JOURNAL OF INDIGENOUS KNOWLEDGE AND DEVELOPMENT STUDIES
JIKDS 02(02) 2020
ISSN (online) 2708-2830 ISSN (print) 2707 – 7640
www.bhu.edu.et/jikds

Analyze Trends and Drivers of Land Use Land Cover Dynamics in Dawa River Basin since 1989, Southern Ethiopia

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ABSTRACT

Land cover alteration is major issue of global environmental change. This change is due to human intervention for various activities. The change is a gradual process and it takes time depending on the drivers. Basin level land cover dynamic has been supposed to be the earliest of all human that brought environmental changes. Thus, trends and drivers of land use land cover dynamics in basin are the key considerations in the research. To detect the trends of the change, TM (1989), ETM+ (2004) and ETM – OLI (2019) Land sats were used. The trends of land cover dynamics that happened from 1989 to 2019 were analyzed using ERDAS 2015 and arc map 10.5. In addition, the drivers that supposed to accelerate the changes were identified by questionnaire, focus group discussion and interviews. In the period comparisons between 1989 and 2019, the farmlands & settlements and bush & shrub lands are increased by 4684.36 and 10496.28 km^2 with rate of 104.09 and 233.25 km^2 per year respectively. In contrast, the forest areas and grasslands & degraded lands are decreased 6770.20 and 8410.44km^2 with rate change of 528.83 and 186.89 km^2 per year respectively. Regarding to the factors that accelerated the changes are population pressure, open grazing activities, lack of professional natural resource managements, weak governmental regulations on forest resources, effect of climate change, and increasing of unemployment. Thus, it is recommended that strategies should be designed for the pastoralists sector due to decreasing trends of forest and grassland in the basin.

Key words: Drivers, Dynamics, Land Cover, Land Use, River Basin, Trends

1. Introduction

1.1. Background of the Study

Land use and land cover alteration is major issues of global environmental change (Parksam, 2010) due to human intervention as a driver for various processes (Batar et al., 2017; Meneseset al., 2017;

Baral et al., 2009; Woldeamlak, 2004). Such as for agricultural, settlement, transportation, infrastructure and manufacturing, park recreation uses, mining and fishery (Ellis 2011). Starting from the domestication of plant, animals and control of fire, humans have been changing the topography in an irreversible state (Bone et al., 2017; Lambin et al., 2003). Nonetheless, in the world history, an abrupt and huge land use change has been begun in the 17th century related with agricultural expansion and industrial revolution (Goldewijk & Ramankutty, 2003).

Land use land cover change in the river basin has been supposed to be the most earliest of all human that brought environmental changes (Solomon et al., 2017; Thapa-Magar and Shrestha, 2015; Gebresamuel et al., 2010). In the globe, land use land cover history in the river basin is quite dynamic (Nejadhashemi et al., 2011) both temporally and spatially with respect to the sustainable socio economic development of human beings (Koch et al., 2012). For example the developed countries, land use land cover change in river basin level had been become stable before fifty years ago (Wang, 2006). Ironically, the land use land cover change process in the river basin in the developing world is still in progress, which devastated their natural resource, facing a challenge on their sustainability (Goldewijk & Ramankutty, 2003).

In Ethiopia, land degradation and deforestation are the most agents for land use land cover change (Moges and Holden, 2009; Gebresamuel et al., 2010; Zeleke and Hurni, 2001; Alemayehuet al., 2009). Empirically, deforestation rate is guessed to be between the range of 150,000 and 200,000 hectare per year (Zeleke and Hurni, 2001). This makes the average annual rate of deforestation in the country 0.8 up to 1.05 % per year (Earths Trend, 2003). In the Ethiopian highlands, because of population growth and shortage of agricultural land, encroachment of farm lands (Woldeamlak, 2004) has been shifted to semi marginal and marginal lands in the last fifteen years than ever before (McKee, 2000; Tesfaye, 1999). For instance, in southern Ethiopian, in the Abaya-Chemo sub-basin of the study conducted by Mengistu (2009) showed that a significant rate of change from forest land into farmland. The farmland

and settlement had increased by about 72% while the forest cover decreased by 17% within less than a decade. Land cover changes are caused by a number of human driving forces (Meyer and Turner, 1994), which is also true for southern Ethiopia (Mengistu 2008; Genene and Ramachandra, 2015). In relation to this, traditional and modern way of mining exploration becomes one of the driver of land use land cover dynamic in southern Ethiopia (Reid et al. 2000). In addition, the rate of deforestation in southern parts of Ethiopia is by far reaching climax point at the moment time due to encroachment of farm lands, firewood, lumbering and home construction (Mengistu 2008; Dessie & Christiansson, 2008). Thus, an understanding of the trends and drivers of land use land cover change is essential for tackling future prospect of land use and land cover dynamics driven impacts on socio-economic development (Pullanikkatil et al., 2016; Bhattarai et al., 2012; Schreier et al., 2003; Rechard, 2005).

Having derived by these views, this study assesses the drivers, trends, patterns and, extents of land use land cover dynamics in the south eastern Ethiopia with particular reference to Dawa river basin. The study area is one of the drought prone areas where land use and land cover change is reaching of a critical stage due to drivers. As the result of the existing driving forces of land use land cover change in the study area, forest coverage and grass land areas are greatly decreased and imposed critical influences for grazing on the pastoralist (Dessie and Kleman, 2007; Dereje, 2007; Mengistu, 2008; Dessie & Christiansson 2008).Furthermore, the area is marked by diverse topographic conditions, which provides an opportunity to analyze trends and drivers of land use land cover dynamics in Dawa river basin since 1989.

2. Materials and Methods

2.1. Location and Descriptions of the Study Area

The study lies between $4^0$5'8" to 6^0 27' 18"N and $38^0$2' 48" to $41^0$2' 34"E. In administrative term, it covers 11 Woreda from both Oromia and Ethio-Somali Regional states. These are Uraga, Bule Hora, Yabelo, Arero, Odoshakiso, Liben, Filtu, Moyale, Dire, Bore and Adolana Wadera Woreda. The study area has special coverage of 42,202km^2 and the basin is located around 567km southwest of Addis Ababa and forms the parts of the southeast highlands of Ethiopia. The following Map helps clearly to show the location of the study area.

The study area is consisting of different topographic conditions. The elevation ranges from 323 to 3011 m.a.s.l. The study area is characterized by mountainous and highly dissected stretches of land

with steep slopes at the upper stream part while an undulating terrain and gentle slopes at the downstream part. Mixed types agriculture on subsistence scale is the major livelihood of the people in the study area. Land and livestock are the most important assets of the people, with which they lead a sedentary life. A Variety of crops are produced by a house hold.

According to the National Meteorological Agency as measured at Negele town ($5^0$19' 58"N and $39^0$19' 27"E with elevation 1496m), the climate condition of Dawa basin is generally characterized by sub-tropical and tropical agro ecology with the mean rainfall of 600mm to 1250mm (for the year between 1989 and 2019) and the average temperature of the study area is 15 to 22.8^0c (for the year between 1989 and 2019). The study has four seasons. These are summer, winter, autumn and spring.

Summer is the main rain rainy season while winter is a dry season in the study area.

The study area is consist of different topographic conditions, which is characterized by mountainous and highly dissected stretches of land with steep slopes at the upper stream part while an undulating terrain and gentle to level slopes at the surface part. The elevation ranges from 323m to 3011 meter above sea level. According to FAO, 1999 classification the topography of the study area consists of level slope 19822.36km^2 (46.97%), very gently slope 9483.16km^2 (22.47%), gentle sloping 6902.92km^2(16.35%), sloping 4148.44km^2(9.83%), strongly slope 1611.64km^2(3.82%), moderate steep 221.16km^2(0.53%) and very steep 12.16km^2 (0.03%). Most parts of the study area are found within level slope while small parts of the study area are just found in very steep slope.

The livelihoods of the majority of the settlers in the study area are mainly depending on pastoral practices. In addition, mixed types agriculture on subsistence scale is the major livelihood of the people in the study area. Land and livestock are the most important assets of the people, with which they lead a sedentary life. A Variety of crops like Maize, Enset, Coffee, banana and etc. are produced by house hold. Moreover, settles who live in urban areas depend on trade.

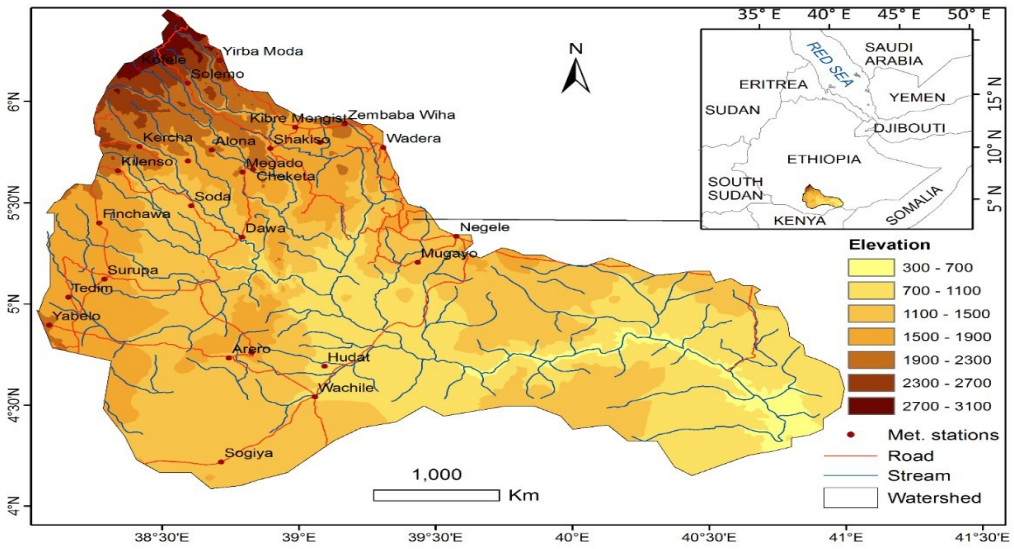

Figure 1. Location map of the study area (Source: authors, 2019).

2.2. Data Sources and Methods of Collection

2.2.1. Satellite Data

The data used to create the spatial data base used for this study were obtained from the Ethiopia Map Agency which were taken in 1989 (TM landsat-5), 2004 (ETM+ Landsat-7) and 2019 (ETM landsat-8 OLI) during February months. These years and months were selected in order to have a clear difference with in each land use and land cover categories of the area for supervised classification. ASTER DEM 30 m*30 m resolution was downloaded from USGS website and was used for basin delineation and slope generation. Even though all the land sat images are freely found in the website addresses, due to lack of experience and internet access to extract and down load the images, the necessarily data were directly purchased from EMA.

2.2.2. Field Data Measurements and Observations

The field data collection were done randomly to verify the classified image and to collect the necessary land use and land cover data for accuracy assessment. In addition, random field data, ground control points, were collected to validate the pour points of the streams in the basin.

Ground control points were collected using Garmin Global Position System model 72 devices.

2.2.3. Sampling Techniques and Size Determination

The intended objective was achieved from the result of focus group discussion, interview and questionnaire. Focus group discussion and interview were selected than other methods of obtaining information because the researcher strived to lead the discussion by moderator. Thus, to identify the possible deriving factors of land use land cover change in the earlier times, elders of the local areas (kebele leaders, administrative officials, illiterate farmers who have changed their crop land to other land use types and the like), were planned to discuss and interviewed. The main reason that the only elders of the local areas were selected for the discussion and interview than other social group was that they have lived a long periods of time and have a chance to observe a significant temporary land use land cover change starting from earlier time within a given study time interval in the study area.

Questionnaire also distributed to the target population in the study area. This was to gather additional causative factors of LULCC from the social groups in the study area and the questionnaires were distributed in the selected districts. Hence, in the process of selecting sample population for the purpose of questionnaire, purposive sampling technique was considered. In the study area there were 11 Woredas. From 11 Woredas in the study area, 6 districts were selected purposefully based on the strength of the LULCC exhibited in the study area.

SS = [redacted]

Whereas, SS is the sample size,

N is the population size, and

E is the level of precision (0.1) (Yamane, 1967).

The study area has a total of 843,343 populations. Hence, the sample size was 100 (Table 1). Finally, In order to determine the weight of sample size in each Woreda, the total sample populations were distributed proportionally in to the respective Woreda's by using proportionality scientific formula (Cochran, 1977) given below.

Finally, the number of population for each district was collected from the respective Woreda's administrative offices. In order to determine the sample size in each district, the total sample populations were distributed proportionally in to the respective districts by using proportionality scientific formula given below (Cochran, 1977).

ni= [redacted]

Where, ni=the number of sample population on each sample district.

Ni=the number of population in each district.

S= total number of sample population.

N= ∑Ni i.e. number of population in districts (Cochran, 1977).

Thus, the possible Drivers land covers land change in the study area identified by the selected sample size populations. Finally, the results of the group discussion, interview and questionnaire were become an input for the identification of possible drivers of Land use land cover change performed in the Dawa river basin.

Table 1. Sample size determination

No.	Name of Sample districts	Distribution of district population(Ni)	Distribution of sample size(ni)	Sample percentage
1	Bule Hora	262,659	31.15	31.15
2	Yabelo	84,563	10.03	10.03
3	Moyale	159,909	18.96	18.96
4	Dire	46,569	5.52	5.52
5	Arero	64,289	7.62	7.62
6	Odoshakiso	225,354	26.72	26.72
	Total	843,343	100	100

The possible deriving factors of land use and land cover change data required for the research was collected using structured questionnaires which consist of open ended questions. The questions were set to generate information related to the possible deriving factors of LULCC in the study area.

The questionnaires were pretested and administered by the researcher, extension workers (DA's) and high school teachers who were recruited from each sample districts and a total of 25 individuals involved in answering the pretest questionnaires.

2.2.4. Methods of Data Analysis

2.2.4.1. Satellite Data and Image Classification

Pre-processing: The pre-processing activities such as layer stacking, haze correction and topographic correction were carried out on the satellite images using ERDAS IMAGINE 2015. The land sat images were extracted by mask with the study area DEM by arc map 10.5.

Image Classification: Supervised image classification systems were carried out using ERDAS IMAGINE 2015 after preprocessing activities. Finally, farmland and settlements, forest, grassland and degraded land, bush and shrub lands were produced corresponding to the three reference years and the result sent to Arc GIS 10.5 software to display, quantify and interpret. The cultivated land and settlements were merged in to one category because it was awkward to recognize the scattered rural settlements as a separate land cover type. Also, cultivated land exists around homesteads and would have to be recognized as such. Hence, for practical reasons, the two land cover types were merged in to one category. In addition, grassland and degraded land includes both open grazing lands and exposed lands. It was difficult to distinguish because the bare lands were identical with grazing lands, which were heavily degraded in the study area. As a result, they were categorized together (Table 2).

Table 2. Descriptions of land cover classes in Dawa basin (1989-2019)

No.	Land cover types	Description
1	Farmland and settlements	Areas used for crop cultivation, and the widespread rural settlements
2	Forest	Areas covered with close growth of trees like eucalyptus and junipers
3	Grass and degraded lands	Savanna grass areas used for pastoral grazing, that has degraded lands
4	Bush and shrub lands	Area covered with bush and shrub lands

2.2.4.2. Field Data Analysis

Ground control points were collected for the purpose of undertaking accuracy assessment to validate and compare the classified images with the true geographical phenomena. After the ground control points were collected by GPS from the field, it was recorded in Microsoft office Excel 2010 spread

sheet so as to put the latitudes and longitudes coordinate points as they represented the types of geographic phenomena. Finally, after land use and land cover change of the study area processed, analyzed and interpreted, the drivers of the land use land cover changes supported with the result obtained from questionnaire, informal interview and focus group discussions.

Accuracy Assessment: After the supervised classification has taken place on the land sat image, accuracy assessment has also under taken to compare the classified images with geographical data that they are assumed to be true. The accuracy assessment of the LULC map have been under taken by comparing the field data collected by GPS with the classified images in ERDAS IMAGNE 2015 software . Four lands used and land cover classes were identified using visual image interpretation and field survey. Thus, from the supervised digital image classification, in this study, accuracy assessment was done for the 2019 satellite images. The overall accuracy was calculated by summing the number of pixels classified correctly and divided it with the number of pixels. Thus, the overall accuracy of 2019 satellite image was 97.76.

Land Use and Land Cover Detection: The amount of different land use and land cover types of the study area quantified from the produced maps, which depicted in percentiles. A combination of information collected from field, local people, elders and natural resource experts through informal interviews and focus group discussions with an information gained from satellite images were used in the analysis of land use and land cover change detection. The land cover maps for the three period series of images were analyzed based on land use and land cover types area comparison. The changes over 30 years were analyzed and rate of change for each land use land cover type is calculated. In the meantime, the rate of land use and land cover changes for the three period's from1989 - 2004 and 2004-2019 and 1989-2019 were computed using the following formula (Geist and Lambin, 2004).

R =……3

Where R= Rate of change, Q1=initial year land use/ land cover in km^2, Q_2 = recent year land use/ land cover in km^2, T= time interval between initial and recent years.

2.2.4.3. Possible Drivers of Land Use and Land Cover Change Interpretation

Having collected the socio economic data for the study, the researcher analyzed those by using qualitative techniques. That implies, after all the possible drivers of the LULCC in the different time intervals had identified from the society, it was interpreted using descriptive methods by matching with the change identified from the imageries.

3. Results and Discussions

3.1. General Background of the Respondents

3.1.1. Demographic Characteristics of Respondents by Sex

Out of the total number of sample size, 66 percents are male and 34 percents are female respondents. Thus, the majority of respondents participated in the study are males (Table 3).

Table 3 Characteristics of Respondents by Sex

Sex of Respondents	Number of Respondents	Percentage
Male	66	66
Female	34	34
Total	100	100

Source: Field Survey, 2019

3.1.2. Demographic Characteristics of Respondents by Age

According to the collected data from field survey, out of the total sampled size, 30 percents, 17 percents and 15 percents of the sampled respondents are the most economically active groups respectively, while the remaining 18 percents of the respondents are economically inactive and 20 percent are elder (table 4).

Table 4.characteristics of sample households by age

Age of Respondents	Frequency Respondents	Percentage
20-25	30	30
26-30	17	17
31-35	15	15
36-40	18	18

>41	20	20
Total	100	100

Source: Field Survey, 2019

3.1.3. Marital Status of the Respondents

Majority (74%) of the marital status of respondents are married who have expected to have family members that depend on them. On the other hand, most of the respondents are married (74%) and significant proportions of them are divorced (4%) and widowed (4%) (Table 5).

Table 5.Marital Status of the sample household

Marital Status	Number of Respondents	Percentage
Single	18	18
Married	74	74
Divorced	4	4
Widowed	4	4
Total	100	100

Source: Field Survey, 2019

3.1.4. Occupations of the respondents

Regarding to their occupation, 33% of the respondents are farmers while 35% of them are merchants. The remaining 21 %, 6 % and 5% of the respondents are daily labor, government employers and others respectively in the study area (Table 6).

Table 6.Occupations of the respondents

Occupation	Number of Respondents	Percentage
Farmer	33	33
Merchant	35	35
Daily labor	21	21
Government employees	6	6
Other	5	5
Total	100	100

Source: Field Survey, 2020

3.1.5. Educational status of the respondents

In their educational status, 25% of the responds are able to read and write while 20% of them are illiterate. In addition, from the total sampled size 16 and 14 percent of the respondents are completed elementary and high school education. Similarly, 10 percent of respondents are achieved preparatory school and 15 percents are completed grade 12 and above. (Table 7).

Table 7.Educational levels of the respondents

Education Level	No. respondents	Percentage
Illiteracy	20	20
Read and Write	25	25
1-8	16	16
9-10	14	14
11-12	10	10
>12	15	15
Total	100	100

Source: Field Survey, 2019

3.1.6. Family sizes of the despondences

Majority (41%) of the respondents have a medium (3-4) number of family members while 32% of the respondents have small number of family (1-2). On the other hand, 18 percent of respondents have 5-7 family size and 9 percent of them owned large number of family size which is greater than 8(Table 8).

Table 8.Family sizes of the respondents

Family sizes	Frequency	Percents (%)
1-2	32	32
3-4	41	41
5-7	18	18
>8	9	9
Total	100	100

Source: Field Survey, 2019

3.2. Spatial Temporal Distribution of Land Use and Land Cover and Accuracy Assessment

3.2.1. Land Use Land Cover Classification for 1989

As information obtained from land sat, the land cover classification of 1989 was identified as bush and shrub lands, farmland and settlements, forest, grass and degraded Lands. Moreover, based on the spatial distribution, most of the farmland and settlements (534.32 km^2 (1.27%)) were found in the north parts of the study area. Most parts of the study area were covered by grass and degraded lands (30171.64 km^2 (71.49%)) and spatially they were found in the most central and south eastern parts of the study area. In addition, the bush and shrub lands (6988km^2 (16.56%)) were mostly concentrated in the south western parts of the study area and forests (3008.04km^2(10.68)) also found in the northern parts of the study area (Figure 2 1989A).

3.2.2. Land Use Land Cover Classification for 2004

The land use and land cover classifications of 2004 were identified as bush and shrub lands (22988.28km^2 (54.47%)), farmland and settlements (2443.08km^2(5.79%)), forest (2237.12km^2(5.3%)), and grass and degraded lands (13033.52km^2 (34.44%)). During this time, most parts of the study area were covered by the bush and shrub lands. Spatially, the bush and shrub lands are dominantly situated in the central parts of the study area. Similarly, the grass and degraded lands also located mostly in the southern edge in the study area. In the same manner, the farmland and settlements are mostly found in most northern edge of the study area (Figure 2 2004B).

3.2.3. Land Use Land Cover Classification for 2019

Furthermore, land use and land cover classifications of 2019 were identified as bush and shrub lands (26741.44km^2 (63.37%)), farmland and settlements (4764.72km^2(11.29%)), forest (694.72km^2 (1.65%)) and grass and degraded lands (10001.12km^2 (23.69%)). During this time, most parts of the study area were covered by the bush and shrub lands. Spatially, the bush and shrub lands are dominantly situated in the central parts of the study area. Similarly, the grass and degraded lands also mostly located in the southern edge in the study area. In the same manner, the farmland and settlements are mostly found in the northern edge of the study area (Figure 2 2019C).

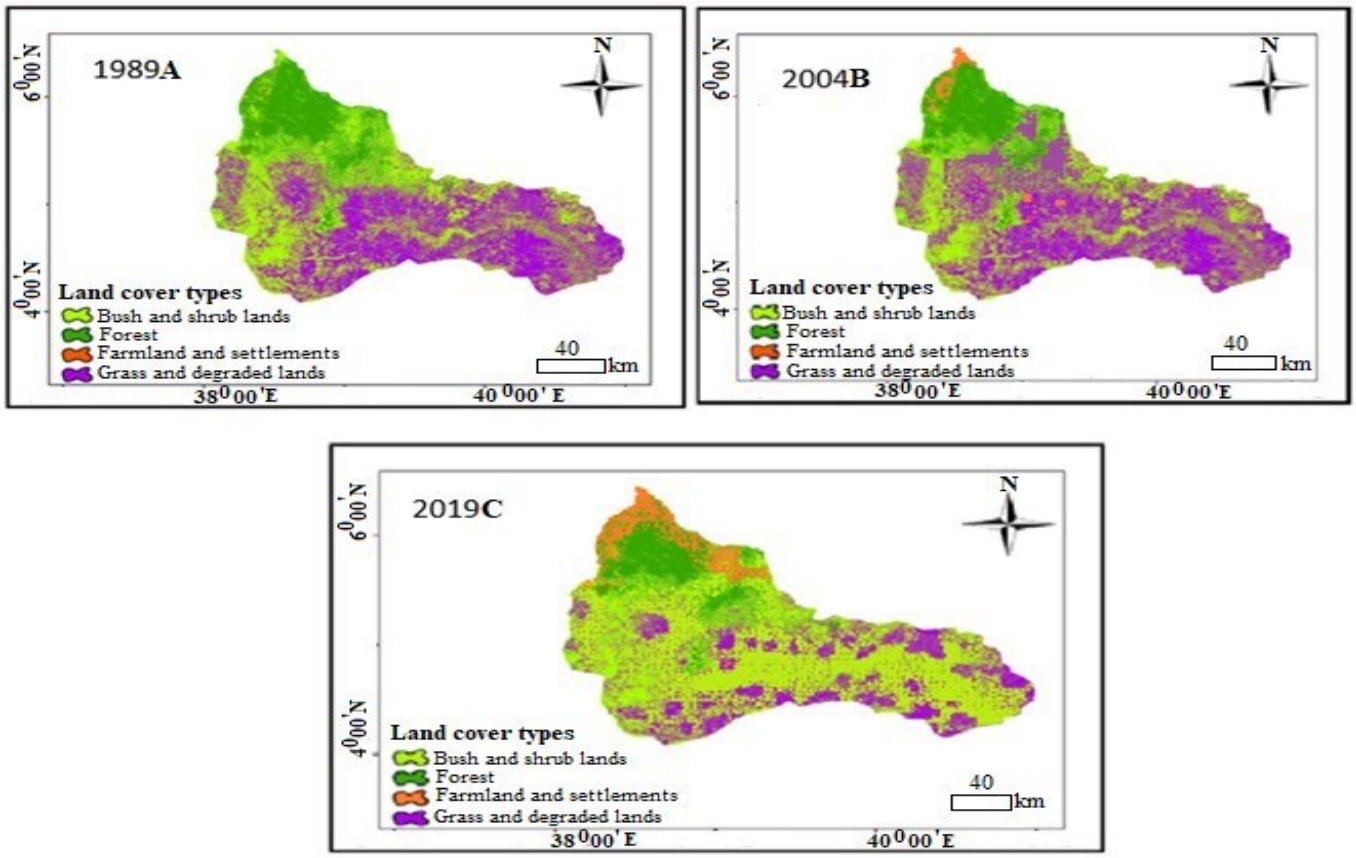

Figure 2. Dawa river basin land use land cover classification map

Accuracy Result: The result of the of overall accuracy assessment of 2019 year classified Landsat imagery was analyzed (Table 9). As its name implies, the accuracy assessment depicted the degree of correctness of assigning a pixel to the predefined land use and land cover classes. Therefore, the base line requirement of the overall accuracy assessment is ≥80 (Congalton, 1991).Higher accuracy result had obtained on the latest imagery in the software matched with the land cover classes on the ground.

Table 1. Classification accuracy statistics of LULCC classes (2019)

Class name	Accuracy (%)	
	2019	
	Producers	users
Bush and shrub lands	100	90.91
Farmland and settlements	100	100
Forest	100	100
Grass and degraded lands	100	100

Over all classification	97.76

3.3. Land Use and Land Cover Change Detection

3.3.1. Land Use Land Covers Change Detection between1989 and 2004

In 1989 the farmland and settlements covered 534.32km² and increased to2443.08 km² in2004.So, within 15years, 532 km² remained constant from being changed. But, it lost 11.12 km² to the other class types and again it gained 1911.08 km² from the other land class types. Generally, the farmland and settlements showed a total incensement of class change (1908.76 km²) in 15 years. Similarly, the bush and shrub lands covered an area of 6988 km² in 1989 but it increased in to 22988.28 km² in 2004. In these years, 6702km² remained constant from being changed. But, it lost 286 km² to the other land class types and 16286.28 km² again gained from the other classes' type. Generally, the bush and shrub lands showed a total reduction of class change (16000.28 km²) in 15 years (Table 11A).

In contrast, in the same study years, the grass and degraded lands covered an area of 30171.64 km² in 1989and it decreased in to 13033.52 km² in 2004. So, in 15 years, 14056 km² remained constant from being changed. But, it lost 16115.64 km² to the other class types and again it gained 477.52 km² from the other mentioned classes. Generally, the grass and degraded lands showed a total decrement of class change (15638.64 km²) in 15 years. Likewise, the forest covered an area of 3008.04 km² in 1989 but it decreased in to 2237.12 km² in 2004. In these years, 2226 km² remained constant from being changed. But, it lost 2272 km² to the other land class types and it gained 11.12 km² from the other classes' type. Generally, the forest showed a total reduction of class change (3170.92 km²) in 15 years (Table 11A).

3.3.2. Land Use Land Covers Change Detection between 2004 and 2019

In 2004 the farmlands and settlements covered an area of 2443.08km² but in 2019 it increased to 4764.72 km².This implies that 2443.08km² was remain unchanged to the other classes and it lost nothing km² to the other class types within 15 years while2321.64 km² gained from other classes. Generally, the farmlands and settlements showed a total increment of class change (2321.64 km²) in 15 years. Similarly, in 2004 the bush and shrub lands covered an area of 22988.28 km² but in 2019 it increased to 26741.44km². This indicated that 22415.44 km² remain unchanged until 2019. Within the 15years, it lost 572.72 km² to the other classes and again it gained 4326 km² from the other class types. Generally, the bush and shrub lands showed a total increment of class change (3753.16 km²) in 15 years (Table 11B).

In contrast, the forest covered an area of 2237.12 km² but it decreased to 694.72 km² in 2019. This indicated that 694.72km² remained constant from being changed until 2019. Within the 15years, it lost 1542.4 km² to the other classes and again it gained nothing km² from the other class types. Generally, the forest showed a total reduction of class change (1542.4 km²) in 15years. Similarly, in 2004 the grass and degraded lands covered an area of 13033.52 km² but in 2019 it declined to 10001.12 km². This indicated that 9928.84 km² remain constant from being changed until 2019. So, within 15 years, it lost 4605.24 km² to the other classes and it again gained 72.84km² from the other class types. Generally, the grass and degraded lands showed a total reduction of class change (3032.4 km²) in 15 years (Table 11B).

3.3.3. Land Use Land Covers Change Detection between1989 and 2019

The overall change in land use and land cover in the last four decades was also assessed. There were an increment of farm land and settlements and bush and shrub lands but a decrease in the area coverage of grassland/degraded land and forests. This was just the general impression of land cover dynamics based on comparison of individual land cover type.

The farmland and settlements portrayed increasing pattern of change during the period comparisons of between 1989 and 2019 .It increased from 80.36 km² to 4764.72 km² in 1989 and 2019 respectively. Within 30 years, farmland and settlements was converted from bush and shrub lands, forests, grass and degraded lands accounted for 3508 km², 1148 km² and 55.72km² respectively. Thus; within 30 years, it gained 4711.72 km² from the other classes. In addition, bush and shrub lands was showed increasing pattern of changes during the periods between 1989 and 2019. It increased from 16230.16 km² to 26741.44 km² and lost 3552.92 km² to the other land types mainly to farmland and settlements (Table 11C).

In contrast, the forest portrayed decreasing pattern during the period comparisons of between 1989 and 2019. It decreased from 7464.92 km² to 694.72km² in 1989 and 2019 respectively. Within the

entire study time, the forest was changed mainly to bush and shrub lands which account 5622.2 km² and 1148 km² respectively. Similarly, grassland and degraded area showed decreasing pattern during

the period comparisons between 1989 and 2019. It decreased from 18411.56 km² to 10001.12km² between 1989 and 2019 respectively. Within the 30 years, it lost 4882.72 km² to other land types mainly to bush and shrub lands and farmlands and settlements (Table 11C).

Generally, during in the period comparisons among 1989, 2004 and 2019, the farmlands and settlements were increased by 4684.36 km²with rate of 104.09 km² per year. In addition, within 30 years, bush and shrub lands were increased to 10496.28 km² with rate change of 233.25 km² per year.

In contrast, the forest lost 6770.20 km² within the entire time intervals with rate change of 528.83 km² per year. Similarly, the grasslands and degraded areas lost 8410.44 km² within 30 years with rate of changes 186.89 km² per years.

Table 2. LULCC matrix between 1989 and 2004; 2004 and 2019; 1989 and 2019

A	2004									
1989	Class Name	BS		FS		F		GD		Total	
		km²	%	km²	%	km²	%	km²	%	km²	%
	BS	6702	29.15	104	4.26	-		182	1.2	6988	16.56
	FS	-		532	21.78	11.12	0.5	-		534.32	1.27
	F	1041	4.53	936.72	38.34	2226	99.5	295.52	2.1	3008.04	10.68
	GD	15230.28	66.32	870.36	35.62	-		14056	96.7	30171.64	71.49
	Total	22988.28		2443.08		2237.12		13033.52		42202.00	
	Class Change	+16000.28		+1908.76		-3170.92		-15638.64			

B	2019									
2004	Class Name	BS		FS		F		GD		Total	
		km²	%	km²	%	km²	%	km²	%	km²	%
	BS	22415.44	83.82	500	10.49	-		72.84	0.72	22988.28	54.47
	FS	-		2443.08	51.28	-		-		2443.08	5.79
	F	93	0.34	1449.4	30.42	694.72	100	-		2237.12	5.30
	GD	4233	15.84	372.24	7.81	-		9928.84	99.27	13033.52	34.44
	Total	26741.44		4764.72		694.72		10001.12		42202.00	

	Class Change	+3753.16	+2321.64	-1542.4	-3032.4

C	2019									
1989	Class Name	BS		FS		F		GD		Total	
		km²	%	km²	%	km²	%	km²	%	km²	%
	BS	12692.24	47.9	3508	73.62	-		44.92	0.46	16230.16	38.49
	FS	-		53	1.14	-		27.36	0.27	80.36	0.19
	F	5622.2	21	1148	24.09	694.72	100	-		7464.92	17.69
	GD	8427	31.1	55.72	1.15	-		9928.84	99.27	18411.56	43.63
	Total	26741.44		4764.72		694.72		10001.12		42202.00	
	Class Change	+10496.28		+4684.36		-6770.20		-8410.44			

3.4. Drivers of Land Use and Land Cover Change between 1989 and 2019

Land cover changes are caused by numbers of natural and human deriving forces (Li et al.,2016;Myer and Turner II, 1994).Whereas natural effects such as climate change are felt only over a long period of time; the effects of socio-economic factors are immediate and radical for LULCC (Woldeamlak, 2004). Moreover, population growth was the most important derivers for land cover change of the human factors in Ethiopia (Hurni, 1993), as it was generally the case in underdeveloped countries (Hurni, 1993).

According to questionnaire, focus group discussion and interviews made with local people, the most influential socio- economic, political and natural factors that have speeded up the conversion of specific class type to the other from the year between 1989 and 2019 were population pressure; open grazing activities, lack of professional natural resource managements, deforestation, weak governmental regulations to wards forest resources, effect of climate change and the day to day increasing of unemployment in the basin.

4. Discussions

4.1. Drivers of Land Use and Land Cover Change

Farmland and Settlements: This class has included cultivated land and settlements. The land cover types were merged in to one category because it was awkward to recognize the scattered rural settlements as a separated land cover type. Also, cultivated land exists around homesteads and would have to be recognized as such. Hence, for practical reasons, the two land cover types were merged in to one category. The areas under the farmland and settlements have showed a slow and persistent increase over the period under the study. Though this was a general trend, the rate of increase was quite small while compared with the total area of the basin. This land use land cover showed increasing pattern of change.

The farmland and settlements showed increasing pattern of change during the first period comparisons of 1989 to 2004.The farmland and settlements have converted mainly from grass /degraded lands, forest areas. According to questionnaire, focus group discussions and interview conducted, the farmland and settlements increased between 1989 and 2004 due to purely population pressure occurred in the study area for the purpose of cultivation. Due to above mentioned reasons the farmland and settlements were increased during the period of comparison had made.

Similarly, the farmland and settlements showed increasing pattern of change during the second period comparisons of 2004 to 2019. Farmland and settlements have converted mainly from woodlands, grass lands and forests. According to questionnaire, focus group discussions and interview conducted, the farmland and settlements were increased between 2004 and 2019 due to the illegal encroachment of the local population in to the grass land and forest areas for cultivation purpose. Due to the above stated reasons the farmland and settlements were increased during the period as comparison had made. Generally, the farmland and settlements were increased in between 2004 and 2019 due to purely population pressure. To sum up, the justification of the informants is similar with Haile (2004) and Gebresamuel et al. (2010), which caused much of the open grazing land and forest to be shifted in to cropland illegally.

Forest: The area under the forest showed a persistent decrease in the first two years study intervals and increase in the last study interval over the period under the study. Though this was a general trend, the rate of decreased was quite high when compared with the total area of the basin.

The area of land that was occupied by forest depicted decreasing situation in the periods between 1989 and 2004. The forest has mainly converted to farm lands and bush/shrub lands. According to questionnaire, focus group discussions and interview conducted, the forest decreased between 1989 and 2004 owning to illegal cutting of the forest for personal consumption. This justification strictly matched with Yigremew (1997), which has helped the people to open the way to extract out the natural indigenous forests for the purpose of constructing the dwelling houses for the whole family. Due to above mentioned reasons the forest was decreased during the period as comparison had made.

Similarly, the forest showed decreasing pattern of change during the second period comparisons of 2004 to 2019. The forest was changed mainly to bush lands and farmland/settlements. Based on information conducted through questionnaire, focus group discussions and interview, forest lands decreased during this period due to the most recent advancement of charcoal ways of production by the local community in the basin. This reason is strictly matched with Yigremew (1997). In addition, the existing government also exploited the forest resource from the basin area forests for the name of rehabilitating the war devastating regions and this situation opened the way for further deforestation for the local community. Moreover, according to questionnaire, focus group discussions and interview conducted in the study area, the community considered the forests resource as the source of income gaining area via selling the forest for the purpose of fire wood to the nearby urban areas and the increasing demand of the forest charcoal by the urban dwellers paved the way of forest destruction by the local community as a daily income especially by the youngster ladies. This justification agreed with Woldeamlak (2004).Due to the above stated reason the forest areas were decreased during the period as comparison had made.

Grass and Degraded Lands: Degraded land included both open grazing lands and exposed lands. This is because, it was difficult to distinguish open bare lands from grazing lands as they were heavily degraded in the study area. As a result, they were categorized together.

The area under the grass and degraded land showed a decreasing pattern of change during the first period comparison in between 1989 and 2004. The grassland and degraded land have converted to bush and shrub lands; farmland and settlements. According to information obtained from questionnaire, focus group discussions and interview the grassland was converted mainly to bush and shrub lands, and farmlands between 1989 and 2004 due to the effect of climate change and population

pressure happened in the basin. Due to above mentioned reason the grassland and degraded lands were decreased during the period as comparison had made.

Moreover, Grass lands and degraded areas showed decreasing pattern during the second period comparisons of 2004 and 2019. The grasslands have converted mainly to farmland/settlements, bush and shrub lands. Based on questionnaire, focus group discussions and interview made with the local people in the basin, the grass and degraded lands converted to bush and degraded lands due to mainly the effect of climate change in the basin. This resulted in the favorable condition for the encroachment of bush and shrub by intermingling deep in to the grass and degraded lands overwhelmed it. Thus, it decreased the grass and degraded lands. The other main reason for the decreasing of the real extent of the grass and degraded lands was population pressure, which have caused much of the open grazing land shifted in to cropland. This agreed with the findings of the previous conducted findings (Amsalu et al., 2007; Gebresamuel et al., 2010; Zeleke and Hurni, 2001). The remaining area now consists largely of bare ground, which is overgrazed and characterized by exposed rocks, thus; decreased the grass and degraded lands.

Bush and Shrub Lands: These types of vegetation have covered the fringe of forest vegetation and sprawled towards the grassland and degraded land. They showed increasing pattern of change during the first period comparisons of 1989 and 2004. The bush and shrub lands have converted from grasslands/degraded lands and forests.

Based on questionnaire, focus group discussions and interview made with the local people in the basin, the bush and shrub lands increased in between 1989 and 2004 owning to the climate change occurrence in the basin. This favorable condition assisted to the encroachment of bush and shrub by intermingling deep in to the grass and degraded lands, resulted in the grass and degraded land areas automatically transformed in to bush and shrub lands, thus; expanded the bush and shrub lands. The bush and shrub lands converted mainly from grass and degraded lands and forests. It increased during the second period comparisons of 2004 and 2019. Based on questionnaire, focus group discussions and interview made with the local people in the basin, the bush and shrub lands converted from grass and degraded lands due to mainly the recent serious occurrence of climate change in the basin. This has resulted in the favorable condition for the encroachment of bush and shrub by intermingling deep in to the grass and degraded lands. Owing to this conversion of the grass land to the bush and shrub lands frequently grass shortage was occurred year from year on pastoralist.

Based on questionnaire, focus group discussions and interview made with the local people in the basin, the bush and shrub lands converted from forest due to population pressure. Population pressure is one of the headache agents of deforestation in the basin. In the basin, the community considered the forest resources as the source of income gaining area via selling the forest products for the purpose of fire wood to the nearby urban areas and the increasing demand of the forest charcoal by the urban dwellers paved the way of forest destruction by the local community as a daily open income gaining area especially by the youngster ladies. This illegal deforestation made the forest area to be degraded and changed in to bush and shrub lands. Thus, it increased the bush and shrub lands.

5. Conclusions

In Dawa river basin land use and land cover changes have occurred since 1989. As a result, during in the periods comparisons among 1989, 2004 and 2019, the farmlands and settlements were increased by 4684.36 km^2 with rate of 104.09 km^2 per year. In contrast, the forest lost 6770.2 km^2 within the entire time intervals with rate change of 528.83 km^2 per year. Similarly, the grasslands and degraded areas lost 8410.44 km^2 within 30 years with rate changes 186.89 km^2 per years. Moreover, during the periods of comparison, bush and shrub lands increased 10496.28 km^2 with rate change of 233.25 km^2 per years. Thus,the major change has observed in increasing of farmlands and settlements at the expense of other identified land classes especially on woodlands, grasslands and forests in the study area. According to the key informants, focus group discussion and questionnaire the major drivers that had accelerated the change were effect of climate change, deforestation, population pressure, and lose governmental policy. Generally, as the result of the existing driving forces of land use land cover change in the basin, forest coverage and grass land areas are greatly decreased and imposed critical influences for grazing on the pastoralist.

6. Recommendations

The findings of the study gives clue for the concerned body including researchers and other stakeholders for further better investigation on the issues and bring possible intervention mechanisms for the dramatic land use land cover change in the study area.

According to the result of the study done in Dawa river basin, the following recommendations has been forwarded. The study tries to see starting from 1989 to 2019. Thus, it needs to be assessed using

before 1989 imageries. In addition, the study points that settlement & farmlands and grass /bare lands are merged together during image classifications due to low image resolution. Thus, it needs to be classified independently using high resolution SPOT images. Moreover, the study tries to investigate only the drivers of land use land cover change in Dawa watershed but it needs to be investigated on the socio-economic impacts of land use land cover change. Similarly, the study tries to identify the drivers of land use land cover change in some selected districts but it needs to be identified in all districts of the study area. Finally, forest and grasslands areas greatly decrease from time to time than the other class types in the study area. Thus, strategies should be designed for these specific cover types to recover back in their coverage in the basin.

Acknowledgements

First of all, I would like to express gratitude to the almighty God, for giving me strength to complete the study and for all things done in all my life. Secondly, I want to express my deepest gratitude to Bule Hora University for the permission, financial support, guidance and inspirations to do more for the best of this study. Thirdly, I want to express my great appreciation to Ethiopian Mapping Authority, United Nation Geological Survey, all the district office staffs found in river basin, respondents. Finally, I want to express my gratitude to all my colleagues and staff members of the department of Geography and Environmental Studies for sharing their experience, material and valuable cooperation in the study.

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