International Journal of Research in Agriculture, Biology & Environment (IJAGRI)

E-ISSN : 2582-6107

DOI: 10.47504/IJAGRI.2022.3.3.1

Volume 3 (3) 2022
July-September -2022

Study on usage of Land and changes in Ecology in Babile Elephant Sanctuary, Eastern Ethiopia

Taye Lemma Geleta[1], Girma Mengesha[2] and Sintayehu Workeneh[3]

[1]College of Natural and Computational Sciences Centre for Environmental Sciences Addis Ababa University, Ethiopia.

[2]Wondo Genet College of Forestry and Natural Resources, Hawassa University, Addis Zoo Park, Addis Ababa, Ethiopia.

[3]Collge of Agriculture and Environmental Sciences, Haramaya University, Ethiopia.

ABSTRACT

The focus of this paper is to investigate how the land covers in Eastern Ethiopia's Babile Elephant Sanctuary (BES). The spatiotemporal patterns of land-cover changes involved using remote sensing, geographic information systems, and questionnaires. Researchers used the Landsat images acquired in 1972, 2000, and 2021 were used. The result revealed that bushland and agricultural land areas expanded highest over the study period (1972–2021) at the expense of natural forests. With an average annual loss rate of 8343.12 ha, riverine forests and woods lost a substantial amount of land cover. The woodland and riverine forest cover decreased steadily from 59.85 and 20.56% in 1972 to 30.37 and 3.13% in 2021.From 1972, the coverage of bushland, agricultural land, bare land, and settlement increased to 17.57, 1.75, 0.23, and 0.04%, respectively, to the year 2021, when it occupied 34.68, 22.30, 4.95, and 4.57%, respectively, of the total land area. Several bushland areas in the sanctuary while data collected for this study, with likely impacts were observed (such as tree-cutting) on the forest and riverine habitat. As a result, there was currently a greater area covered by wilderness patches (i.e., 34.68 % in 2021). The result showed that the increasing agricultural land and settlements become a threat to the ecological integrity of elephant habitats, leading to habitat fragmentation and human encroachment on elephant habitats, and high pressure and competition over resources. Based on the study, the interpretation drawn is that, BES is necessary to build gaps in knowledge for conservationists to design plans for the restoration of habitats and the species by lowering the impact on land cover change, immediate action, and restoring mechanisms to conserve biodiversity and associated ecosystem services in the area.

Keywords: Anthropogenic Factors, Babile Elephant Sanctuary, Bushland, Land cover change, Riverineland, Woodland.

1. INTRODUCTION

Land use and land cover change (LULCC) refers to human modification in the land surface (Ellis, 2006). Globally, the land cover (LC) changes mainly as a threat to biodiversity. For instance, according to Ellis *et al.* (2010), about 39% of the land habitats have been converted into farmland and settlements. Even due to land cover change, the populations of large mammals in the Masai Mara–Serengeti ecosystem have declined by 25% (Ogutu *et al*., 2008). One of the highest environmental issues for human populations today is the harmful impact of LULCC on biodiversity, climate, water, soil, and air, in particular, as well as on ecosystem services (World Resource Institute-WRI, 2001). LULCC is not a new phenomenon in Ethiopia; similar occurrences occurred between 7000 and 1800 BC (WRI, 2001). However, size, pace, and permanence exacerbate the existing LULCC (WRI, 2001; Ellis, 2006). Today, about 40% of the land area for agriculture (crops and grazing) is a cause of direct change (Global Environment Facility-GEF, 2012).Urbanization has led to a decline in numerous ecosystem services, including biodiversity, in addition to cropland and tree plantations, that are used to produce food, lumber, housing, and other commodities (Lawler *et al.*, 2014). The Babile Elephant Sanctuary (BES), one of Ethiopia's wildlife-protected areas, was founded in 1970 to protect the Horn of Africa's last remaining population of elephants. In BES, during the 1970s, land-cover changes brought on by the growth of communities and agricultural land have resulted in the loss of almost 82% of the natural area that elephants could once roam freely (Yirmed Demeke, 2008). The current LCC in the sanctuary increased the reduction of the home range area, which had a significant impact on the elephant's conservation efforts because elephants require wide home ranges. Land cover change analysis has developed into a tool for decision-makers, conservationists, wildlife managers, and local communities. Besides, others produce evidence for decision-making, formulate appropriate policies and strategies, produce data for spatial planning, develop detailed plans, and comprehend agents of change (Iqbal and Khan, 2014). As relatively few studies were available with regards to land cover change (Sintayehu and Merkebu, 2019). The purpose of this study is to give or deliver current information on land cover change and the factors that influence it. Because of this, LCC analysis supports conservationists and decision-makers in ensuring sustainable development and comprehending the dynamics of the changing environment.

2. MATERIALS AND METHODS

2.1. Description of the Study Area

The Babile Elephant Sanctuary (BES), which covers an area of approximately 6,982 km^2, was founded in 1970. The BES is located between Oromia and the Ethio-Somali Regional States in the eastern region of Ethiopia, some 560 kilometers from the capital Addis Ababa. Its location falls within the latitude range of 08^{o}22'30" to 09^{o}00'30"N and the longitude range of 42^{o}01'10" to 43^{o}05'50"E (Figure 1). The sanctuary has an altitude between 850 and 1,785 meters above sea level (m.a.s.l.). According to data from the National Metrological Service Agency (NMSA), between 2002 and 2016, the average annual and monthly temperatures were 20.5 ^{o}C and 21.02 ^{o}C, respectively. There are two rainy seasons (i.e., bimodal rainfall); the short and long rainy seasons were reported from March to May and June to October. But each year, only a little rain fall (Source: NMSA data from 2002 to 2016). According to Stephenson (1976), the sanctuary's vegetation included Acacia commiphora forest, semi-desert scrubland, and evergreen scrub habitats, as well as meadows with a high degree of endemicity (Yirmed Demeke *et al*., 2006). The sanctuary's vegetation had grouped between riverine and woodland vegetation (Stephenson, 1976; Yirmed Demeke *et al.*, 2006). But due to circumstances that humans have caused, the woodland structure has been replaced by bushlands (such as deforestation). For instance, during field observation with key informants in the Fedis district (Anani PeA-Peasant Association), intensive charcoal production, and tree cutting were detected. Mostly shrubs and trees make up the sanctuary's floristic composition. Trees consist only 5.1% of the total density, compared to shrubs' 94.9% (Yeneayehu Fenetahun and Tahir Abdala, 2017).The sanctuary has housed a variety of animal, bird, and reptile species that have adapted to the semi-arid habitat. The sanctuary is one of Ethiopia's 73 important bird places and is home to 191 bird species and 30 animal species (Mihret Ewnetu *et al.*, 2006). Various wildlife species, including mammals, birds, and reptiles, can be found throughout Eastern Ethiopia. These species have adapted to the region's semi-arid climate and had supported by the region's black soil (10%), clay soil (2%), and clay loam soils (88%), respectively (Yirmed Demeke *et al*., 2006). Hence, sustainability depends on protecting the sanctuary's natural resources.

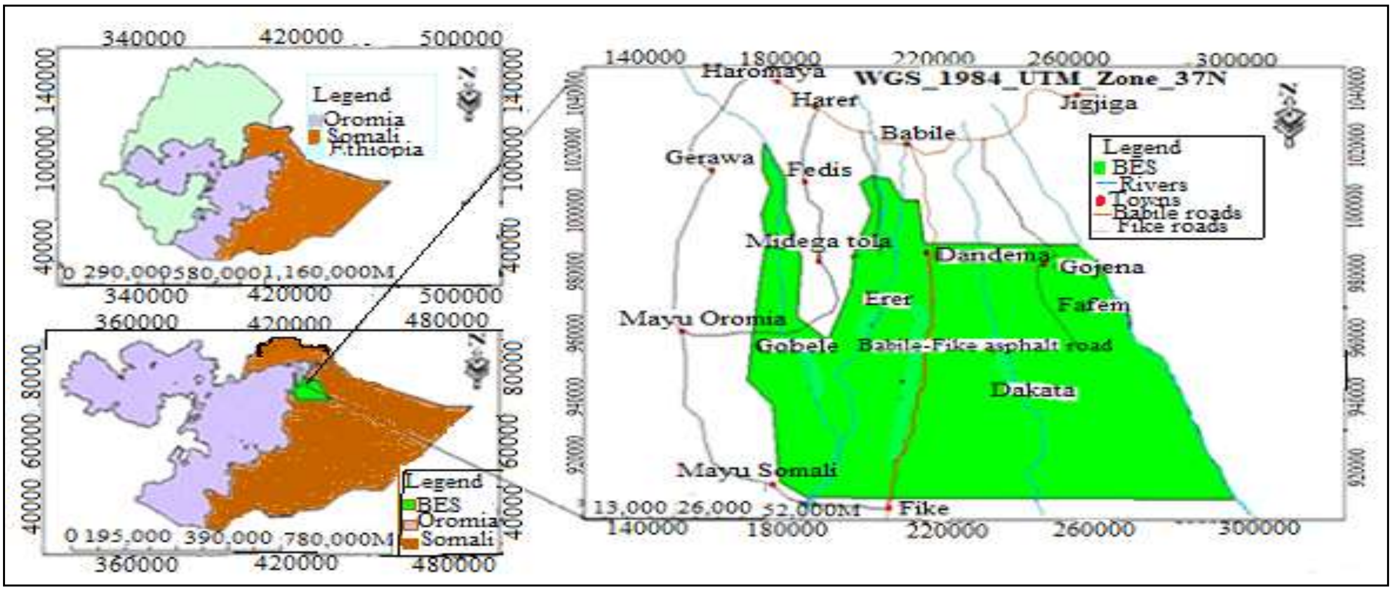

Figure 1. Map of Babile Elephant Sanctuary

2.2. Methods and Analysis

Methods

Field observations and interviews carried out on current land use types of BES concerning different trends of land use patterns changes over the past 49 years. The reasons why landuse types have changed also noted. The landsat images acquired in 1972, 2000, and 2021 used for land cover classification. Landsat images are medium-resolution remote sensing tools for land use and land cover change analysis. The Landsat program is the oldest Earth observation Program, which started in 1972 (Bakker *et al*.,

DOI: 10.47504/IJAGRI.2022.3.3.1

2001). Landsat used for mapping land cover, landuses, soils and geology is worth noting (Bakker *et al*., 2001). Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM) are the two sensors in landsat, which have been in use since 1982. The sensors used for Land Use Land Cover Change (LULCC) analysis. Obtaining accurate data sets requires sensor selection, relevant wavelength bands, and the date of acquisition. The satellite image cover 185x185Km with a spatial resolution of 30m (i.e., a single pixel in the image represents 30x30m on the ground). Dry season and cloud-free Landsat images with a spatial resolution of 30m, georeferenced and radiometrically corrected, accessed from the United States Geological Survey (USGS) Earth Explorer (http://earthexplorer.usgs.gov, accessed on April 2022). The dates for the acquisition of satellite images slightly differed within and among years, as image acquisition done in March, April and May.

2.3 Processing of images

Digital files that contain pixels (i.e., picture elements) that represent measured local reflectance (emission or backscatter) values in a specific region of the electromagnetic spectrum make up satellite images (Bakker *et al*., 2001). The most crucial steps in image processing for LULCC analyses are image layer stacking, sampling, and image enhancement of the image dataset. A new multiband file was created using the layer stacking technique from georeferenced images with different pixel sizes, extents, and projections. Sampled input bands used and projected to common user-selected output projection and pixel size. The output file usually has a geographic extent encompassing all the input file extents or only the data extent where all the files overlap. Accordingly, six bands of the Landsat 7 images (1, 2, 3, 4, 5, and 7) of each year and three were (2, 3, and 4) for Landsat 5 were layer stacked to form one image with all bands to help the interpreter understand all features in the study area. Image enhancement used for image improvement (Bakker *et al*., 2001). Image enhancement makes a raw image readily interpretable for a particular application (Bakker *et al*., 2001). False-color composite, edge enhancement, and linear stretching were applied. After images corrected, all scenes from the same year were mosaicked together to cover the study area. From the mosaicked image, the portion that fell within the study area extracted (sub setting) to limit the size of the mosaicked image to the size of the study area for preliminary classification, field verification, and the processing work to take place at a later stage. The initial work in transfer of images to a common UTM and geo-referenced to the datum that Ethiopia selected by WGS-84. The LCC of the area was covering the last 49 years. Pre-processing satellite images is vital for detecting change to have a direct association between the acquired data and the biophysical phenomena on the ground (Cheruto *et al*., 2016).

2.4 Classification

According to Boakye *et al*. (2008), image classification aids in extracting meaning-rich information by classifying all pixels in an image into LULC classes. To correct the data, sensor irregularities, atmospheric noise correction, pre-classification techniques used. Additionally, image classification used for spectral signatures from the LANDSAT datasets to various LULC following each LULC type's reflectance characteristics. To make elements of the imagery more visible, color composites used (Cheruto *et al*., 2016). For the visual interpretation of photos for land use and vegetation mapping, the band combination of red, blue, and green (RGB) used to present the raw images in conventional color composites (Boakye *et al*., 2008). Other color composites used to distinguish between built-up areas and barren soils. These composites include Short Wave Infra-red, Near Infra-red, and Red combinations (Cheruto *et al*., 2016). The standard land cover classes established by the United States Geological Survey served as the basis for describing the land cover. As a result, six categories—agricultural land, bushland, riverine forest, woodland, settlement, and bareland—were defined (Table 1). .Moreover, a reconnaissance survey conducted to get a broad overview and the present state of the land use pattern in the study area since an actual field visit to the site can support the classification and identification of the main land use types.

Table 1.The description of the land-cover (LC) classes used in BES, Ethiopia

LC classes	General description
Agricultural land	Areas of land ploughed or prepared for crop growing (i.e., both areas identifiably under crop agriculture and land under preparation).
Bushland	Areas with shrubs bush and small trees in which multiple stems and branches are produced from the base of the main stem.
Woodland	Areas dominated by Acacia species with mean height of above 5 m and the canopy cover ranges from 10% to 40% for open woodland and above 40
Bare land	Areas with essentially no vegetative cover
Riverine forest	A type of forest found along the major perennial rivers. The vegetation is usually evergreen (due to continuous water supply from the rivers).
Settlement	Land, which is mainly covered by rural village

DOI: 10.47504/IJAGRI.2022.3.3.1

2.5 Analysis

Validation of the results and change detection used to analyze the LULC alterations. GPS used to gather the ground truth information in the form of reference points for the 2021 image analysis, which used for picture categorization and overall accuracy evaluation. For image processing, categorization, and creating land cover maps, the analyses required Arc GIS 10.8, ENVI 4, and ERDAS IMAGINE 10.4. Landsat MSS (Multi-Spectral Scanner) and Landsat Thematic Mapper Data used to map LULCC trends for the chosen year. To ensure the classification of each land use type, the purpose of change analysis is accurate, and truth evaluation is vital. Precise estimation and understanding of the changes are also crucial. It displays the degree of agreement between what is happening on the ground and the classification outcomes. This study assessed the accuracy of the Landsat 7 ETM+ 2021 satellite image, with which the ground truth data is probably associated. The sum of the correctly categorized sample units divided by the total number of sample units to determine the overall accuracy (Cheruto *et al*., 2016). Following this, the LULC types at the site identified and categorized. Land types for the study site chosen based on information gathered from the field and a Landsat image from 2021. Arc GIS (version 10.8) was used to import satellite pictures from 1972, 2000, and 2021 for processing and analysis. For further investigation, World Geographical System (WGS) 1984 geographic coordinate system was projected to the Universal Transverse Mercator (UTM) Zone. As part of image processing, categorization, and analysis, we performed picture cleaning, compositing, masking, clipping, and mosaicking. The maximum likelihood function, a standard tool for supervised land cover classification, was utilized to classify LC changes from Landsat data (Thomas *et al*., 1987). Most Maximum Likelihood classifiers make the assumption that the cluster statistics have a "normal" (Gaussian) distribution. Additionally, it is crucial to provide extremely accurate findings because every pixel is assigned to the class to which it has the greatest possibility of belonging (Campbell and Wynne, 2011). Then, utilizing GIS features, visual interpretation and computer picture classification were integrated. Arc GIS was used to design training sites and create signature files for the supervised land-cover change classification (version 10.8). Ground control stations throughout the study area used to confirm the classified photographs. Classification, analysis, and accurate evaluations of the LULC performed using ERDAS IMAGINE 10.4. Utilizing a change detection matrix, ERDAS change detection statistics tool used to examine change detection between 1972 and 2000 and 2021 using the categorized data as an input image. For the three time periods under inquiry, the post-classification also completed.

3. RESULT

3.1. The Land covers types and their changes in BES

The analyses of the LULCC (Land Use Land Cover Change) have revealed major changes in BES Ecosystem over the 49-year study period (Figure 2).

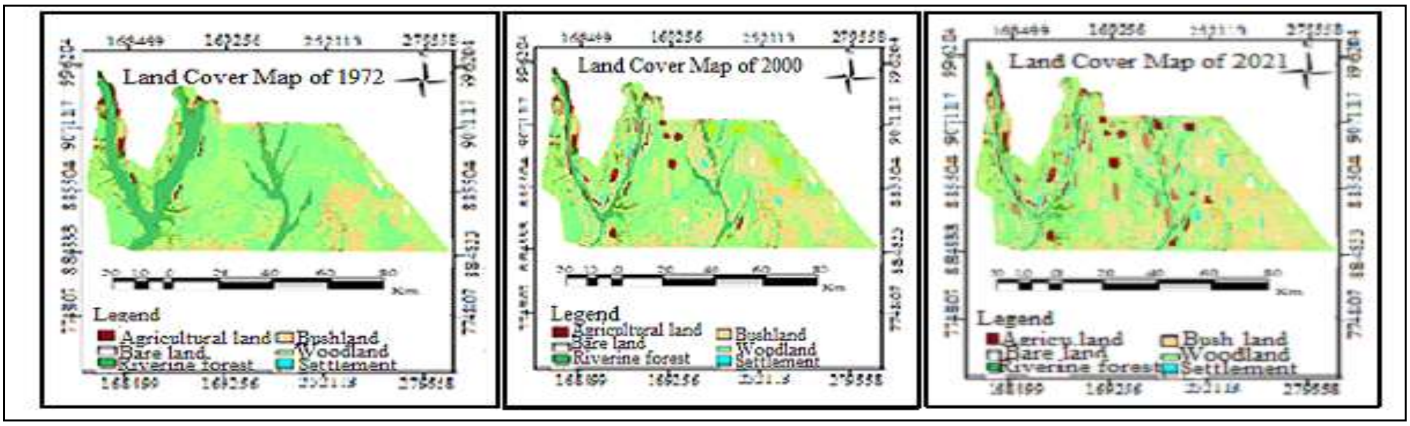

Figure 2. A map depicting the relative actual LULCC in the BES in 1972, 2000, and 2021

In BES, between 1972 and 2000, woods took up the most space, followed by bushland and agricultural fields (Fig.3). Beginning in 2000, there were more bushlands than woodlands and other types of land cover (Figure 3).

DOI: 10.47504/IJAGRI.2022.3.3.1

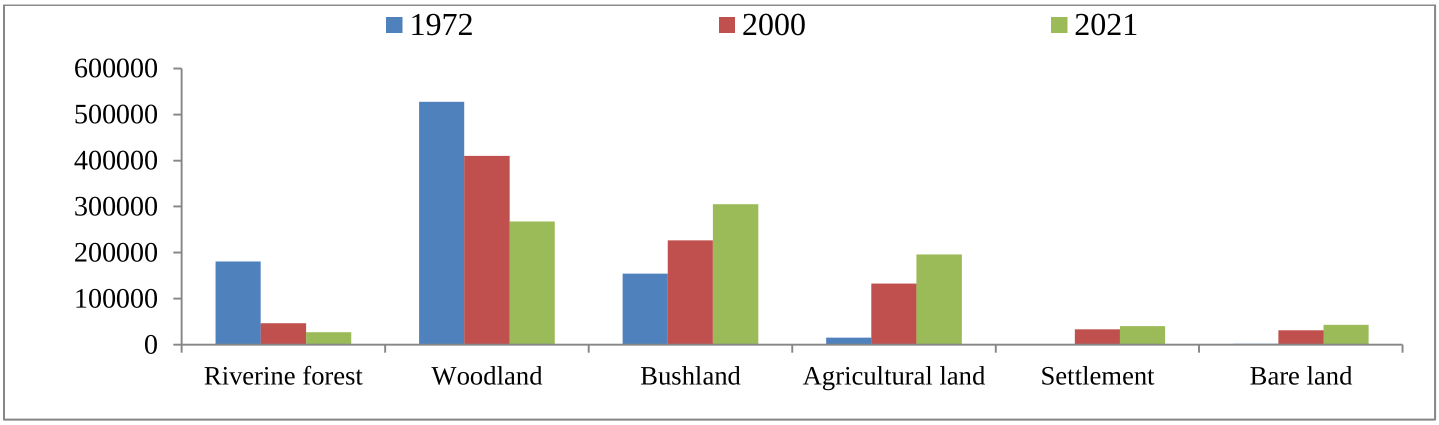

Figure 3. Actual LULCC in BES from 1972 to 2021

During the study period (1972–2021), the expansion of bushland and agricultural land areas acquired the most at the expense of natural forests, according to this research (Table 2). On the contrary, riverine forests and woodlands lost a significant amount of land over the study period, with an average annual loss rate of 8436.1 ha (i.e., land converted to other land cover types) (Table 2). From 59.85 and 20.56% coverage in 1972 to 30.37 and 3.13% in 2021, there was a continuous decline in woodland and riverine forest (Table 2). From 1972, the coverage of bushland, agricultural land, bareland, and settlement were increased to 17.57, 1.75, 0.23, and 0.04%, respectively, to the year 2021, when it occupied 34.68, 22.30, 4.95, and 4.57%, respectively, of the total land area (Table 2). Several bushland areas in the sanctuary while data collected for this study, with likely impacts were observed (such as tree-cutting) on the forest and riverine habitat. As a result, there was currently a greater area covered by wilderness patches (i.e., 34.68 % in 2021) (Table 2).

Table 2. Area and percentage of different forms of land cover in the BES in 1972, 2000, and 2021

Type of land cover	1972		2000		2021	
	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)	Area (ha)	Proportion (%)
Riverine forest	181140.44	20.56	46570.75	5.29	27576.78	3.13
Agricultural land	15416.93	1.75	132783.55	15.07	196495.39	22.30
Bare land	2047.17	0.23	31654.28	3.59	43656.04	4.95
Bush land	154768.69	17.57	226647	25.72	305531.88	34.68
Settlement	366.11	0.04	33345.24	3.78	40284.58	4.57
Woodland	527360.69	59.85	410099.23	46.54	267555.37	30.37
Total	**881104**	**100.00**	**881104**	**100.00**	**881104**	**100.00**

In the sanctuary, the average yearly rates of the land cover types were also investigated (Table 3). Within 28 years (between 1972 and 2000), the riverine forest and woodland land areas of cover types were 4806 ha and 4187 ha, respectively, whereas, in 21 years (between 2000 and 2021), they were 904 ha and 6787 ha, respectively. Though both of the habitats' original land covers were destroyed or replaced with new land cover types, woodland habitats now had higher damage rates than riverine forests (Table 3). However, even though both of the habitats' land covers were destroyed or converted to other land cover types, woodland habitats now had higher damage rates than riverine forests (Table 3).

DOI: 10.47504/IJAGRI.2022.3.3.1

Table 3. Area and rate of land-cover changes in the Babile Elephant Sanctuary from 1972 to 2000 and 2000 to 2021

Type of land cover	1972 to 2000 (28yr)		2000 to 2021 (21yr)	
	Area (ha)	Rate(ha/yr)	Area (ha)	Rate(ha/yr)
Riverine forest	-134569.65	-4806.06	-18993.97	-904.47
Agricultural land	117367.07	4191.68	63711.88	3033.90
Bare land	29607.11	1057.40	12001.76	571.51
Bush land	71878.31	2567.08	78884.88	3756.42
Settlement	32979.13	1177.83	6939.34	330.44
Woodland	-117261.46	-4187.91	-142543.9	-6787.80

4. DISCUSSION

Of the six land cover types identified, most of the area grew over the 49-year study period, while the extents of riverine forest and woodland only decreased yearly over the study period (1972 to 201) because formerly used by elephants were converted into bushland, agricultural land, settlements, and bare land (Fig. 2) (Fig. 3) (Table 2)(Table 3). Due to various issues humans have caused, the sanctuary's natural area was shrinking. According to field research and key informants, elephants' natural range has noticeably diminished by rising agricultural land demand and shifting human settlement patterns. According to Yirmed Demeke (2008), human-induced activities in BES have caused the natural regions that were once home to elephants to shrink by 82 % since 1970. Due to anthropogenic effects, even the range and population of elephants on the African continent have decreased (Brown, 2019). Currently, more individuals in the BES have changed from practicing pastoralism to a mixed farming (i.e., livestock and crop production) cultivation-centered economy. Besides, more people own land to control vital resources like green spaces and water supplies for towns, animal grazing, and crop development. As a result, the elephants' paths to the water had been restricted. Therefore, the BES's growing population and agricultural land might have affected conservation efforts (Sintayehu Workeneh and Merkebu Kassaw, 2019; Neil and Greengrass, 2021). As a result, in the BES, related to other land cover types, settlements and agricultural land expansions were greater frequency and severity (testing the conservation efforts). As a result, land cover change is made worse by the growth of towns and the conversion of land to agriculture (Alemenesh Hailu *et al*., 2020; Zhou *et al.,* 2021). For instance, Neil and Greengrass (2021) reported that the number of illegal houses in the BES increased from 18,000 (in 2006) to greater than 50,000(in 2017); of which greater than 32,000 of it were observed in the elephant's range. Similarly, this research showed that settlements and the increase of agricultural land accounted for around 26.87% of the change in land cover in BES (Table 2). Between 1972 and 2021, agricultural activity in BES expanded by 181,078.5ha, or from 15416.93ha to over 196495.39ha (Table 2). The study area's land cover shift was affected by agricultural growth. Based on field research and key informant interviews, government policies (such as the lack of individual land ownership laws) and the increased livestock and human population around and inside the sanctuary may be what led to the expansion of agriculture, which in turn exacerbated the changes in the land cover. Agriculture expansion is a negative factor for animal conservation (Mekonen Sefi, 2020). According to other studies, habitat encroachment and deforestation have detrimental effects on the distribution of wild species (Tadele Mosisa and Girma Asefa, 2020). Overall, settlements and agriculture damaged wildlife habitats, obstructed their migratory paths, and raised the likelihood of conflict (i.e., HEC) (Nyumba *et al*., 2021). Therefore, it is imperative to reduce the expanding human population and changes in land cover. Hence, bridging the gap between conservation efforts and policy concerns requires recognizing land cover changes and their effects on elephants and their ecosystems.

5. CONCLUSION

According to this study, the ecosystem may eventually see an expansion of land-cover changes and a decline in the coverage habitats of elephants. There are many interconnected causes, but habitat loss caused by expanding agriculture and human settlements negatively impacted elephant habitat, obstructing their main migration routes and ultimately playing a significant role in the long-term survival of elephants. Designing for the sustainable use of resources requires knowledge about the various patterns of changing land cover through time and the factors affecting these changes. This study intends to improve regional land-use planning, identify regions and species that may be noteworthy, and raise awareness of the potential impacts of conservation policies in different locales. Land-use policies that support animal corridors, buffer zones, and benefit or resource sharing with the local community are also essential in areas is significant regular interest or connection between wildlife and people. Due to this, the impact of human activity might be lessened and ensure animal protection.

DOI: 10.47504/IJAGRI.2022.3.3.1

ACKNOWLEDGEMENT

We would like to express our gratitude to the Babile Elephant Sanctuary staff members and scouts for their valuable assistance while collecting data. We also thank Mr. Abiyot Hailu who was wildlife expert in EWCA for supporting the GIS technique. Moreover; we thank the key informants and individuals who assisted during data collection.

DECLARATION

Abbreviations: BES-Babile Elephant Sanctuary,GEF-Global Environment Facility, LCC-Land Cover Change, LULCC-Land Use and Land Cover Change, NMSA-National Meteorological Service Agency, PeA-Peasant Association, WRI -World Resource Institute,

Competing interest: All the authors do not have any possible conflicts of interest

Ethical approval and consent to participate: Not applicable

Consent for publication: Not applicable

Ethical approval and consent to participate: Not applicable

Funding: Addis Ababa University for its financial support.

Author contribution: All data collection, analysis, writes up of the draft paper was done by the corresponding author while commenting, finalizing, and approving the whole document was by both authors

REFERENCES

Alemenesh Hailu, Siraj Mammo and Moges Kidane (2020). "Dynamics of land use, land cover change trend and its drivers in Jimma Geneti District, Western Ethiopia." *Land use policy*, 99: 105011.

Bakker, W.H.; Gorte, B.G.H.; Janssen, L.L.E.; Pohl, C.; Prakash, A.; Reeves, C.V.; Weir, M.J.C.; and Woldai, T.(2001). Principles of Remote Sensing; ITC: Enschede, The Netherlands, p. 180.

Boakye, E., Odai, S.N., Adjei, K.A., and Annor, F.O. (2008). Landsat Images for Assessment of the Impact of Land Use and Land Cover changes on the Barekese Catchment in Ghana. *European Journal of Scientific Research*, 22(2): 269-278

Brown, J. L. (2019). Update on comparative biology of elephants: factors affecting reproduction, health and welfare. *Reproductive sciences in animal conservation*, 243-273.

Campbell JB, and Wynne RH (2011). Introduction to remote sensing. Guilford Pres, Spring Street New York

Cheruto MC, Kauti MK, Kisangau PD, and Kariuki P (2016). Assessment of Land Use and Land Cover Change Using GIS and Remote Sensing Techniques: A Case Study of Makueni County, Kenya. *Journal of Remote Sensing and GIS,* 5(1):175.

Ellis EC, Klein Goldewijk K, Siebert S, *et al*. (2010). Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology and Biogeography*, 19(5):589–606

Ellis, E(2006). Land-Use and Land-Cover Change. The Encyclopedia of Earth, Environmental Information Coalition,National Council for Science and Environment. http://www.aughty.org/pdf/landuse_landcover.pdf

Ethiopian Wildlife and Natural History Society (EWNHS) (1996). Important Bird Areas of Ethiopia. A first inventory. Addis Ababa.300 pp.

Global Environment Facility(2012). Land Use, Land-Use Change, and Forestry (LULUCF) Activities; GEF: Washington,DC, USA.

Iqbal, M.F and Khan, I.A (2014). Spatiotemporal land use land cover change analysis and erosion risk mapping of Azad Jammu and Kashmir, Pakistan. Egypt. J. Remote Sens. Space Sci. 17(1): 209–229

Lawler, J.J.; Lewis, D.J.; Nelson, E.; Plantinga, A.J.; Polasky, S.; Withey, J.C.; Helmers, D.P *et al*.(2014). Projected land-use change impacts on ecosystem services in the United States. Proc. Natl. Acad. Sci. USA 111(1): 7492–7497.

Mekonen Sefi (2020). "Coexistence between human and wildlife: the nature, causes and mitigations of human wildlife conflict around Bale Mountains National Park, Southeast Ethiopia." *BMC ecology*, 20(1): 1-9.

Miheret Ewnetu, Fedlu Abdela, Aklilu Kebede, Roman Kassahun, Hailu Mecha and Wondoson Sisay (2006). An overview of wildlife status, habitat conditions the threats of Babile Elephant Sanctuary and possibilities of boundary demarcation. Ethiopia Wildlife Conservation Organization. Addis Ababa, Ethiopia. pp.24

Neil, E., and Greengrass, E. (2021). Illegal settlement in the Babile Elephant Sanctuary is threatening the resident elephant population. *Oryx*, *56*(3): 457-464

Nyumba, T. O., Sang, C. C., Olago, D. O., Marchant, R., Waruingi, L., Githiora, Y., and Omangi, S. (2021). Assessing the ecological impacts of transportation infrastructure development: A reconnaissance study of the Standard Gauge Railway in Kenya. *Public Library of Science one*, 16(1), e0246248.

Ogutu J, Piepho HP, Dublin H, *et al.* (2008). Dynamics of Mara–Serengeti ungulates in relation to land use changes. *Journal of Zoology,* 278(1):1–14.

DOI: 10.47504/IJAGRI.2022.3.3.1

Sintayehu Workeneh D. and Merkebu Kassaw (2019). Impact of land cover changes on elephant conservation in babile elephant sanctuary, Ethiopia. *Biodiversity International Journal*, 3 (2):65–71

Stephenson, J. G., (1976). Reports on the Harar elephant dilemma. EWCO, Addis Ababa (Mimeographes).

Tadele Mosisa and Girma Asefa (2020). "The Impacts of Land Use/Land Cover Change on Range Land Biodiversity in Ethiopia." *Journal of Biodiversity and Endangered Species*, 10(4):1-6

Thomas IL, Benning VM and Ching NP (1987). Classification of Remotely Sensed Images. *Journal Geocarto International*,.2(3):77.

World Resources Institute (WRI) (2001). People and Ecosystems: The Frying Web of Life; WRI: Washington,DC, USA

Yeneayehu Fenetahun and Tahir Abdala (2017). Review on Floristic Diversity and Threated Plant Species in Babile Elephant Sanctuary in East Hararge, Ethiopia, *American Journal of Environmental Science and Engineering*, 1(1):1-6.

Yirmed Demeke, Marilyn, B.R, Roger, V.S. and Richard, F.B. (2006). The undisclosed facts about the relic elephant population in the Horn of Africa. Proceedings of Biological Society of Ethiopia, 16th annual conference and workshop. 13 pp.

Yirmed, Demeke (2008). The Ecology and Conservation of the Relice Elephant Population in the Horn of Africa. Four years report. Addis Abeba, Ethiopia.

Zhou, N., Hu, X., Byskov, I., Naess, J. S., Wu, Q., Zhao, W., and Cherubini, F. (2021). Overview of recent land cover changes, forest harvest areas, and soil erosion trends in Nordic countries. *Geography and Sustainability*, 2(3): 163-174

Taye Lemma Geleta[1], Girma Mengesha[2] and Sintayehu Workeneh[3]

[1]Email: lemmageletamereba@gmail.com

[2] Email: gutgirma@gmail.com

[3] Email:Sintekal@gmail.com

DOI: 10.47504/IJAGRI.2022.3.3.1