Analyzing Wetland Dynamics Using Geospatial Techniques: A Case of Abay Choman and Jimma Geneti Watershed, Horo Guduru Wollega Zone, Western Ethiopia

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ABSTRACT: Wetland ecosystems are one of the most important areas that provides different ecosystems services as well as habitat for plant and animal species. In spite of multipurpose, wetland ecosystems are under threats. This study attempts to analyze wetland dynamics of Abay Choman and Jimma Geneti watershed in Horo Guduru Wollega Zone, Western Ethiopia using geospatial techniques. The land use land cover (LULC), the Normalized Difference Vegetation Index (NDVI), and Normalized Difference Water Index (NDWI) were investigated using Landsat 5 TM of 1991, Landsat 7ETM+ of 2003, and OLI/TIRS of 2021. In the present study, the LULC was classified using a supervised classification method with maximum likelihood algorithm. The red and infrared bands of Landsat imagery from three different time periods were used to calculate NDVI, while the NDWI was estimated using the green and near infrared (NIR) bands of multispectral Landsat images. Results show that wetland ecosystem in the study area decreased by about 125.2 km^2 (8.8%) with the rate of 4.2 km^2/year. In contrast, agricultural land increased by 223.4 km^2 with the rate of 7.4 km^2/year between 1991 and 2021. About 66.7 km^2 wetland was converted to cultivated land whereas 29.3 and 24.7 km^2 of grassland and shrubs land were converted into cultivated land. As a result, the maximum NDVI and NDWI values were decreased between 1991 and 2021. To minimize the rapid loss of wetland and water bodies in the study area, proper land use planning and environmental education should be promoted.

KEYWORDS: Land use, land cover, wetland, maximum likelihood algorithm, normalized difference vegetation index, normalized difference water index, Abay Choman watershed

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Introduction

Wetland ecosystems are under threats due rapid expansion of agricultural lands particularly in developing countries. The conversion of wetland ecosystems to agricultural land exposed wetland dependent species to threats. To overcome the problem of wetland degradation, different organizations are working to rehabilitate wetland ecosystems. Watershed management is an ever-evolving activity that involves the ecological, social, and economic management of land, water, biota, and other resources in a given area (Shine & Klemm, 1999; Wang, Mang et al., 2016). Wetlands are the transition between the land and sea and thus from freshwater to marine environments (Basset et al., 2013; Facca, 2020). Wetlands are one of the most important habitats for various plant and animals. It provides different varieties of ecosystem services (Maltby, 1991; Zollitsch et al., 2019). The presence of wetlands is one of the main indicators of environmental health.

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Correction (December 2023): The full form of the word "EWRP" has been corrected on page 2; see in-text footnote 1 for details.

Inland and coastal wetlands span about 2.16 million km^2, an area nearly as large as Greenland, with 54% permanently flooded and 46% flooded seasonally (Gardner & Finlayson, 2020). Wetlands are critical resources with numerous values and uses (Shi et al., 2008). In their natural condition, wetlands provide a variety of ecological and socio-economic benefits that contribute to the well-being of rural communities and the country's environmental security (Dixon et al., 2021; Wood, 2001).

Human-wetland interactions must be prioritized in the development of wetland policy and management strategies (Nguyen et al., 2017). Monitoring changes in land use and land cover (LULC) particularly expansion of agricultural land to wetland is seeking to control uncontrolled growth particularly in rural areas (Patil et al., 2012). Geographic Information Systems (GIS) and remote sensing satellites have become the most powerful tools for assessing and monitoring of natural resources and the environment (Das et al., 2022; Garg, 2015; Najar et al., 2017). Substantial studies highlight that GIS and remote sensing techniques are widely used to survey wetland change very quickly, at low cost, and with greater accuracy (Brooks et al., 2004; Haque & Basak, 2017; Liu et al., 2006; Mabwoga & Thukral, 2014; Schmidt & Skidmore, 2003; Tobore et al., 2021). GIS and remote sensing techniques are more accurate than field observations and other techniques for measuring the rate of change of LULC over time. This is due to its capacity to calculate the extent of gain and loss in hectares and other units.

Wetlands are under threats all over the world, despite the benefits and services they provide to humans (Maltby, 1991). At global level, wetland ecosystems are destroyed by agricultural expansion, urban development, hydrological changes, pollutants input from factories, and municipalities (Allen et al., 2020; Das & Basu, 2020; Dinsa & Gemeda, 2019; Gemeda et al., 2016; He, 2019; Kundu et al., 2022; Levin et al., 2009; Orimoloye et al., 2020). Despite the fact that Ethiopian Wetlands Research Programme (EWRP)[1] has had a significant impact on developing national interest in wetlands among research, government, and non-governmental organizations, its more holistic social-ecological interpretation of wetland management has been overlooked within a policy arena dominated by specific sectoral interests and little recognition of local people's needs (Dixon et al., 2021).

Ethiopia has an abundance of water resources and wetlands, including twelve river basins, eight major lakes, numerous swamps, floodplains, and man-made reservoirs (Abunie, 2003). According to studies, approximately 110 billion cubic meters of water runoff from the aforementioned sources each year, with 74% of that water flowing into rivers that drain into neighboring countries (Ethiopian Forestry Action Programme [EFAP], 1989). Despite its widespread distribution, Ethiopia's inventory of wetland resources is incomplete. Ethiopian wetlands cover about 13,700 km^2 (1.14%) of the country (Hillman & Abebe, 1993).

In the study area, wetland areas were degraded due to various human induced activities: including poor watershed management practices such as deforestation, expansion of agricultural land, poor farming methods, overgrazing by domestic livestock are the main causes of wetland loss and degradation. These changes contribute to the degradation of water quality, a decrease in the abundance and diversity of wetland. Furthermore, these changes reduce the availability of wetland products (medicinal plants, fish farming activities, recreational areas) and ecosystem services. This, in turn, has a negative impact on food security and poverty alleviation, with a significant impact on communities that rely heavily on wetland products for a living.

Accurate, efficient, and repeatable mapping of changes in wetlands and riparian regions (referred to collectively as wetlands) is critical for monitoring human, climatic, and other effects on these critical systems (Baker et al., 2007). Wetlands are under threats all over the world, despite the benefits and services they provide to humans (Maltby, 1991). Several studies have been conducted in and around the study area to show drivers and implications of LULC change and soil erosion risk assessment (Beyene, 2019; Dibaba et al., 2020; Hailu et al., 2020). Geospatial technologies are widely used in the mapping and monitoring of wetland ecosystems. The spatio-temporal change of wetland ecosystems has been also calculated using geospatial technologies. However, detail information on wetland dynamics is uncertain to design wetland conservation and management strategies. Therefore, this study attempts to fill the existing research gap by analyzing wetland dynamics using geospatial techniques in Abay Choman and Jimma Geneti watershed, Horo Guduru Wollega Zone, Western Ethiopia. The results of this study will be useful specially to design effective strategies to conserve wetland degradation in the study area and beyond.

Materials and Methods

Description of the study area

The Abay Choman and Jimma Geneti watershed is part of the Abay basin, which is located in the Horo Guduru Wollega of the Oromia National Regional State (Figure 1). Geographically, the study area is situated between 9°11′00″N to 9°38″30″N and 37°4″00″E and 37°26″00″E and the elevation of the study area varies from 3,200 to 1,644 m above the mean sea level. The study area was approximately 1,426.6 km^2. The watershed is characterized by high topographic relief and has cold climate condition. The area has large upstream water potential sites, intensive irrigable downstream lands, and high hydropower potential (Dibaba et al., 2020). Previous studies in southwestern Ethiopia have documented a decline in wetland resources due to environmental pressure and human stresses (Berhanu et al., 2021; Dibaba et al., 2020; Dixon et al., 2021; Hussien et al., 2018). The study area has different LULC classes: cultivated land, forest, grassland, shrubs land, and settlements. Among the LULC types, agricultural land is the most dominant in the study area (Hailu et al., 2020).

Soil types

There are eight major soil groups were identified in the Abay choman and Jimma Geneti watershed: Chromic Luvisols, Eutric Cambisols, Eutric Leptosols, Eutric Vertisols, Haplic Alisols, Haplic Arenosols, Haplic Phaeozems, Rhodic Nitisols (Kenea et al., 2021).

Climate

The study area is found in the wettest part of the country. The area receives sufficient amount of rainfall throughout the year except during dry season (December to February). The mean annual rainfall of the study area is about 1,320 mm (Kitila et al., 2015). The study area received maximum rainfall between the month of June and September, which shares about 80% of the total annual rainfall. The share of annual rainfall for winter season (December to February) accounts about 5%. The average annual maximum and minimum temperatures is about 30°C and 14.8°C, respectively (Tessema & Simane, 2019).

Data sources and descriptions

Landsat imagery for the years 1991 TM, 2003ETM+, and 2021 OLI/TIRS was obtained from the Earth Explorer

[1] The full form of the word "EWRP" has been corrected to "Ethiopian Wetlands Research Programme" from "Emergency Wetlands Reserve Program" after the article's original OnlineFirst publication.

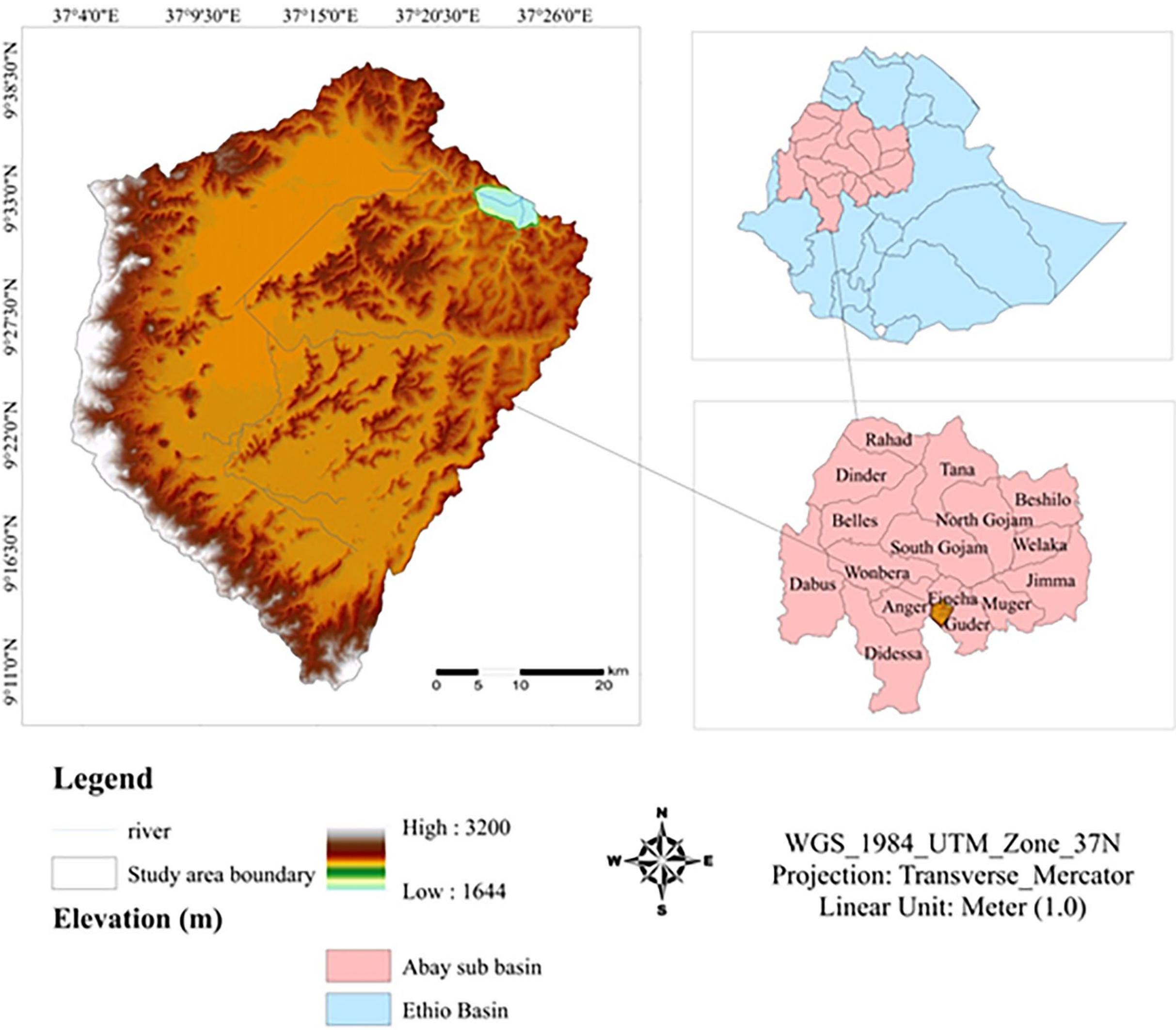


Figure 1. Map of the study area.

Table 1. Data Sources and its Descriptions.

DATA TYPES	SENSOR	ACQUISITION YEAR	PATH AND ROW	RESOLUTION	SOURCE
Landsat 5	TM	1991	169 & 054	30 m	USGS
Landsat 7	ETM+	2003	169 & 054	30 m	
Landsat 8	OLI/TIRS	2021	169 & 054	30 m	
ASTER DEM	-	-	-	30 m	

website (http://eathexplorer.usgs.gov/) by path 169 row 54. These Landsat images were downloaded from cloud-free images during the dry season (January-February) (Table 1 and Figure 2). These Landsat images were used to calculate the LULC, NDVI, and NDWI.

Software packages used

For image processing and categorization, the Earth Resources Data Analysis System (ERDAS) Imagine 2015 software was employed. For analyzing and visualizing spatial data, ArcGIS 10.3 was employed. ArcGIS software was used to create the drainage network and extract the sub basins using Arc SWAT.

Methodology

Analyses of LULC types

Landsat images TM from 1991, ETM+ from 2003, and OLI/TIRS from 2021 were used to classify land use and land cover types in the Abay Choman watershed. The LULC classification was supervised and using the maximum likelihood approach (Moisa & Gemeda, 2021; Moisa et al., 2021). The

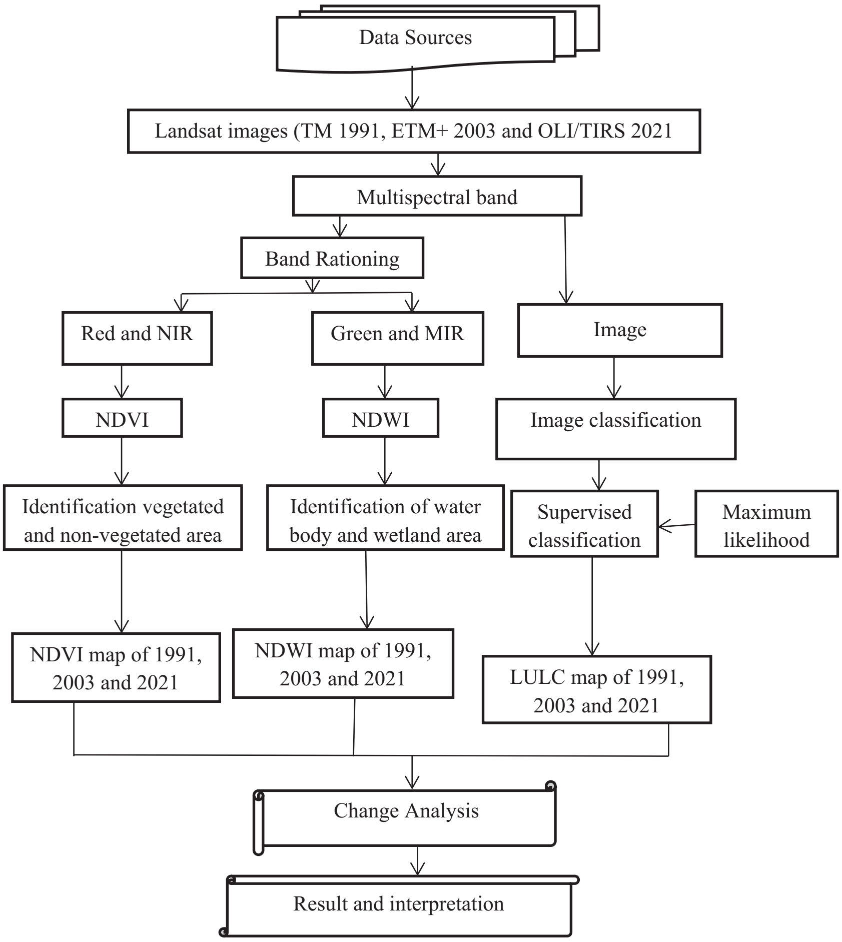


Figure 2. Methodological flowchart.

study area's LULC was divided into four categories: cultivated land, grassland, shrubland, and wetland.

Accuracy assessment

Ground control points were collected using GPS and Google Earth for accessible and inaccessible area respectively. The collected ground control points were used to calculate accuracy assessment for each LULC class. For each LULC type, 40 samples were collected using random stratified method. The field photos (high-resolution Google Earth images) of these field samples were attached in Supplemental Figure 1.

As indicated in Congalton (1991) and Moisa and Gemeda (2021), the overall accuracy was calculated by dividing all the pixels properly categorized by the total number of pixels in the matrix (equation (1)). Alam et al. (2020), Merga et al. (2022), Mishra et al. (2020), and Moisa et al. (2021) calculated the overall accuracy and Kappa coefficient (Khat) to measure the degree of agreement between the two maps in the form of a confusion matrix (Alam et al., 2020; Mishra et al., 2020; Moisa et al., 2021; (equation (2)).

$$\text{Overall accuracy} = \frac{\textit{Sum of the diagonal elements}}{\textit{Total number of accuracy sites (pixels)}} \times 100 \quad (1)$$

$$Khat = \frac{\boldsymbol{Obs - exp}}{1 - \boldsymbol{exp}} \quad (2)$$

where: Obs is observed correct or overall accuracy and Exp is represents correct classification.

LULC change detection. The quantity of altered area, extent of change utilized to assess the degree of change over time is determined using equation (3) (Abebe et al., 2019; Eyasu et al., 2019; Gessesse et al., 2017; Kabite et al., 2020; Moisa, Dejene, Merga, et al., 2022a).

$$Rate\ of\ change\left(\frac{\boldsymbol{km2}}{\boldsymbol{year}}\right) = \frac{\boldsymbol{A2 - A1}}{\boldsymbol{Z}} \quad (3)$$

$where$, $A2$ $is\ an\ area\ of\ LULC\ in\ square\ kilometer\ in\ time\ 2$,

$A1\ is\ an\ area\ of\ LULC\ in\ square\ kilometer\ in\ time\ 1$;

Z is Time interval between A2 and A1 in years.

Estimation of NDVI. The NDVI is used to calculate the quantity of aboveground green vegetation cover (Moisa, Dejene, Hirko, et al., 2022; Moisa, Dejene, Merga, et al., 2022a; Wolteji et al., 2022; equation (4)).

$$\boldsymbol{NDVI} = \frac{\boldsymbol{NIR - R}}{\boldsymbol{NIR + R}} \quad (4)$$

Table 2. LULC Change of the Study Area.

LULC TYPES	1991		2003		2021	
	AREA (KM²)	AREA (%)	AREA (KM²)	AREA (%)	AREA (KM²)	AREA (%)
Cultivated land	546.3	38.3	678.2	47.5	769.7	54.0
Grassland	102.1	7.2	71.9	5.0	51.1	3.6
Shrubs land	161.7	11.3	132.7	9.3	114.5	8.0
Wetland	616.5	43.2	543.8	38.1	491.3	34.4
Total	1,426.6	100.0	1,426.6	100.0	1,426.6	100.0

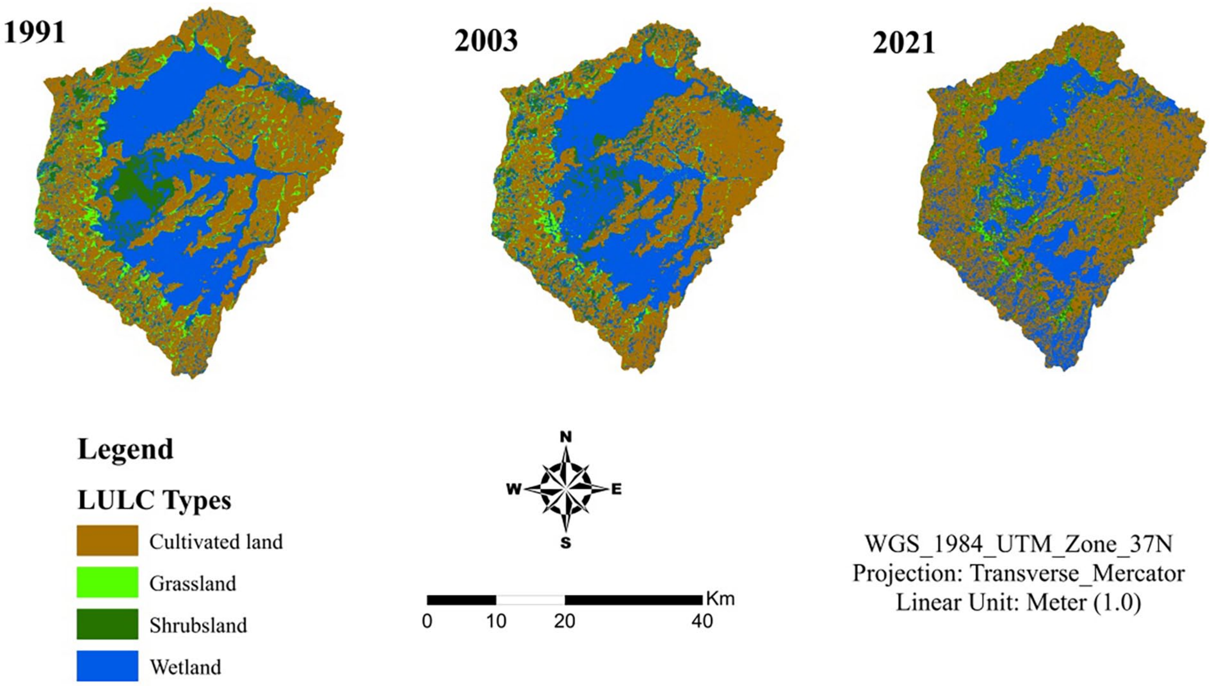


Figure 3. LULC map of the study area.

where NDVI is Normalized Difference Vegetation Index, NIR is the near infrared band and R is the red band

Landsat 8 data used Bands 5 (Infrared) and 4 (red), whereas Landsat 5 and 7 used Bands 4 and3, to calculate the NDVI values.

Normalized difference water index (NDWI). When modeling the thermal environment, the NDWI is used to simulate water areas, which often have significant thermal changes (Siqi & Yuhong, 2020; Zhou & Wang, 2011). Green band (band 2 for Landsat 5 and 7, band 3 for Landsat 8) and near infrared (band 4 for Landsat 5 and 7, band 5 for Landsat 8) reflectance measurements were used to build the formula (equation (5)). The Near-Infrared (NIR) and Green (G) channels are used to calculate the NDWI (Jackson et al., 2004).

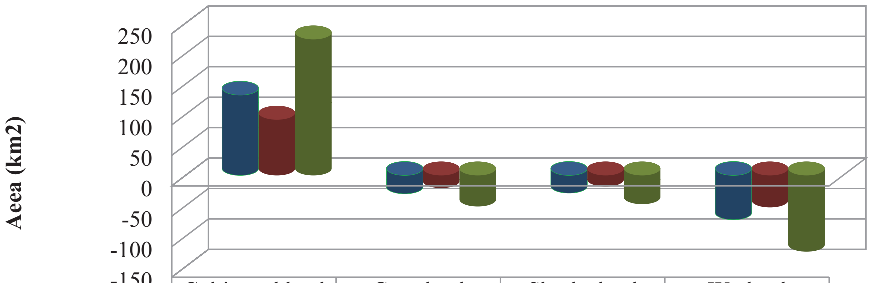
$$NDWI = \frac{Green - NIR}{Green + NIR} \quad (5)$$

Results and Discussions

Analyses of LULC change

The LULC of the study area was classified into four classes as cultivated land, grassland, shrubland, and wetlands for the year 1991, 2003, and 2021 (Table 2; Figure 3). The results show that cultivated land was the most prominent LULC type in 1991, 2003, and 2021, with an area of 546.3 km² (38.3%), 678.2 km² (47.5%), and 769.7 km² (54.0%), respectively. This clearly demonstrated that the amount of cultivated land increased over the study period.

Between 1991 and 2021, the amount of wetlands was decreased. For instance, in 1991, wetland covers about 616.5 km² (43.2%), and declined to 543.8 km² (38.1%) and 491.3 km² (34.4%) in 2003, and 2021, respectively. Furthermore, shrubs land and grassland showed a downward tendency. These results are consistent with Moisa, Dejene, Merga, et al. (2022b), Moisa, Merga et al. (2022a), and Negash et al. (2021), who reported that shrubs land and grassland were showed a decreasing trend. A study by Dibaba et al. (2020) confirmed that, forest land, water body and swampy areas were decreased due to



	Cultivated land	Grassland	Shrubs land	Wetland
1991-2003	131.9	-30.2	-29	-72.7
2003-2021	91.5	-20.8	-18.2	-52.5
1991-2021	223.4	-51	-47.2	-125.2

Figure 4. Trends of land use land cover of the study area.

Table 3. Rate of LULC Types of the Study Area.

LULC TYPES	1991–2003	2003–2021	1991–2021
	KM²/YEAR	KM²/YEAR	KM²/YEAR
Cultivated land	11.0	5.1	7.4
Grassland	−2.5	−1.2	−1.7
Shrubs land	−2.4	-1.0	−1.6
Wetland	−6.1	−2.9	−4.2

expansion of agricultural land in Fincha'a catchment from 1987 to 2017. Changes in LULC could have a large impact on climate change, which in turn could affect agricultural production. Changes in LULC are one of the key drivers for the increasing trends in mean minimum and maximum temperatures in the wettest parts of Ethiopia (Gemeda et al., 2022; Gemeda, Korecha et al., 2021).

It is clear that there is a direct relationship between precipitation, runoff, temperature, groundwater and wetland ecosystems. The combined effects of LULC change and climate change significantly affects the ground water potential and results in changes in water balance particularly in tropical areas (Ha et al., 2019; Marhaento et al., 2017). The functioning of wetland ecosystem relies upon the water level and precipitation, that have a huge effect on wetland habitat and the corresponding species (Dawson et al., 2003). House et al. (2016) highlight that in areas with groundwater upwelling, the response of water levels to climate change is exaggerated. Gemeda, Feyssa et al. (2021) concluded that environmental factors such as wetland and river size are important indicators of climate change. As reported by Li, Hu et al. (2021) evaporation had a significant negative impact on the distribution of wetlands.

Trends of LULC change

Results revealed that different LULC types showed both positive and negative tendencies. Among the existing LULC types, cultivated land is the only land category that shows a positive trend during the study period. Negative values indicate a declining trend, while positive values indicate a rising tendency. Over cultivated land, there was a rising tendency, with an increase of 223.4 km² from 1991 to 2021. Wetland was declined by 125.2 km², from 1991 to 2021 (Figure 4). Furthermore, shrubs land and grassland showed a decreasing tendency. The loss of grassland and shrub land cover classes over the study period is almost comparable in terms of loss in hectare. The expansion of cultivated land was the primary cause of the loss of wetland, shrubland and grasslands in the study area. Another study by Negassa et al. (2020) and Moisa et al. (2021) found that rapid population growth is one of the main drivers of increased development of cultivated land, leading to land degradation, especially on steep slopes. Hailu et al. (2020) stated that in the Jimma Geneti district wetland were declined by 19.2% from 1973 to 2019. On the other hand, cultivated land has increased by 13% from 1973 to 2019 with the rate of 7.4 km²/year.

Rate of LULC change

The findings demonstrated a high rate of change in cultivated land and wetlands. From 1991 to 2021, cultivated land expanded by 7.4 km²/year, whereas wetland was decreased by 4.2 km²/year. In addition, between 1991 and 2021, shrubs land and grassland lost 1.6 km²/year and 1.8 km²/year, respectively (Table 3). This result is more consistent with previous studies (Eyasu et al., 2019; Moisa & Gemeda, 2021; Wedajo et al., 2020), where agricultural land exhibits a high positive rate of change, while vegetation experienced a declining trend. Rapid population growth and the increasing demand for agricultural land are some of the key drivers for rapid conversion of LULC in the study area. In addition, the concern for environmental conservations by stakeholders and individuals' interest has not reached the required level.

Accuracy assessment

The accuracy of the classified LULC maps was assessed in the current study to ensure their trustworthiness. The reference data was compared to the classified LULC types. The total

Table 4. Accuracy Assessment of LULC for 1991, 2003, and 2021.

LULC TYPES	1991		2003		2021	
	PRODUCERS ACCURACY (%)	USERS ACCURACY (%)	PRODUCERS ACCURACY (%)	USERS ACCURACY (%)	PRODUCERS ACCURACY (%)	USERS ACCURACY (%)
Cultivated	89.0	82.6	87.5	95	88.6	92.8
Grassland	90.1	88.2	92.3	91.8	93.3	95.2
Shrubs land	92.3	93.5	94.3	95.8	96.4	94.7
Wetland	82.6	81.7	90.5	85	91.7	92
Overall Accuracy	86.8%		83.4%		85.7%	
kappa coefficient	0.85		0.82		0.83	

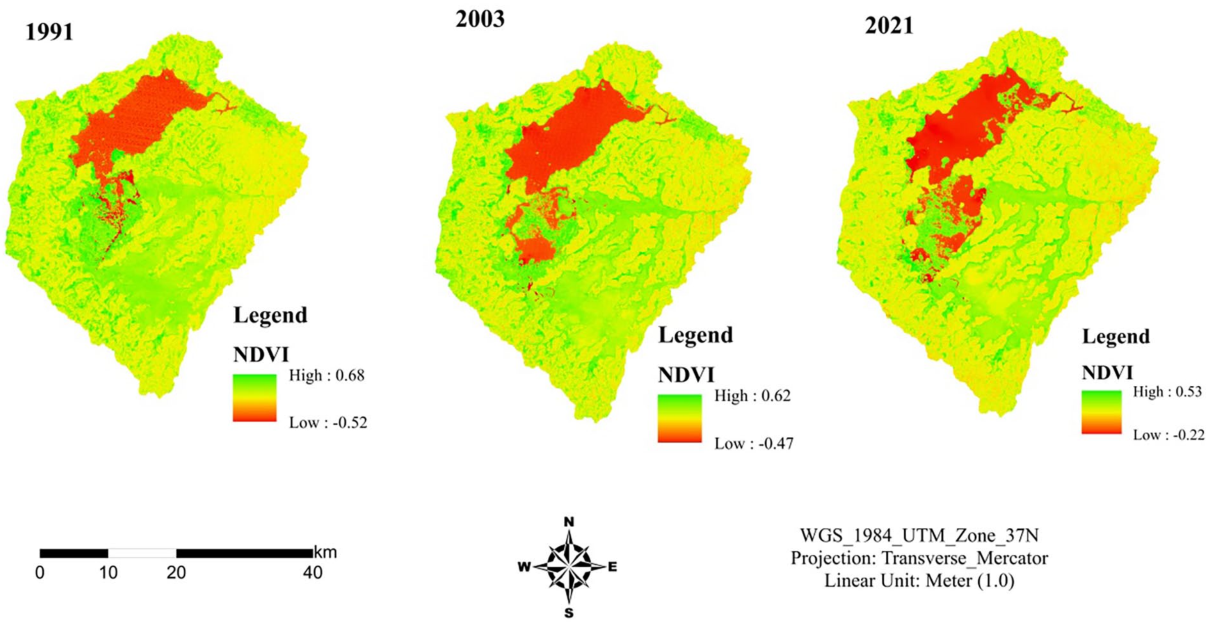


Figure 5. NDVI map of the study area.

classification accuracy of the LULC accuracy assessments for the study periods 1991, 2003, and 2021 was 86.8%, 83.4%, and 85.7%, respectively. As a result, for the study periods 1991, 2003, and 2021, the kappa coefficients were 0.85, 0.82, and 0.83, respectively (Table 4).

Spatiotemporal distributions of NDVI

The NDVI value was used to evaluate the decline of shrubs land and grassland in the study area. Due to a drop in green vegetation and the extension of cultivated land, high NDVI values decreased dramatically from 1991 to 2021, with a maximum value of 0.68 to 0.53. Wolteji et al. (2022) in the Central Rift Valley of Ethiopia confirmed that low NDVI values indicate forest degradation that may be related to drought. In this study, results of NDVI values between 1991 and 2021 show a decreasing spatial distribution of green vegetation. The center and southern regions of the research area have greater NDVI values, according to the findings. Low NDVI values were found over cultivated land (after harvesting), lake bodies, and marsh areas with less vegetation (Figure 5). According to previous studies by Moisa, Dejene, Merga, et al. (2022a) and Moisa, Merga et al. (2022b), agricultural land expansion is the primary source of green vegetation reduction.

Spatiotemporal distributions of NDWI

The decline in NDWI from 1991 to 2021 reduced the size of water bodies and wetlands. The main reason for the decrease in NDWI in the study area was the expansion of agricultural land. Agricultural land was increased by 15.7%, whereas, water body and wetland were decreased by 3.7% and 5.7% respectively. The greatest NDWI value in 1991 was 0.58, 0.48 in 2003, and 0.21 in 2021, according to the results. The NDWI results revealed that there was a high value in the central areas of the study area during the study period (Figure 6). The data show that cultivated land has a low NDWI value. The outcome is consistent with earlier research (Mukherjee & Pal, 2021; Roy et al., 2021).

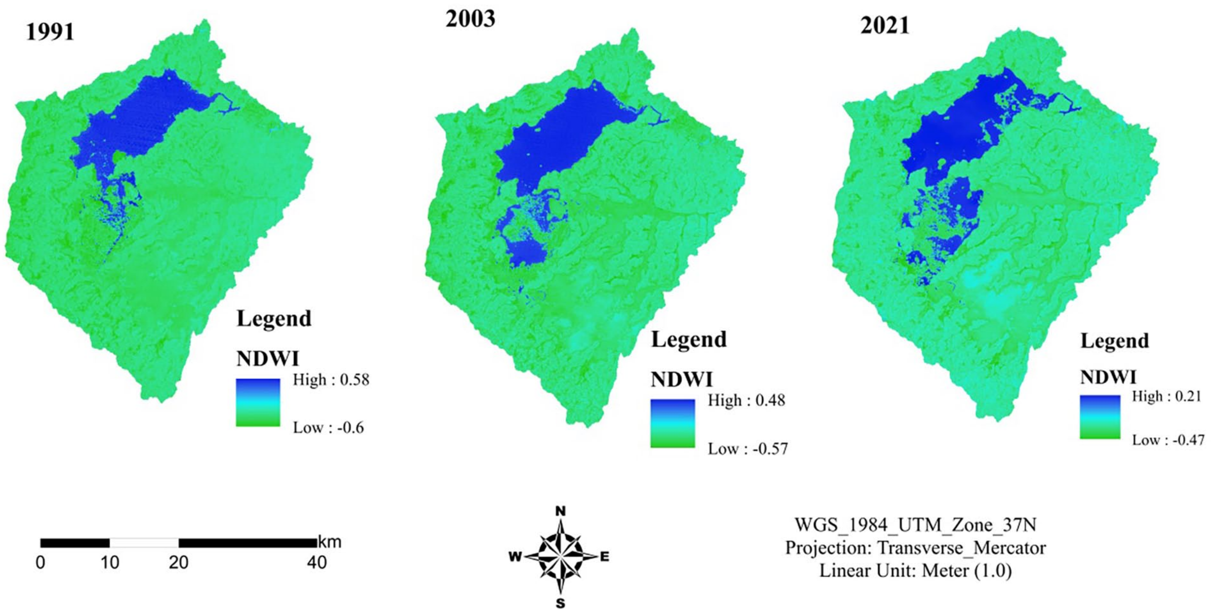


Figure 6. NDWI map of the study area.

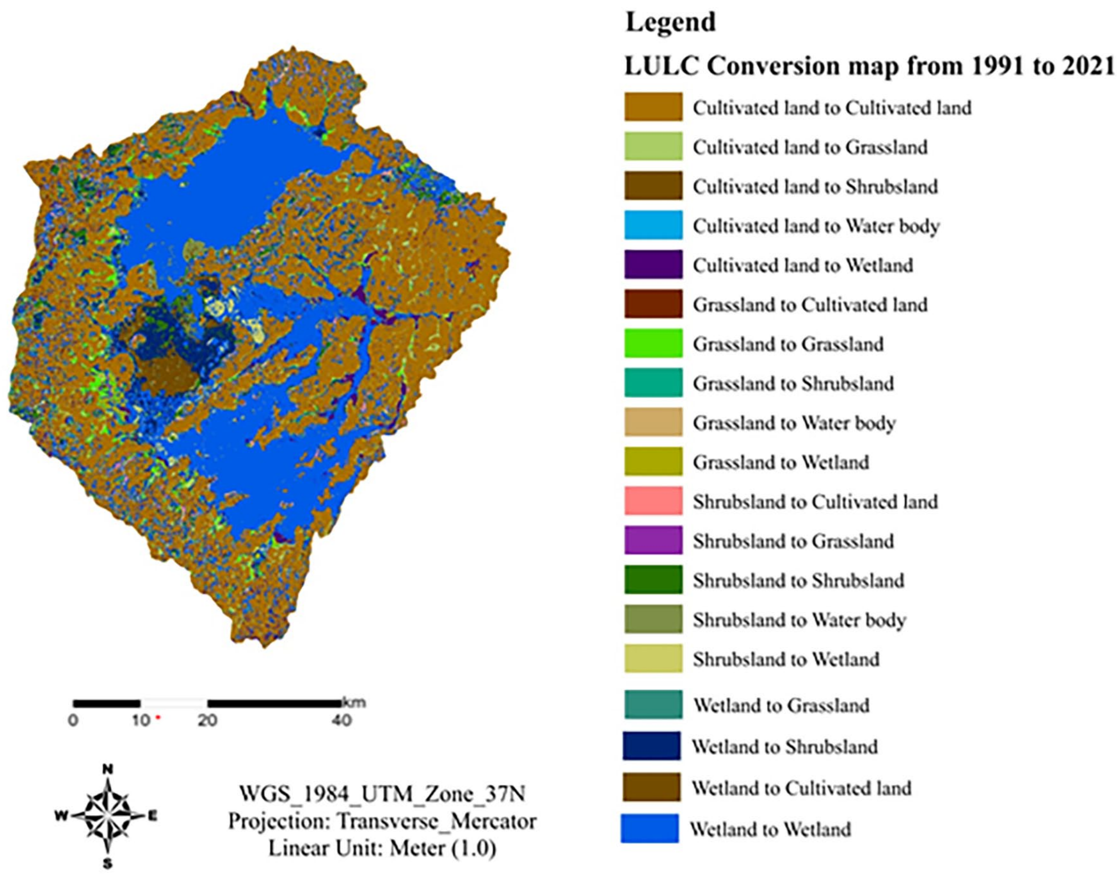


Figure 7. LULC conversion map from 1991 to 2021.

LULC conversions from 1991 to 2021

We employed the land use transfer matrix (LUTM) method to analyze the LULC change during the study periods 1991 to 2021. Major LULC conversion within Abay Choman and Jimma Geneti watershed was presented in Figure 7. The results show that about 66.7 km^2 wetland was converted to cultivated land, whereas 29.3 and 24.7 km^2 of grassland and shrubs land were converted to cultivated land during the study periods of 1991 to 2021 (Table 5). The high conversion of forest cover to agricultural land has been reported by Negassa et al. (2020) in Komto protected forest priority area from the years 1991 to 2019. A study by Moisa, Dejene,

Table 5. LULC Conversion From 1991 to 2021.

LULC CLASSES		2021				
		CULTIVATED LAND	GRASSLAND	SHRUBS LAND	WETLAND	TOTAL
1991	Cultivated land	634.9	49.2	5.0	51.5	740.5
	Grassland	29.3	70.4	4.7	20.0	124.4
	Shrubs land	24.7	3.3	76.0	30.3	134.3
	Wetland	66.7	19.0	58.0	283.6	427.3
	Total	755.6	141.9	143.7	385.3	1,426.6

Hirko, et al. (2022) reported a rapid decline of forest and grassland land cover due to high conversion to agricultural land in Anger River sub basin. The results clearly show that the extreme decline in high NDVI and NDWI values between 1991 and 2021 was caused by a sharp decrease in vegetation cover and degradation of wetlands and wetlands due to expansion of cultivated land. A recent study by Moisa, Gabissa et al. (2022) found that agricultural expansion was the main cause of the decline in NDVI and NDWI in Gida Kiremu, Amuru and Limu districts from 1990 to 2020.

Conclusions

Wetlands are vital resources with numerous values and functions, notably in terms of climate change mitigation. This study clearly shown that the wetland ecosystems are changing from time to time due to overexploitation for agricultural land and other activities. In this study, geospatial techniques were used to explore wetland dynamics in the Abay Choman and Jimma Geneti watershed. The results showed that cultivated area increased and wetland ecosystems decreased during the study period. Agricultural land was expanding at a 7.4 km^2/year, whereas wetland was shrinking at 1.8 and 2.4 km^2/year, respectively. Between 1991 and 2021, shrubland and grassland lost 1.6 and 1.8 km^2/year, respectively. Due to a drop in green vegetation and the extension of cultivated land, high NDVI values decreased dramatically from 0.68 to 0.53. The main reason for the decrease in NDWI in the study area was the expansion of agricultural land. There great variation of NDWI value over the study period, which is between 0.58 in 1991, and 0.48 and 0.21 in 2003, and 2021, respectively. The decreasing values of NDWI indicates can accurately indicate the problem of environmental change in the study area, which requires further research and conservation initiatives to minimize the current declining trend. Natural resource managers and environmental professionals therefore need to raise public awareness and advocate for the wise use of natural resources, with a particular focus on wetland conservation and protection. Furthers studies particularly the impact of rainfall and temperature on wetland ecosystem should be investigated.

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Author Contributions

MBM, TWB, BCW, and DAN authors were design and draft manuscript. MBM and DAN involved in data analysis and method preparation. DOM, YWB, and AKCH authors were involved in study design and manuscript edition. All authors read and approved the final manuscript.

Availability of Data

Available in this manuscript.

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Declaration of Conflicting Interests

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Consent for Publication

The authors agreed to publish the manuscript on journal of Air soil and water research.

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Supplemental Material

Supplemental material for this article is available online.

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