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Impact of Resettlement Program on Forest Cover Change: The Case of Anbessa Forest, Benishangul-Gumuz Region, Ethiopia

Mekonen Hunde[1, *], Aduwa Anjulo[1], Bekele Tulu[2]

[1]Department of Geography and Environmental Studies, College of Social Science and Humanities, Assosa University, Assosa, Ethiopia
[2]Department of Natural Resources Management, College of Agriculture and Natural Resource, Assosa University, Assosa, Ethiopia

Email address:
mekonnenhunde@gmail.com (M. Hunde), aduwa46@gmail.com (A. Anjulo), obishtulu@gmail.com (B. Tulu)
[*]Corresponding author

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Abstract: *Background*: Resettlement has been considered as a viable solution to the continual impoverishment of Ethiopian rural populations. But it has considerable impacts on natural resources. This study was carried out on impact of resettlement program on forest cover change the case of Anbessa forest. *Methods:* ArcGIS 10.5, ERDAS Imagine 2015, Landsat satellite imageries were acquired from USGS to analyze LULC for 44 years. The images of the area were categorized into five different LULC classes; namely dense forest, open forest, shrub land, agricultural land and settlement. Through simple random sampling procedure, a total of 129 households were selected from the total of 1941 households. Data were collected using questionnaires, GPS, interviews, focus group discussions and field observations and analyzed both quantitatively and qualitatively by descriptive statistics. *Results:* The results revealed that during the last 44 years, agricultural land (698ha to 15180ha) and settlement area (72ha to 13270ha) were increased, while dense forest, open forest and shrub land were decreased. The cause of forest cover change is directly linked with settlers as result expansion of agricultural activities, forest fire, fuel wood collection and constructional materials. Moreover, results revealed that deforestation, loss of biodiversity, hydrological impact and land degradation were the main consequences of forest cover change. *Conclusions*: Resettlement scheme has resulted in the depletion and dynamics of forest cover in Anbessa forest. From the current study, it was found that the area is under problem of deforestation, which calls for immediate attention from all concerned bodies.

Keywords: Anbessa Forests, Forest Cover Change, GIS & RS, Resettlement Program, Rural Society

1. Introduction

Resettlement is a planned or spontaneous phenomenon of population redistribution. It can be voluntary or forced; can also be temporary or permanent. Spontaneous resettlement is when people resettle in a new place under their own initiative and planned resettlement is when it imposed on people by an external agent in a planned and controlled manner [1].

Worldwide experience suggests that resettlement, caused by development projects, conflicts or other socio-economic, political and environmental factors, is a risky process that often leads to impoverishment and rarely results in sustainable development [2-4].

In Africa, resettlement is a serious issue of current as well as future concern. Africa's share of displaced people has been exceptionally high [4]. The most common causes of state-initiated resettlement and displacements in Africa such as displacements by Development programs, environmental conservation programs and population redistribution programs initiated by governments may for disaster avoidance [5, 6]. Environmental degradation is a major problem in Africa especially in Sub-Saharan Africa a region that has seen untold numbers of internally and extra-territorially displaced persons often referred to as internally displaced persons and refugees respectively [7].

Ethiopia has been planned and implemented population resettlement from drought and famine affected highland areas to presumably unutilized vast and fertile lowland areas in the successive governments [8-10]. In the Benishangul gumuz region, the rate of deforestation and forest degradation relatively lower as compared to other regions of the country due to less population pressure, forest dependency and low livestock [11].

However, currently, Assosa, Bambasi and Pawi districts are not free from the deforestation and forest degradation mainly due to settlement programs. Likewise, the forest cover of the Anbessa forest is declining rapidly due to the combined effects of various factors occurring during the last 20 – 30 years [12].

Hence, conducting research is needed to fill the gap of the previous studies to ensure the forest management sustainably. Moreover, how much rapidly of Anbessa forest is changing from time to time is not visible. Thus, no research was conducted using GIS and remote sensing on the assessment of impact of resettlement program on forest cover change at the study area. Therefore, the purpose of this study was intended to analyze impact of resettlement program on forest cover change using GIS and Remote Sensing the case of Anbessa forest, Benishangul gumuz region, western Ethiopia.

2. Materials and Methods

2.1. Description of the Study Area

Bambasi district is one of the 20 districts in the Benishangul-Gumuz regional state and it is a part of Assosa Zone. The administrative center of Bambasi district is Bambasi town. The district bordered on the southwest direction by Begi district of Oromia Region and Mao-Komo special district of Benishangul Gumuz Region, Assosa district in the northwest, Oda Buldigilu in the northeast and Mene Sibu of Oromia Region in the southeast. Anbessa forest covers the total area of 44,569 ha. Bambasi district is 640 Kms away from the capital city of the country; Addis Ababa. The district is geographically located 9°30ˈ0"to 9°50ˈ0"N latitude and 34°22ˈ30"E to 34°43ˈ30"E longitude (Figure 1). The total population of Bambasi District is 71,279; out of this, 37543 (52.65%) are males and 33,736 (47.34%) are females [13].

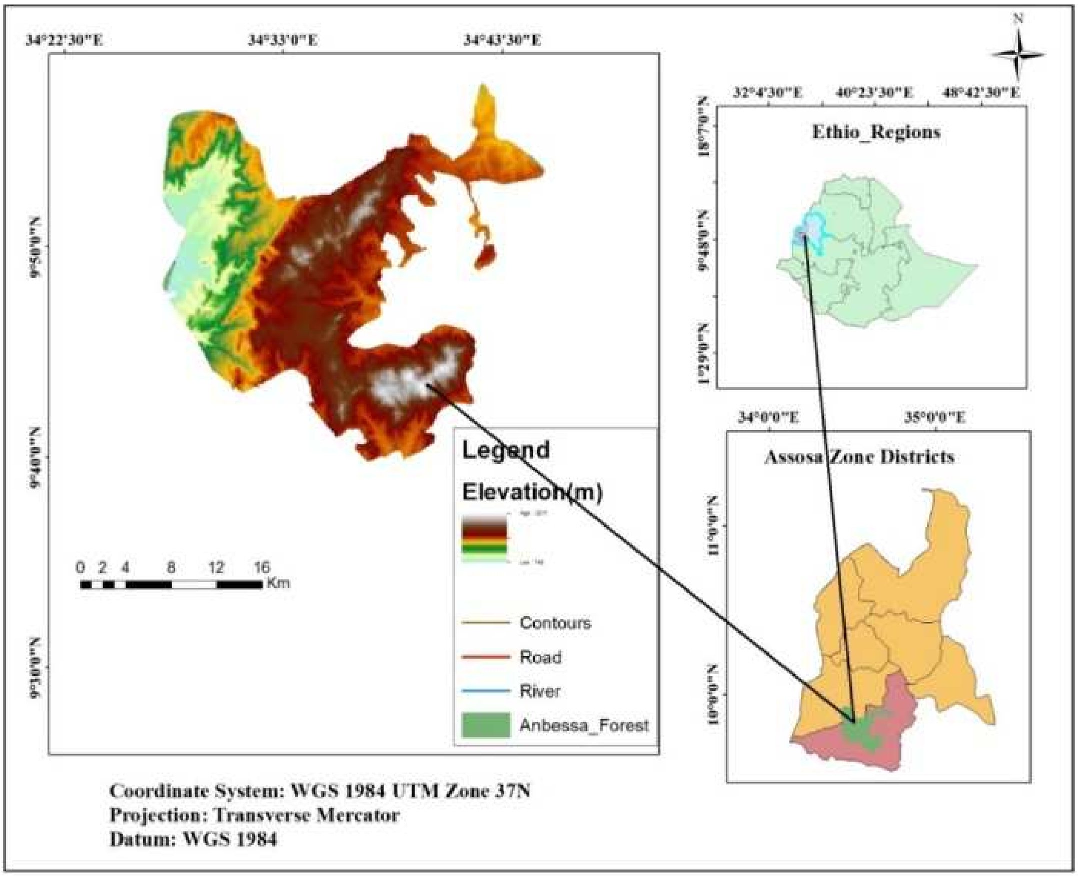


Figure 1. *Location map of study area.*

2.2. Research Design

In this study, explanatory sequential approach of the mixed research design was implemented. According to [14] the overall determined design is to have the qualitative data that help to explain more detail about initial quantitative results. With this particular study, the spatial data is considered as quantitative data whereas the socio-economic data is qualitative. Qualitative data was carried out in order to provide information on the land use dynamics and deforestation of the study area in the study period. The socio-economic aspect of the study was use to explore how the resettlement causes and consequences the forest cover changes in the study area.

2.3. Software Used

The software used to investigate for this study were ERDAS Imagine 2015: used for image analyses, ArcGIS 10.5: was used for vector data analysis, clipping and make layout for final mapping.

2.4. Data Types and Data Sources

For this study, both primary and secondary data types were used. The primary data was obtained from key informant interview, Focus Group Discussion, Household survey and field observation. The secondary data was obtained mainly from satellite image (Table 1).

Table 1. *Satellite data.*

Date Acquisition	Types of image	Types of sensors	Path	Row	Spatial Resolution	Number of bands	Source
Jan 10/01/1975	Landsat 2	MSS	184	053	60m*60m	7	USGS
Jan 12/01/1985	Landsat 5	TM	171	053	30m*30m	7	USGS
Jan 14/01/2002	Landsat 7	ETM+	171	053	30m*30m	7	USGS
Jan 05/01/2019	Landsat 8	OLI	171	053	30m*30m	11	USGS

2.5. Sample Size and Sampling Techniques

In the study area, there are 36 rural village administrations, out of which 20 villages are occupied by settlers. From these villages, six re-settler villages are surrounded Anbessa forests namely: Amba 16, Jematsa, Garabiche Metema, Mender 47, mender 48 and mender 49 (Table 2). So, all six surrounded villages were selected by purposive sampling method based on its geographical location or proximity to forest. The sample size was determined by using Cochran (1977) sample size determination formula [15] and decided proportional to the total population size (Table 2).

$$no = \frac{Z^2(p)(q)}{e^2} \quad n1 = \frac{no}{1+\frac{(no-1)}{N}}$$

Table 2. *Sample Size of Settlers Households.*

No	Name of villages	Total household size	Sample size
1	Jematsa	346	23
2	Garabiche Metema	410	28
3	Mender 47	289	19
4	Mender 48	277	18
5	Mender 49	289	19
6	Amba 16	319	22
Total	6	1941	129

Source: Villages registry, 2019.

2.6. Accuracy Assessment Classifications

Along with field observation, GPS point data was collected within the study area to examine the major types of land use land cover and for each LULC was taken for each 20 GCP total 100. Such kind of data collection methods are useful for identifying LULC was categories in the study area and accuracy assessment of LULC category was developed. Accuracy of the classified LULC maps was assessed using a combination of overall accuracy, producer's accuracy, user's accuracy, errors of commission and omission [16], and kappa coefficient [17]. The overall accuracy and kappa coefficient results were checked to be above the minimum and acceptable threshold level.

2.7. Data Processing and Analysis Method

2.7.1. Pre-Processing of Satellite Imageries

The image pre-processing tasks were carried out using ERDAS Imagine 2015 software. Prior to data analysis, initial processing on the raw data is usually carried out to correct for any distortion due to the characteristics of the imaging system and imaging conditions [18].

Pre-processing is the preliminary step which transforms the data into a format that was more easily and effectively processed. The raw images downloaded from the USGS websites are not suitable for analysis directly processing due to the various noises' existent in these images. Pre-processing includes importing, layer stacking, and subset the image in to the study area shape file, geometric correction such as resampling, radiometric correction such as atmospheric haze and removal of stripes, and image enhancement techniques.

2.7.2. Methods of Data Analysis

After collecting all necessary data, the socio-economic data were analyzed using SPSS software version 20. Descriptive statistics were used to analyze the household survey. The spatial data were analyzed by image classifications on LULC using ERDAS Imagine 2015.

(i). Image Classification

Lillesand and Kiefer [19] stated that, the objectives of image classification procedures are automatically categorizing all pixels in an image into land-use/land-cover classes. In this study, supervised classification was carried out for the purpose of identifying land-use/land-cover classes and used supervised classification of Maximum Likelihood Classification (MLC) algorithm, which assumes that each spectral class can be described by a multivariate normal distribution in the study area. For the Supervised classification during the preliminary field visit, the various land cover classes were taken by systematic sampling using GPS devise. Based on the field observation/ prior knowledge the study area was classified in to five land-use/land-cover classes and this was help to generate land-use/cover maps Such as: dense forest, open forest, shrub land, agricultural land, and settlements, by using ERDAS Imagine software.

(ii). Normalized Difference Vegetation Index Analysis

Normalized Difference Vegetation Index (NDVI) is the most widely used technique that differentiates vegetation resource from other land cover classes based on vegetation reflectance properties. It shows vegetation abundance distribution, degradation status and coverage [1, 2]. The value of NDVI ranges from − 1 to + 1. Non-vegetation (barren rock, sand, water) typically has NDVI value 0.1 or less; sparse vegetation (shrubs, grasslands) values are between 0.2 and 0.5 and dense vegetation values are over 0.5 [20]. In this study, Landsat imageries of 1975, 1985, 2002 and 2019 were used to extract NDVI values. The values were reclassified as non-forets, open forest and dense forest based on NDVI results to analyze vegetation cover changes of the area. According to Gandhi [21], NDVI can be calculated as follow:

$$NDVI = (NIR-R) / (NIR + R).$$

where NDVI is Normalized Difference Vegetation Index; NIR is Near Infrared band reflectance at 0.76–0.9 µm and R is Red band reflectance at 0.63–0.69 µm.

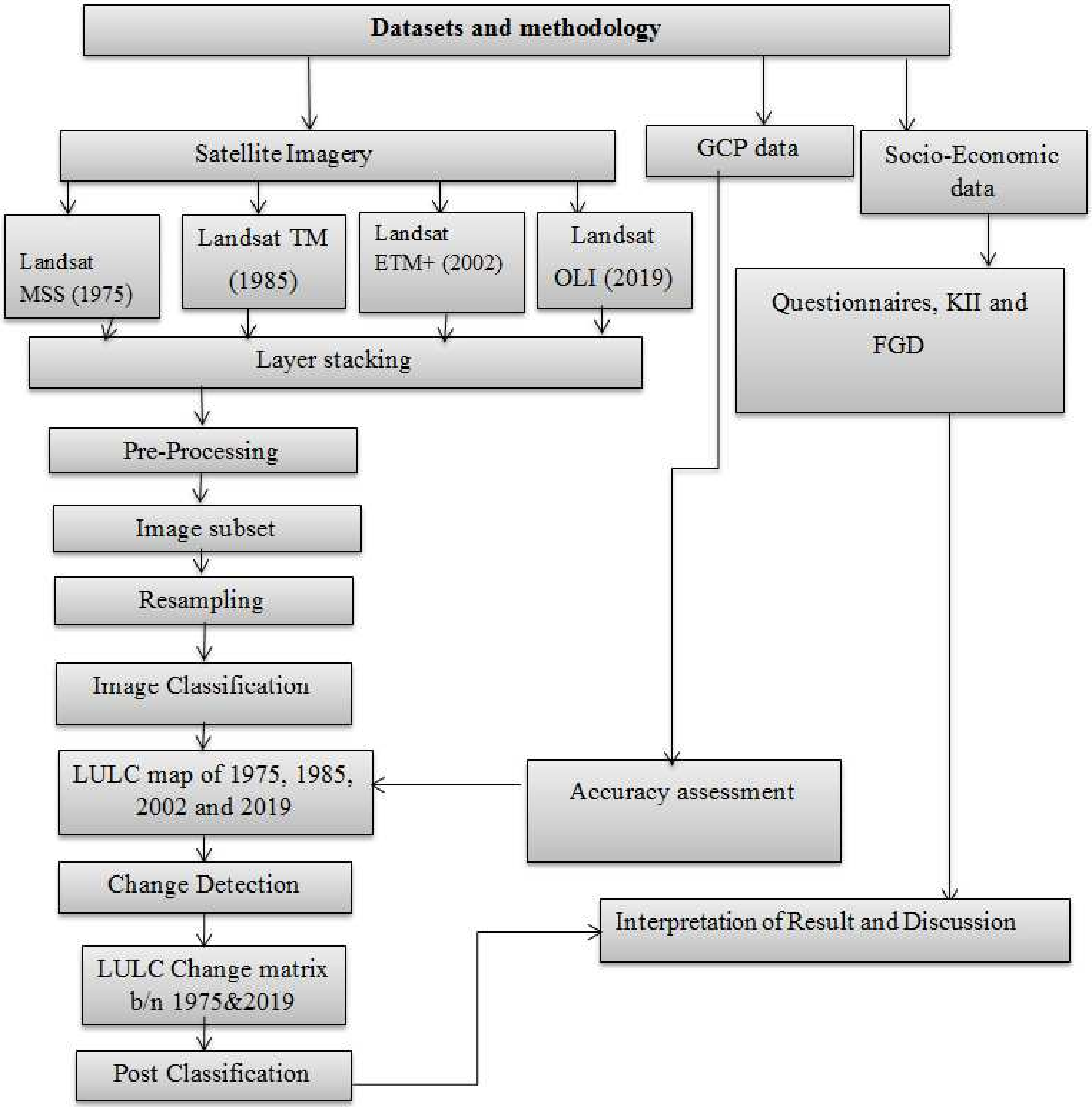
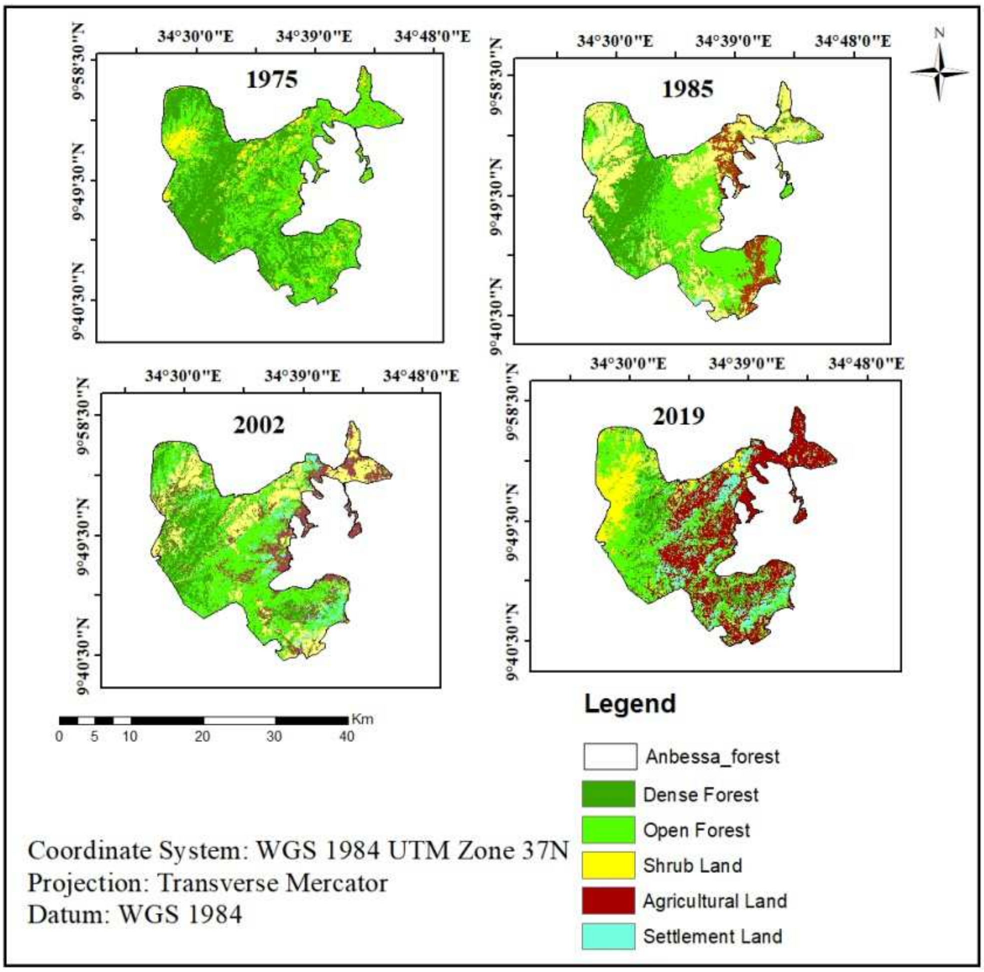


Figure 2. *Methodological flow Chart of the Study.*

3. Result

3.1. Land Use/ Land Cover Classification

Multi spectral images from Landsat TM, ETM+ and OLI images of 1975, 1985, 2002 and 2019 were used to evaluate forest cover changes in the study area. Training sample were collected and used to create classification of the satellite image using ERDAS imagine software. Land-use/land-cover maps produced were presented in the Figure for the stated years. Initially, images were classified in to five land cover classes; these are: dense forest, open forest, shrub land, farmland and settlement.



Sources: From satellite image interpretation

Figure 3. *LULC Maps of 1975 – 2019.*

Figure 3 and table 3 revealed LULC of the study area in quantity and thematic map respectively. During the year of 1975 before resettlement program was implemented in the study area, there was almost covered with dense forest and open forest about 40.4% and 25% respectively while shrub land, Agricultural land and settlement represented only 32.9%, 1.54% and 0.16% respectively.

In the year of 1985, during resettlement program was implemented in the study area, the areal coverage of agricultural land and settlement have increased positively to (16%) and 14.5% respectively. As per the image, areal coverage of dense forest, open forest and shrub land were decreased to 23%, 21.5% and 25% respectively. In the year 2002, the area coverage of dense forest decreased by 17%, followed with open forest 12.8% and shrub land 20%, while the coverage of agricultural land, settlement and shrub land increased to 30% and 20% respectively. Lastly, the last period of the study in the year of 2019 the area coverage of dense forest, open forest and shrub land were decrease by alarming rate 6.3%, 10% and 19.7% respectively. While agricultural land and settlement land was increased by 34% and 30% respectively. Therefore, the four years LULC areas coverage during stated periods revealed that, agricultural land and settlement show general trend of increase in both periods. This is just the general impression of land cover dynamics based on comparison of individual land cover maps.

Table 3. *Land use land cover change in hectare and percentage between 1975-2019.*

Land	Years							
	1975		1985		2002		2019	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Dense Forest	17,997	40.4	10328	23	7528	17	3042	6.3
Open Forest	11,117	25	9427	21.5	5786	12.8	4272	10
Shrub Land	14,685	32.9	11207	25	8912	20	8805	19.7
Agricultural Land	6,98	1.54	7200	16	13293	30	15180	34
Settlement	72	0.16	6407	14.5	9050	20.2	13270	30
Total	44,569	100	44,569	100	44,569	100	44,569	100

Table 4. *Matrix of land-use /land covers change between of 1975 and 1985 in ha.*

		LULC 1985							
		DF	**OF**	**ShL**	**AL**	**ST**	**Row total**	**Total change**	**Net change**
LULC 1975	DF	8834	8038	4106	1084	208	22270	-9872	13436
	OF	1252	8431	8774	2934	503	21894	5355	13463
	ShL	520	1188	3409	458	148	5723	24234	2314
	AL	10	158	363	150	12	693	8433	543
	ST	0	25	31	12	1	69	1674	68
	Column total	10616	17840	16683	4638	872	50649	6109	50649
	Gains	1782	9409	13274	4488	871	29824	-	-
	Loss	-11654	-4054	10960	3945	803	0	-	-

3.2. Change Matrix of LULCC

Post classification and the change matrix of LULC between each year were after four years image classified on the ERDAS Imagine 2015, then on the Arc GIS change to vector under analysis tool intersect finally, the change matrix LULC were presented in the following.

3.2.1. Matrix Change Between 1975 and 1985

The major cover changes observed during this period had been the reduction in the area of both forest categories, dense forest and open forest about -11654ha of dense forest were loss and open forest -4054ha were lost. Likewise, the net changes of dense forest and open forest increased to 13436ha and 13463ha. While, the remaining are shrub land 2314ha, agricultural land 543ha and the settlement 68ha the net changes are increased or gain in the periods.

3.2.2. Change Between 1985 and 2002

This period shows the trend of the previous period the agricultural land was increased to 2877ha, settlement was increased to 2175ha while the dense forest open forest and shrub land cover were -1545ha, -1098ha and -4605ha losses respectively (Table 5). Therefore, this result indicates that the forest cover change was affected by human activities and surprisingly immediate and often drastic. The difference in population increases together with land cover changes through people after settle increase the need of farm land expansion.

Table 5. *Matrix of Land-use /land covers change between 1985 and 2002 in ha.*

LULC 1985		LULC 2002							
		DF	**OF**	**ShL**	**AL**	**ST**	**Row total**	**Total change**	**Net change**
Use Land Cover Class	DF	5735	3706	820	318	38	10617	1792	4882
	OF	1620	9872	2250	2809	1301	17852	10176	7980
	ShL	1525	3665	7497	2847	1164	16698	-9	9201
	AL	162	1411	1215	1407	460	4655	3502	3248
	ST	30	296	311	151	86	874	5138	791
	Column total	9072	18950	12093	7532	3049	50696	20599	26102
	Gains	3337	9078	4596	6125	2963	26099	-	-
	Loss	-1545	-1098	-4605	2877	2175	0	-	-

3.2.3. Change Between 2002 and 2019

During this period, the area coverage of the forest cover was decreased; dense forest-5276ha, open forest-4022ha and shrub land -4317ha were lost i.e., changed in to the other LULC.

However, the agricultural land and the settlement were increased/gain positively. Agricultural land 10541ha and the settlement land 3074 increased respectively (table 6).

Table 6. *Matrixes of Land-use /land cover change between 2002 and 2019 in ha.*

		LULC 2019							
		DF	**OF**	**ShL**	**AL**	**ST**	**Row total**	**Total change**	**Net change**
LULC 2002	DF	2977	3912	1360	733	91	9073	-4456	6096
	OF	604	8406	1075	6792	2078	18955	2505	10549
	ShL	152	1441	4385	4332	1809	12119	-900	7734
	AL	56	597	738	5639	510	7540	22983	1901
	ST	8	577	244	585	1636	3050	7562	1414
	Column total	3797	14933	7802	18081	6124	50737	27694	27694
	Gains	820	6527	3417	12442	4488	27694	-	-
	Loss	-5276	-4022	-4317	10541	3074	8044	-	-

3.2.4. Change Between 1975 and 2019

During the 1975 to 2019 year the reduction of forest cover which are both dense forest and open forest were lost. About-18474ha dense forest and -6964ha forest were lost. However, the increase agricultural land and settlement at all period due to high shift of forest cover in to settlement and agricultural lands. The loss of the two extreme times, 1975 between 2019 years indicated that forest cover in 44 years was lost (Table 7).

Table 7. *Matrix of Land-use /land covers change between of 1975 and 2019 in ha.*

		LULC 2019							
		DF	OF	ShL	AL	SL	Column total	Total change	Net change
LULC 1975	DF	3354	10120	2223	5262	1310	22269	-18033	18915
	OF	278	4319	2882	10696	3715	21890	3643	3643
	ShrL	161	448	2528	1633	933	5703	7241	3175
	AL	2	38	93	445	114	692	34957	247
	ST	0	1	10	11	47	69	12122	22
	Column total	3795	14926	7736	18047	6119	50623	39930	26002
	Gains	441	10607	5208	17602	6072	39930	-	-
	Loss	-18474	-6964	-2033	17355	6050	0	-	-

3.3. Detected Changes by Post Classification

Land cover change analysis by post classification method revealed different types of changes in the periods (Table 8). The pattern of change from forest cover to other land cover land use units between in the year 1975 and 2019 is presented in table 7. The result indicates the areal distribution of forest cover lands and also gives information about what proportion of forest cover land changed in to other land cover and land use units in the indicated time period.

Table 8. *Land covers change detected by post classification techniques.*

Forest cover change	1975-1985		1985-2002		2002-2019		1975 -2019	
	Area in ha	%	Area in ha	%	Area in ha	%	Area in ha	%
Dense Forest to Shrub land	4106	16	820	7.2	1360	8.6	2223	6
Dense forest to Open forest	8038	31	3706	30	3912	24	8044	19
Open forest to Shrub land	8774	35	38	0.3	1075	6.7	2882	7
Dense forest to Agricultural land	1084	4.2	318	5.5	91	0.7	5262	13
Dense forest to Settlement	208	0.8	2250	20	733	5	5262	13
Open forest to Settlement	503	2	1301	12	2078	13	5215	14
Open forest to Agricultural land	2934	11	2809	25	6792	42	11272	28
Total change	25647	100	11242	100	16041	100	40160	100

According to above table results revealed that from year 1975 to 1985 years about 25747 ha of forest cover land are converted into other land cover and land use units. Specifically, about 35% of the forest cover is changed into shrub land followed by forest cover to open forest (31%) The remaining 11%, 4.2%, 2% and 0.8% of the open forest into agricultural land, dense forest into agriculture, open forest into settlement and dense forest in to settlement respectively. In this period the forest coverage change into agricultural and settlement low as compared with other land use land cover class. So, this result revealed that before resettlement program there is low population growth as well as settlement. From the 1985 and 2002 forest cover conversion summary output, 11242 ha of forest cover land are changed in to other land cover units. The conversion of forest land to agricultural land and settlement were increased. Specifically, open forest into agricultural land by 25%, dense forest into agricultural 5.5%, dense forest into settlement 20% and open forest into agricultural lands 12% (table 9).

During 2002 to 2019 year dense forest to shrub land 8.6% dense forest to open forest 24 and open forest to shrub land 6.7% (table 7). Likewise, the forest land coverage change into agriculture land settlement was increased. Specifically open forest into agricultural land 42%, open forest into settlement 13%dense forest in to settlement 5% and dense forest in agricultural land 0.7% (table 9). During 1975 to 2019 years the total forest covers 40160ha were converted to other land use land covers. From those changes dense forest to shrub land 6%, dense forest to open forest 19% and open forest to shrub land 7%. Likewise, from dense forest into agricultural land 13%, dense forest into settlement 13%, open forest into settlement 14% and open forest into agricultural land 28% (table 7).

Generally, in all period from the initial year to final year the forest coverage was change to other land use land cove by alarming rate the problem was directly linked with human activities through agricultural land expansion and settlement.

3.4. Resettlement and Forest Cover Change in Anbessa

In 1985, a large-scale national resettlement program was carried out by the government in Bambasi district. Following this scheme, the area was characterized by remarkable changes and adverse impacts are induced by resettles on forest resources of the area. To detect the dynamics of forest cover, Normalized Difference Vegetation Index (NDVI) analysis was carried out for the district using Landsat imageries of 1975, 1985, 2002 and 2019 (Figure 4). The results of NDVI indicated that there have been significant changes of forest cover in the study area as shown in Figure 4. NDVI image differencing cannot provide detailed change information. It can only give the information of increase or decrease in NDVI value or the healthy vegetation. The negative threshold indicates loss in NDVI and positive threshold indicates area of increased NDVI. As indicated in the following figures.

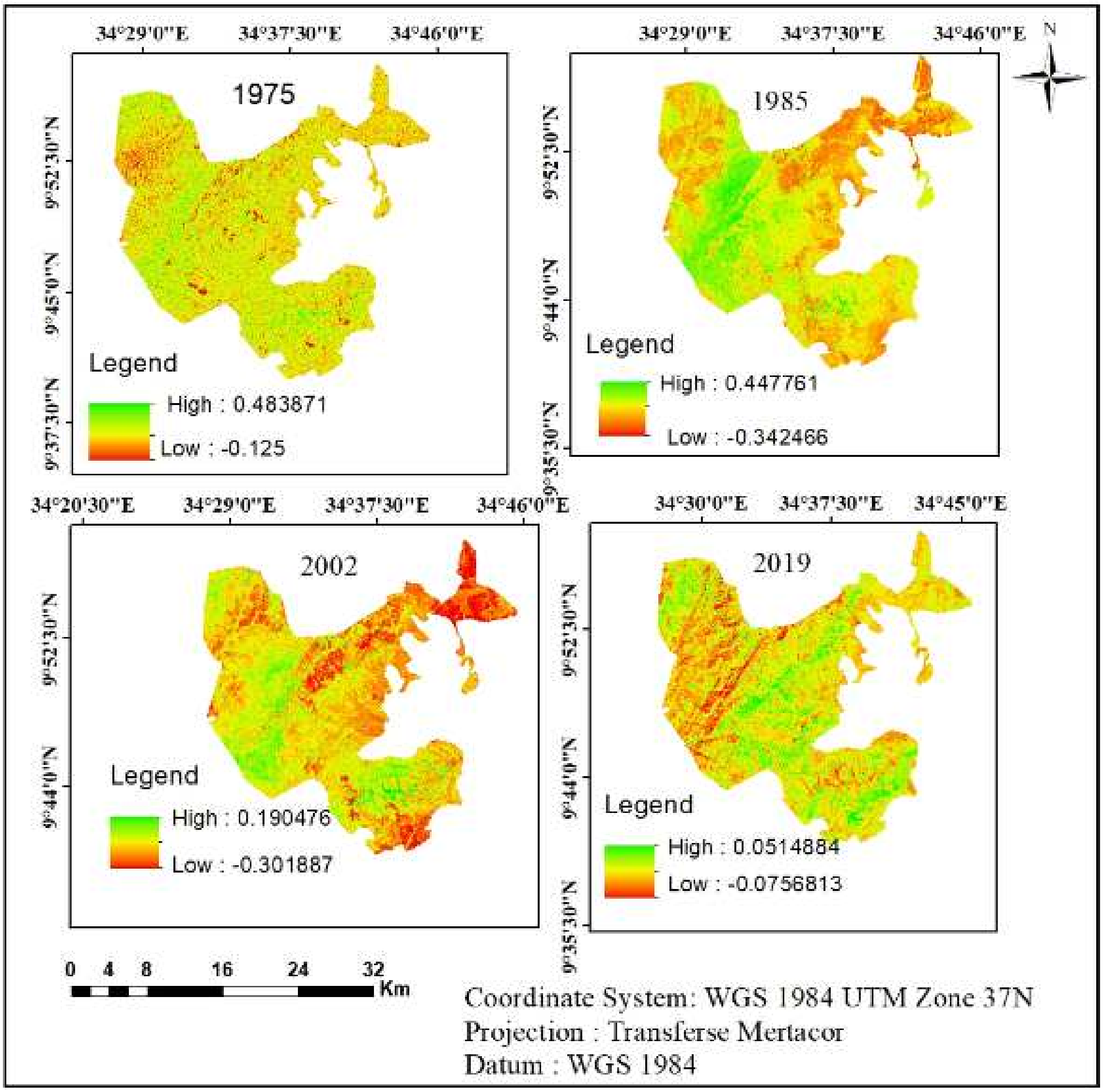


Figure 4. *NDVI between 1975 – 2019.*

3.4.1. Areal Extent and Rate of Forest Cover Change

The forest cover change was decreased from the year 1975- 2019, according to figures 5 and 6 result revealed that dense forest, open forest and shrub lands were negative percentage. Open forest and Dense forest showed continuous decline in the entire period considered. However, the reaming agricultural land and the settlement were increased their percentages. Therefore, the rate and the areal extents of forest cover change are the resettlement and agricultural land expansion was the main deriving factors in the study area.

Table 9. *Annual rate of forest cover change.*

	Cover class	Years 1975	1985	2002	2019	Rate of change 1975 to 1985	1985 to 2002	2002 to 2019	1975 to 2019
Forest Cover ha	DF	17,997	10328	7528	3042	-767.2	-164.7	-263.8	-340
	OF	11,117	9427	5786	4272	-169.0	-214	-89	-155.6

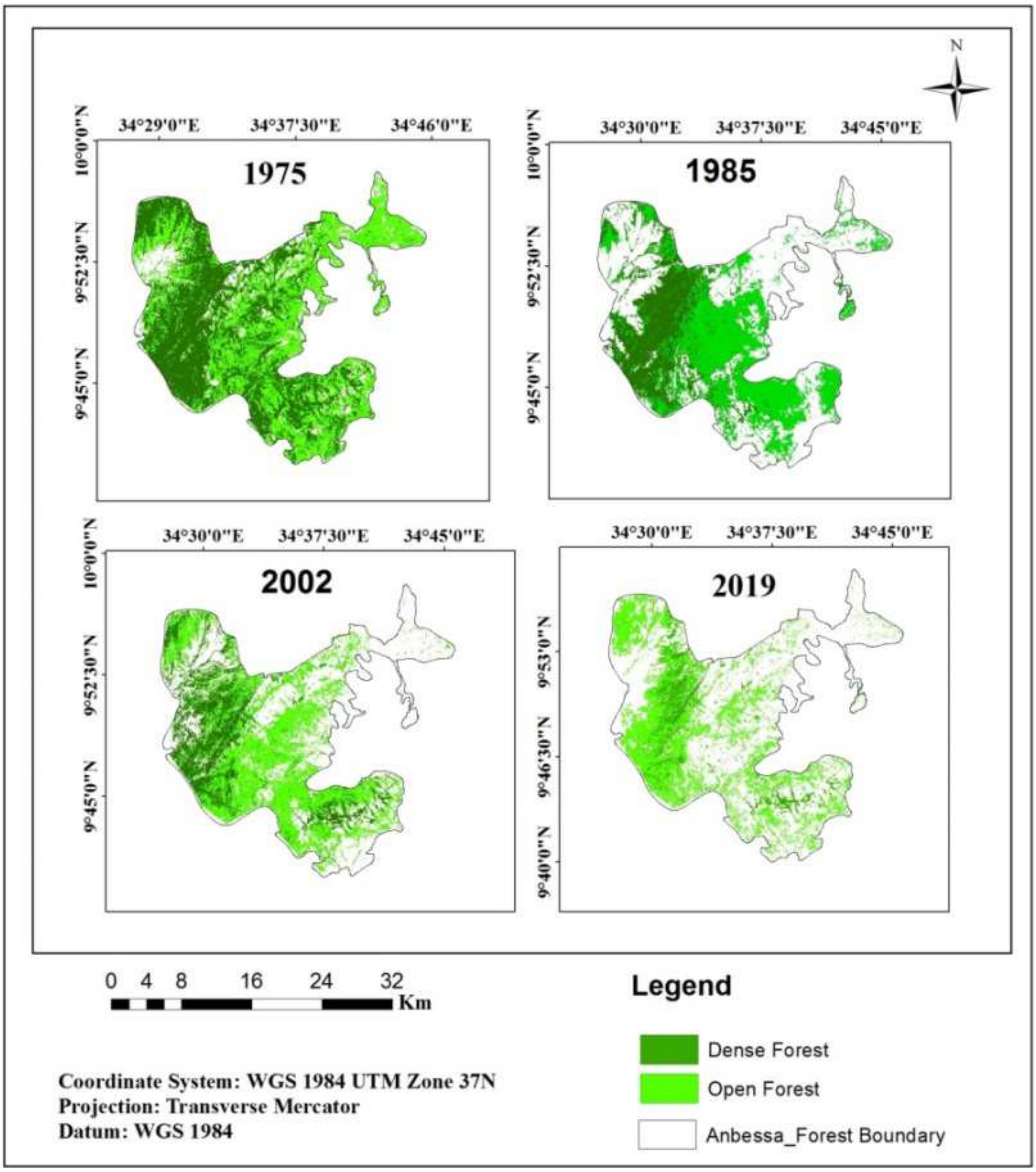


Figure 5. *Anbessa Forest cover dynamics in 1975, 1985, 2002 and 2019.*

According to Berhan [22], to compute the rate of land use/land cover changes; the following equation was performed for computing rate of change.

$$R= (Q1-Q2)/T$$

Where,

R= rate of change

Q2= recent year of LULC

Q1= Initial year of LULC

T= Interval year between initial and recent year

The result is presented in table 10.

According to (table 9) result presented that the average rate of dense forest cover change from year 1975 to 1985 is -767.2 ha per year, from yea 1985 to 2002, it was 164.7ha per year annually, from year 2002-2019 yaer -263.8ha per year and from 1975 to 2019 year -340ha per year annually. Annual rate of open forest cover change between 1975 to 1985 yaer -169.0ha per year, 1985 to 2002 year -214ha per year, 2002 to 2019 year -89ha per year and 1975 to 2019 year were -155.6ha per year annual.

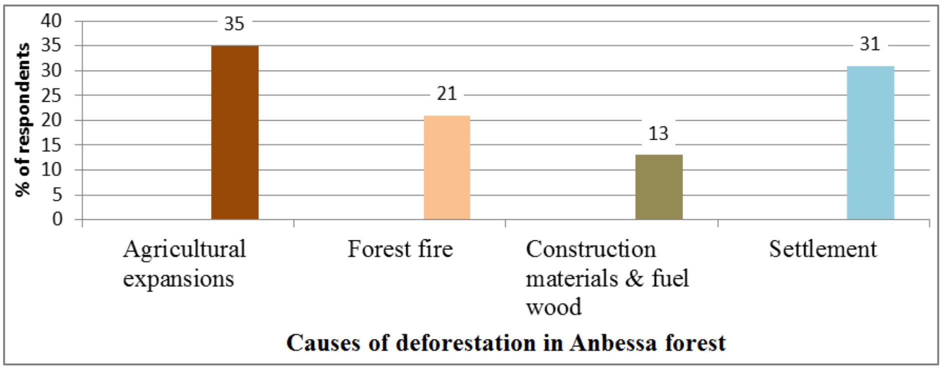
Accuracy assessment

The overall accuracies for the four reference years: 1975, 1985, 2002 and 2019 are 82%, 87%, 85% and 89% and with the Kappa statistics of 0.811, 0.819, 0.822 and 0.874 respectively. The Kappa statistics value greater than 0.80 (80%) represents a strong agreement and a value between 0.60 and 0.80 represents a substantial agreement [23]. Hence, the maps met the accuracy requirements for change detection analysis [24], and there is a positive correlation between the remotely sensed classified samples and the reference data.

3.4.2. Cause of Anbessa Forest Cover Change

The forest cover change and its driving factors studied in Anbessa forest also reaffirm this phenomenon. The forest cover change was triggered/caused by various factors, of which man are responsible. For the purpose of clarity in the present study, the factors have been grouped into population pressure and its resultant effects such as the prevalence of various types of agricultural activities, fire wood and charcoal production, cutting trees to satisfy the demand of constructional materials and settlement expansion. Each of the factors has been reported by respondents in the study area (figure 6).

According to data collected in the field with respondents in all selected villages the most common causes for land use land cover changes in general and forest cover changes in particular were the expansion of farm land (35%), resettlement and population growth (31%), forest fire (21%), fuel wood collection and charcoal production (13%) (figure 6).



Sources: Field Survey Result, 2019.

Figure 6. *Causes deforestation in Anbessa forest.*

3.4.3. The Effect of Resettlement on Anbessa Forest Cover Change

The resettlement program established during the previous and current regimes and refugee settlement are also the driving phenomena to deforestation which have brought about adverse effects on land use and land cover changes in the study area. In the study area, people depend on forest more than ever, especially for their socio-economic value. Despite all this importance, forest resource is mal-treated and deforested unwisely and the major environmental problems in the study area which resulted from forest cover change through deforestation loss of biodiversity, hydrological impact and land degradation.

The result from Table 10, majority of the respondents (78.3%) revealed that the effect of resettlement on Anbessa forest was forest deforestation, whereas 14% of the respondents responded that the effect of resettlement on forest cover change were loss of biodiversity in both fauna and flora. According to FGD revealed almost all indigenous tree species and wild animals were disappeared and the remaining few plants and animals were in endangered.

Table 10. *Consequences of resettlement on Forest cover change.*

Response	Selected Villages of the respondents						Total	percent
	Amba 16	Jematsa	Mender 47	Mender 48	Mender 49	Garabiche metema		
Loss of biodiversity	3	5	4	0	4	2	18	14.0
Deforestation	18	17	11	14	15	26	101	78.3
Hydrological impact	1	0	3	3	0	0	7	5.4
Land degradation	0	1	1	1	0	0	3	2.3
Total	22	23	19	18	19	28	129	100

Sources: Field survey result, 2019.

4. Discussion

The findings of this study revealed that during the study period (1985–2019), five land use/cover types namely; dese forest, sparse forests, settlement, shrub land, agricultural land were identified in Anbessa forest. The district has undergone substantial land use/ cover changes due to the implementation of resettlement program in the area. As shown in the result, rapid reduction on dense forest was recorded annually (-340ha) and sparse forest (-155.5ha) between 1985 and 2019 (Table 9), whereas Settlement and agricultural lands have expanded from 698ha to 15180ha and 72ha to 13270ha respectively (Table 3). The survey result showed that the increasing demand for agricultural lands; firewood and charcoal production, construction materials and settlement areas have resulted in changing the land use/cover of the area. In agreement to this finding, a significant loss of woodland cover was reported by Alemu [25] in Northwestern lowlands of Ethiopia (Metema, Kafta-Humera and Sherkole) during 1985–2010. Abera [10] in Chewaka district of Ethiopia during 2000-2018 showed a rapid reduction of woodland forest, grassland and bare land due to resettlement. Asmamaw [26] also found a major decline in grassland cover in Gerado catchment, Northeastern Ethiopia between 1980 and 2006 at 1.17% annual rate. In contrast, Shiferaw and Singh [27] reported a slight expansion in grassland coverage in Borena woreda, South Wello highlands of Ethiopia during 1985–2003 due to the conversion of forest and shrub land to grassland. On the contrary, Tesfaye [28] reported increment in forest cover between 1986 and 2008 in Gilgel Tekeze catchment, Northern Ethiopia mainly due to tree plantation campaign undertaken in the area. Deribew and Dalacho [29] reported during (1957–2017) the extent and direction of LULC have become more dynamic. The appearance of farm lands and settlement areas were found to be the result of 1985 resettlement program in Bambasi district.

Minale and Rao [30] in Gilgel Abbay catchment, Northwestern Ethiopia also found that agricultural lands and settlement areas were expanded at the expense of forests, riparian vegetation and grasslands during 1973–2008. Similarly, Gebrehiwot [31] in Koga watershed at the headwaters of the Blue Nile Basin; Kindu [32] in Munessa Shashemene landscape of the Ethiopian highlands; Gebrelibanos and Assen [33] in Hirmi watershed of Northern Ethiopia; Molla [34] in Arsi Negele District, Central Rift Valley Region of Ethiopia reported that the decline of grassland and natural vegetation including forests and woodlands have occurred due to conversion to croplands, grazing lands and human settlement areas. The socio-demographic data analysis showed that huge population resettlement and high rate of population growth exerts pressure on land resources of the area. Population increment needs cultivable land for their livelihood requirements. This situation forced the settlers to encroach into forest areas for cropping, grazing and settlement which intensify the conversion of vegetation cover in the area. The resettles' livelihood strategies are found to be main driving force for the existing forest cover changing aspects. The existing expansions of traditional farming practices into grasslands, forests and shrub land ultimately led to a reduction in forest cover. In addition, households are increasingly engaged in firewood collection, construction materials and charcoal production as lucrative to sustain their livelihood.

In agreement to this finding, Kidane [35] in the Bale mountain of Southeast Ethiopia, Abera [10] in Chewaka district, Found that population growth and resettlement have caused vegetation dynamics due to encroachment of settlers into vegetated areas for farm plots and settlements. The key informants and focus group discussion participants mentioned that the existing land tenure system has also contributed to vegetation covers changes in the area. Respondents feel as they have no full right over the land. Therefore, they lack preparation and initiation to take environmental protection actions like afforestation and reforestation programs. They further mentioned that lack of land use planning and environmental impact assessment before the execution of resettlement program has contributed to the depletion of vegetation resources in the area. Besides, the result showed that deforestation and forest fire incidence for agricultural land clearing has resulted in the depletion of vegetation cover in the area.

Similarly, Walle [36] in the resettlement areas of Metema and Quara woredas, Amhara region of Ethiopia pointed out that the problem of forest fire due to charcoal production and agricultural land expansion poses a serious threat on vegetation resources. In general, resettlement scheme coupled with a range of demographic, socioeconomic and institutional related factors underpin the observed changes in Bambasi district. In overall, the joint use of geospatial techniques as well as socio-economic data could provide useful baseline information to know the patterns of change and driving forces so, as to design effective management opportunities and protect the outstanding forest resources.

5. Conclusion

Societies in Ethiopia have a long history of moving from environmentally degraded regions to more secure areas. The overpopulated and environmentally degraded northern and north-central highlands of the country have been major sources of settlers since the 1985s. These people have drifted toward, or been encouraged to resettle in, the wet, productive, and relatively underutilized highlands and lowlands in the western, southwestern, and northwestern parts of the country. For different reasons including absence of planning, random selection of resettlement sites, and forced resettlement most government-sponsored resettlement programs implemented in the study area have failed to meet their goals. As a consequence, severe deforestation and environmental degradation have occurred in the resettlement area. The series of resettlement programs implemented in the study area increased the pressure on forest resources farmers to intensify and magnify their agricultural activities.

The results of this study revealed the existence of significant LULCC in the last 44 years. Especially the expansion of settlement and agricultural land however, the dense forest, open forest and shrub land become decrease in different years. Accordingly, Settlement and agricultural land was expanded throughout the four periods.

In relation to this, currently, the overall condition of the forest cover land of the study area is deforested. According to local people responded that the main driving force o forest cover change in the study area was resettlement program beside that demand of forest products for construction, forest fire, food wood and Charcoal production and expansion of agricultural activities. The consequences of forest cover change are loss of biodiversity, hydrological impact, deforestation and land degradation.

The findings from this study have policy-related implications from local to global scales. Initially, resettlement programs should be planned well ahead and in close discussion with different stakeholders at different levels to confirm sustainable use of natural resources with minimum environmental impacts. The implementation of resettlement programs should be closely monitored and regularly reevaluated to minimize the potential environmental impacts that migrants bring to the destination areas. It is important to scarify both time and resources in raising local awareness levels regarding the value of conserving forest resources. Lastly, it is important to use improved Earth observation technologies (e.g. time series of Landsat satellite images) to build forest datasets. These datasets should be used to continuously monitor the status of forest cover in the region and inform policy decisions.

Abbreviations

CSA: Central Statistical Agency of Ethiopia; ERDAS: Earth resource data analysis system; ETM+: Enhanced Thematic Mapper Plus; OLI: Operational land imagery; FAO: Food and Agricultural Organization; GCPs: Ground control points; GIS: Geographic information system; GPS: Global Positioning System; ha: Hectare; LULC: Land use/cover; TM: Thematic mapper; SPSS: Statistical Package for Social Science; USGS: United States Geological Survey.

Authors' Contributions

Mr. Mekonnen Hunde run the image analysis for land use land cover change. Mr. Bekele Tulu and Mr. Aduwa Anjulo analyzed socioeconomic data collected from the study area. Finally, all authors read and approved the final manuscript.

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Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

An effort was made to conduct the research in an ethical manner. A research site permission letter was obtained from the concerned institutions and the participants' consent was asked before commencing the interviews, discussions and taking photographs.

Consent for Publication

All authors agreed and approved the manuscript for publication in International Journal of Environmental Monitoring and Analysis.

Competing Interests

The authors declare that they have no competing interests.

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