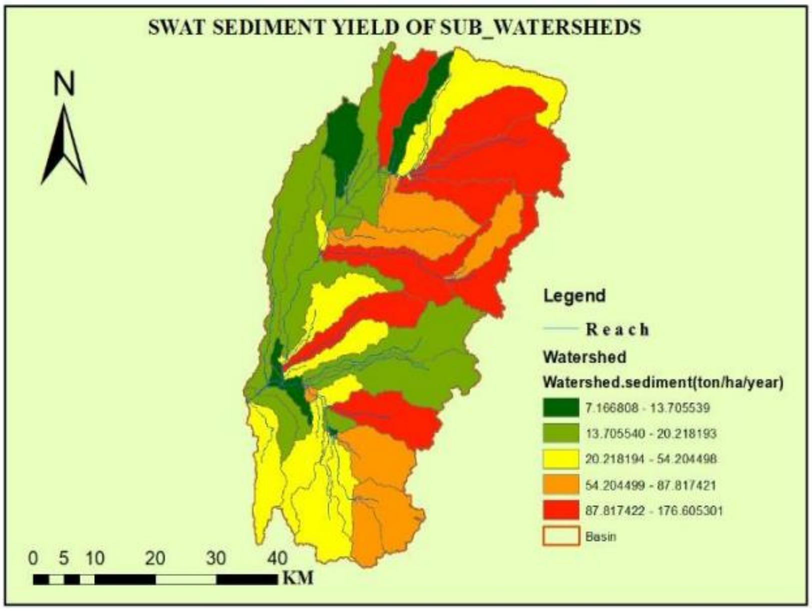

Figure 5: Spatial distribution of sediment yield in Gidabo catchment(source: (Yared 2019)

3.3. Approaches used to estimate the sediment yield and siltation rate at Gidado river basin

Many authors have predicted the sediment yield of the Gidabo river basin at different time and catchment scales. For instance sediment yield of upper part of watershed (at gauging station Aposto) estimated by (Belihu et al. 2020a) and (MOHAMMED 2015); Buruk (2019) predicated the sediment yield of wider basin (at gauging stations Aposto, Bedassa and Maesso) . Similarly Meshesha (2017) estimated sediment yield and siltation rate of Gidabo irrigation dam at stream gaging station of Maesso. All of the researchers used SWAT models to estimate sediment yield and siltation rate of the basin. In a fact obtaining all the required data for this model it is not possible for the study area and all of the studies did not considered the limitations of this model. For example, in the land use and land cover map, the leaf area index data that SWAT needs are not available.

Similarly, the soil data in Ethiopia are very coarse and are missing basic information such as soil texture, hydraulic conductivity and other parameters that need to update the model database. Due to this, in different parts of the county the researchers are comparing the models based with the amount of data they required, ability to capture the real world and accessibility. For sediment data limited area like Gidabo, USLE/RUSLE may be an appropriate model. Due to it its high degree of flexibility and data accessibility, a parsimonious parametrization, extensive scientific literature and comparability of results, R/USLE model is widely using throughout the world (Alewell et al. 2019). Hence, the ubiquitous usage of the R/USLE can be attributed to its relatively lower data requirements compared to more complex soil loss models, making it potentially easier to apply in areas with scarce data. The effect of earliest watershed intervention activities can also be easily detected by USLE/RUSLE model. From this review we recommend to test the basin sediment yield by using the widely used model R/USLE. The principal equation for the USLE model is $A = R \times K \times L \times S \times C \times P$. The parameters R (Rainfall and runoff factor or rainfall erosivity factor), K (Soil erodibility factor), L (Slope-length factor), S (Slope-steepness factor), C (Cover and management factor) and P (Support practice factor) are under modification for each country and watershed.

For Ethiopian highlands, the R factor is recommended to be R = -8.12 + 0.562P (r2= 0. 8) by (Hurni 1985). Where p is the mean annual rainfall (mm). Later, as sited by Benavidez et al.,(2018), (kaltenrider 2007) developed another equation to estimate R factor for Ethiopia highland as: R= 0.36X+47.6. Where, X is mean annual rainfall in mm. Hence it is crucial to develop an appropriate R estimation method for central Ethiopia like Gidabo watershed. The soil erodiblity (K factor) indicates soil's susceptibility to detachment and transport by agents of erosion. Several methods have been developed to estimate the K-factor. However, for highlands of Ethiopia, (Hurni 1985) has interrelated the K factor with soil colour. This may be erroneous due to it subjectivity and good to develop another quantitative method for central parts of Ethiopian soils. In over all, it is recommended to developed a new approach for all USLE parameters for central Ethiopia specially for Gidabo watershed. During the field work, the soil samples will be collected to develop a new K factor and all the necessary metrological data will be collected to develop or modify the R estimation method. In Gidabo watershed, no study was carried out on Gully and land slid. Base with the level severity, gully is the worst erosion type. The model SWAT as well as USLE can't detect the level of gully erosion. Hence the location of the gully should be collected from the filed for validation and for full watershed the gully as well as the land slid will be mapped by using the Google map.

3.4. Developing an Alternative Empirical Model to Estimate Watershed Sediment Yield of Gidado Water shed.

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In the Gidabo river basin there are many steam flow gauging stations and stream flow data is available starting from the year 1989. The available sediment data of the basin is shown in the table below.

Table 4: The available sediment data at Gidabo river basin

Station	**Year**	**No of Data**	**Year**	**Data**	**Year**	**Data**	**Year**	**Data**	**Year**	**Data**	**Year**	**Data**	**Year**	**Data**	**Year**	**Data**	**Total**
Gidabo (Aposto)	1989	2	1990	1	1996	3	2005	2	2007	5							13
Wonsho	1990	5	1994	3	1995	1	1996	3									12
Kola	1989	1	1990	10	1993	2	1994	4	1995	1	1996	6	2004	4	2005	2	30

As shown in the table 4 above, the maximum data is available only at gauging station Kola. Studies carried out by modelling at Menso gauging stations were used a regional sediment rating curve developed during the master plan study of Ethiopia Rift valley lake basin for west-stern parts of the basin. For Aposto gauging stations we have only 13 days' data within 30 years. In overall the accessibility of sediment data for the basin is so scarce. Hence, to have sediment data for model validation and calibration, it is good to genet the sediment data by using the watershed hydrology and geomorphology. Practically, the watershed sediment yield can be described as a function of the different parameters namely: hydrologic and geomorphologic factors. The empirical formula between sediment yield (SY) and watershed geomorphological and hydrological parameters can be determined using nonlinear regression equation in Datafite model. SY = function (geomorphology and hydrology), Mathematically, the parameters of the above equation can be equated as:

$$SY = X\left(Q_s^b * A * S_b * K\right) + Y\left(q_r^d * S_r\right), \text{----}1$$

where SY = sub basin sediment yield (tone/month)

Qs is Surface runoff (m3/s), A is area of each sub basin (km2), Sb is average slope of each sub basin (%), K is soil erodibility factor of the soil, qr is stream flow (m3/s), Sr is average slope of the river (%), X and Y are constants from regression equation; and b and d are peak flow adjustment factors. In Gidabo river basin there are two gauging stations Aposto and Kola has a measured sediment data. Hence the sediment estimation empirical model will be developed for one of the stations let say Kola and will be validated at Aposto gauging station.

4 Conclusions

From this the current assessment, the study team have detected the following main findings:

1. In Gidabo river basin, land use cover change was studied for full basin as well as for upper parts of the basin from the years 1985 to 2018 by using Landsat TM and Landsat ETM+ and Landsat OLI/TIRS images. Except Belihu et al.(2020), other were used a supervised land classification by generating the control points from the Google Earth. Due to that the result reported by scholars is too different from one another. In similar manner the LULC impact study done by Belihu et al.(2020) is limited at Aposto gauging station and which will cover only 60% of the full Gidado river basin. As the

result, the team of this reach group should undertake the detail land use land cover change effect in the Gidabo river basin.

2. For Gidabo river basin, the water balance as well as the sediment yields of the basin is carried out by different scholars for full basin as well as for upper watershed. But, all of the studies were limited up to the year 2006. In the past 15 years, in Ethiopia there was a great soil and water conservation interventions and none of the studies were tried to test the effect of this measures. Moreover, most of the reviewed papers were tried to show the hotspot soil erosion area of the basin based with data of 1989 to 2006. Due to the reasons given above, this the identified host spot erosion area mapped in the watershed may be erroneous. Therefore, with updated data, the watershed host spot erosion area should be delineated by this research group.
3. All of the studies carried out in the Gidabo river basin were used SWAT model to detect the water balance as well as sediment yield. In a fact obtaining all the required data for this model is not possible for the study area and all of the studies did not considered the limitations of this model. For example, in the land use and land cover map, the leaf area index data that SWAT needs are not available. Similarly, the soil data in Ethiopia are very coarse and are missing basic information such as soil texture, hydraulic conductivity and other parameters that need to update the model database. Hence, the team of this research group should collect the soil data of the basin to develop the data base of SWAT model for Gidabo river basin.
4. Different parts of the county the researchers are comparing the models based with the amount of data they required, ability to capture the real world and accessibility. Based to that, for Ethiopia highlands researches have modified the parameters of USLE/RUSLE for Ethiopia condition. Hence this research group has proposed to assess and develop a new method for USLE/RUSLE parameter estimation for Gidabo river basin. To develop the new alternative soil erodibility model, the soil sample will be collected from the basin major soil class and for erosivity parmater development; the methodological data (rail fall intensity) will be collected from the NMA.
5. In the River basin, the maximum data is available only at gauging station Kola (30-day data). Studies carried out by modelling at Menso gauging stations were used a regional sediment rating curve developed during the master plan study of Ethiopia Rift valley lake basin for west-stern parts of the basin. For Aposto gauging stations we have only 13 days' data within 30 years. In overall the accessibility of sediment data for the basin is so scarce. Hence, to have sediment data for model validation and calibration, it is good to genet the sediment data by using the watershed hydrology and geomorphology. This research team has proposed to develop an empirical formula between sediment yield (SY) and watershed geomorphological and hydrological parameters by using nonlinear regression equation in Datafite model.

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