Chapter 11
Urban Sprawl and Landscape Transition in Awutu Senya East Municipal Assembly

Cudjoe Justice and John Manyimadin Kusimi

Abstract The rapid rate at which cities and towns are urbanising is of concern to urban planners globally. Urbanisation has caused urban sprawl and densification of urban landscapes of cities. This chapter is based on a project that has used remote sensing and social survey methods to assess the transformation of the physical landscape into urban landscape in the Awutu Senya East Municipality between 1986 and 2021. Remote sensing analysis entailed image classification and change detection. Social survey involving questionnaire administration and key informant interviews were conducted to ascertain the causes and impacts of declining vegetative cover. Vegetation and barelands were more transformed into urban landscape. Rising population of the locality related to urban sprawl and intensification causing a decrease in vegetal cover and barelands from a coverage of 53.5% and 35.4%, respectively, in 1986 to 15.3% and 13.7%, respectively, in 2021, while built-up environment increased from 9.7% in 1986 to 70.6% in 2021. Most conversions of vegetation were between 1986 and 2002, barelands between 2002 and 2021 while built-up assumed a rising trend throughout the period. The main driving force of vegetal and bareland diminution is urbanisation which caused an increase in the built-up environment. The landscape transformation is perceived to be causing urban heat, urban aesthetic damage, flooding, etc. The study recommends the development and implementation of a land use plan focusing on urban greening to improve upon the ecological services of the municipality.

Keywords Kasoa · Land use and land cover change · Remote sensing analysis · Urban green space · Urbanisation and urban sprawl

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Introduction

The world is becoming progressively more urbanised. Urbanisation rate is increasing at an unprecedented rate, mostly within the developing countries in sub-Saharan Africa and Asia (United Nations Department of Economic and Social Affairs [UNDESA] 2018). According to UNDESA (2018), as the world urban population continue to increase, cities will further expand to other remote areas and create mega cities culminating into urban sprawl. This global growth in urban population is because of demographic factors mostly rural–urban migration which has seen a surge in recent years in developing countries (Acheampong et al. 2019). About 55.7% of the world population as of 2019 lived in urban areas, as compared to 30% urban population in 1950 with the urban population of developing countries like Ghana, Nigeria, Kenya projected to double by the year 2050 (UNDESA 2018). Addae and Oppelt (2019) have also postulated that about 40% of the population of Africans that lived in urban areas as of 2014 are projected to increase to about 56% by 2050.

The rate at which Ghana is urbanising is very rapid. According to Ghana Statistical Service (2014), the urban population of the country has increased from about 23.1% in 1960 to about 50.9% and has been predicted to further escalate within the next coming years (Owusu 2018). Most of the urban population in Ghana is seen to be concentrated within Accra; the national capital followed by Kumasi and Tamale (Addae and Oppelt 2019). According to Adarkwa (2012), since the pre-colonial era, there has been extensive change in urbanisation and urban infrastructure of Ghana owing to colonial policies and strategies which developed areas of natural resources and national/regional capitals. The bruises of these situation among other factors have ended up with Accra been the most urbanised region in Ghana, having about 90.5% urban population as of 2010 and continuous to urbanise in recent years (Ghana Statistical Service [GSS] 2012).

Urbanisation directly influences and alters vegetation in the world and is a major phenomenon that contributes largely to the alteration of the natural vegetation (Cao and Natuhara 2019; Owusu 2018). The spreading of towns and cities due to the rapid escalation of urban population has also led to the situation where there is a rapid transformation of agricultural land to urban land use (Acheampong et al. 2019). Thus, agricultural lands, vegetative covers and other land use and land cover (LULC) get transformed to residential and commercial space to suit the growing population. Some impacts of urban sprawl include loss in peri-urban lands and environmental pollution, loss of indigenous species of plants and animals, reduced tourism and loss of ecosystem services that are vital to humans (Agyeman 2018; Blay 2019; Cobbinah and Amoako 2012).

Due to the rapid rate at which the Greater Accra Region has urbanised, it has been challenging for the local authorities to manage urban sprawl and the cascading effects (Addae and Oppelt 2019). The Greater Accra Region has sprawled into neighbouring regions like the Central Region where the Awutu Senya East Municipality is located. The Greater Accra Region has the highest migrants of 23,673 people residing in the municipality (Ghana Statistical Service 2012). A respectable number of government employees and businessmen now stay in the Awutu Senya East Municipality and work in Accra. Significant vegetal cover has been converted into open spaces for the sake of livability. The proportion of the population living in urban areas in Awutu Senya Municipality as of 2010 is 94.1% compared to 5.9% in the rural areas (Ghana Statistical Service 2014). The urbanisation of the municipality has caused land cover transformations. The municipality which was known to be highly agricultural and whose land was mainly used to produce food and other agricultural purposes has turned into residential areas to serve the escalated urban population of Accra. There is the need for urban planners to put in measures to curb the indiscriminate destruction of vegetation as a result of urbanisation and urban sprawl due to the several benefits urban vegetation offers: including carbon sequestration, air filtering, reduction of heat, beautification, and recreation, and the stabilisation of the ecosystem and microclimate among others (Owusu 2018). Despite the numerous benefits urban vegetation brings to the cities, protecting vegetation in urban areas has become very difficult to achieve in sprawling cities in the developing worlds like Ghana. Stow et al. (2016) in a study of towns in four regions of southern Ghana between 2000 and 2010 revealed that 1.5% of the study area transitioned to built, an increase of 56% built area since 2000, while population increased by 33%. Anarfi et al. (2020) also showed that urbanisation has been rapid in Kumasi and Obuasi over the years and this has resulted in changes in land cover in the localities between 1986 and 2018. Other studies that analysed the nexus of urbanisation, urban sprawl and land use and land cover changes in Ghana include Owusu (2018), Addae and Oppelt (2019), Acheampong (2019), Blay (2019) among others. What are the urbanisation effects on vegetal cover and what have been the effects of urbanisation on the earth's systems? It becomes very expedient to investigate the changing trends of vegetal cover amidst rapid urbanisation in a developing country like Ghana to contribute to the literature. By employing remote sensing approach, researchers have been able to come out with major findings and suggestions to curb the issue of urbanisation associated with vegetation and other land conversions (Anarfi et al. 2020; Cai et al. 2019; Stow et al. 2016; Yang et al. 2017). Thus, to better understand the scenario of the adverse effects of urbanisation and urban sprawl on the vegetal cover and other landscape elements in the area, the study undertook a spatio-temporal analysis of the land use and land cover changes in the locality between 1986 and 2021 using remote sensing.

Literature Review

Urbanisation and Urban Sprawl

The urban area can be considered as a composite of built-up and the non-built-up (vegetated or bareland) surfaces in urban areas (Zhou et al. 2014a, b). Acheampong et al. (2019) defined urbanisation as the increase in the number of people living in the towns and cities within a particular country. This is when the population of cities increases leading to the expansion of the cities. The total number of inhabitants that qualify a town to be classified as urban is not universal, but it depends on the population criteria for defining urban centres in a particular country. For example, in Denmark, a town with 250 inhabitants can be classified as urban; 1,000 in Greece; and 20,000 in Nigeria (Bodo 2019); while in Ghana, localities with a population of 5,000 are classified as urban (GSS 2014). The increase in population according to Acheampong et al. (2019) could be caused by numerous factors. They stated that countries with high economic growth like China with a low rate of childbearing have their growth in urban population caused by in-migration, while developing countries of sub-Saharan Africa had experienced growth mainly because of natural increase, thus high birth and low mortality rates coupled with rural–urban migration. Glaeser (2014) relates urbanisation to globalisation, agricultural productivity, transport improvements in an open economy. According to modernisation and urban bias theories, rural–urban migration, natural population growth, economic development, infrastructure are the noted driving forces of urbanisation of cities globally; however, some of these factors are not very tenable in the developing countries (Njoh 2003; Park et al. 2017). A resultant effect of urbanisation on peri-urban fringes is urban sprawl.

Urban sprawl has various definitions depending on the context and characteristics pertaining to regions. Urban sprawl according to Cobbinah and Amoako (2012) refers to the unstructured model of development mostly around peri-urban areas. Johnson (2001) also defines urban sprawl as urban development with low-density housing, both residential and commercial, segregated land use and high level of automobile use combined with lack of public transport. Urban sprawl is mostly characterised by scattered, spread out, little planning control of land development and discontinued development (Habibi and Asadi 2011; Liu et al. 2018). Habibi and Asadi (2011) and Liu et al. (2018) have enumerated the characteristics of urban sprawl and among them are low-density residential and commercial settlements, leapfrogging of development, dominance of private transport system, loss of farmlands and income inequality among dwellers. As the population of inner cities increases, the economic, environmental and sanitary problems of urbanisation in these areas also increase pushing the marginalised to urban fringes. Other triggers of urban sprawl comprise high income, high taxation, increase crimes, high land value/land financing in the city centres thus pushing the marginalised to the periphery (Habibi and Asadi 2011; Han 2020). This therefore results in more people choosing to stay on the fringes of the city where the associated impacts cannot be felt. This causes urban sprawl, as is the case of Accra and Kasoa, Kumasi, Obuasi and other cities in Ghana (Cobbinah and Amoako 2012; Blay 2019).

Effects of Urbanisation and Urban Sprawl on Earth's Systems

The benefits of urban vegetation are air purification, carbon storage, biodiversity conservation, enhancement of urban aesthetics and beautification, regulation of storm water and the microclimate (Kabisch et al. 2015; Wolch et al. 2014). These ecosystem services of urban vegetation improve public health, increase the life quality of urban citizens by offering aesthetic enjoyment, recreational opportunities which contribute to the improvements in physical and psychological wellbeing of residents (Dong et al. 2022; Luan and Li 2021; Zhang et al. 2022). The effects of urbanisation and urban sprawl on earth's systems are legion. In developing countries, the direct effect of urbanisation is urban sprawl due to uncontrolled development. Urban expansion results in environmental degradation and pollution and ecosystem transformation of urban periphery and rural areas (Saaty and De Paolo 2017; Xie and Liu 2019). Other effects include urban heat island and the degradation of the many ecological services enumerated (Yang et al. 2017). The impact of urban sprawl on vegetation has therefore been the focus of many scientists like ecologists, urban planners, climatologists among others.

Two differing views have emerged in response to urbanisation: sprawling into peri-urban landscape or densify/compact city through the development of existing urban green space (UGS) (Dallimer et al. 2011). Urban sprawl is noted to threaten the peri-urban and rural areas (Antrop 2004; Haaland and van den Bosch 2015; Swenson and Franklin 2000) while densification leads to green space loss within the cities and threaten urban agriculture and gardening (Haaland and van den Bosch 2015; Zhao et al. 2013). With the projected population of people living in urban areas expected to increase to 68% by 2050 (UNDESA 2018) urban sprawl and/or densification or the compact city approaches become inevitable.

The problems of urban sprawl have been recognised and discussed from the 1960s (Jacobs 1961) and the term compact city/densification dates to the 1970s (Dantzig and Saaty 1973; Breheny 1996) and has increasingly been debated since the 1990s (Newman 1992; De Roo 2000). Westerink et al. (2013) provided an overview of both advantages and disadvantages of urban sprawl and compact city development which are related to environmental, social, economic and resilience factors. Though there is evidence of loss of urban green space due to densification processes worldwide in Asian, Australian, some European and North America cities (Dong et al. 2022; Haaland and van den Bosch 2015), some studies are however showing reverse trends of increasing urban green space in China and most European cities because of strategic development policies and plans (Liu et al. 2022; Zhang et al. 2022; Zhao et al. 2013). Dong et al. (2022) revealed that approximately, 93.3% of some China cities showed significant decreasing trends of UGS coverage from 12.23 ± 0.32% in 2003 to 7.69 ± 0.22% in 2015. On the contrary, Zhao et al. (2013) found average green space coverage of some cities in China to increased steadily with urbanisation from 17% in 1989 to 37.3% in 2009. Sustainable urban development policies are key to managing the problems of sprawling and densification in our cities.

Study Area

Awutu Senya East Municipal Assembly (ASEMA) is in the Central Region of Ghana and is located on latitude 5°45′ south and 6°00′ north, and longitude 0°20′ west and 0°35′ east (Fig. 11.1) (GSS 2014). It is located about 31 km away from the national capital Accra with Kasoa as its capital (GSS 2014). It covers about 10 km^2 and is bordered by the Ga South Municipal Assembly, Awutu Senya and Gomoa East Districts at the east, north, west and south, respectively (Fig. 11.1).

The land area is made of isolated undulating highlands which range between 76 and 300 m above sea level. The soil is loamy with lowlands soils being clayey. The soil supports arable crops like pineapple, cassava, plantain, yam, maize, citrus and pawpaw. River Okrudu is the main river draining the landscape which overflows its banks and causes flooding in the rainy season (GSS 2014; Blay 2019). The municipality lies in the southwest plains of Ghana, characterised by high temperatures throughout the year. Temperatures range between 23 and 33 °C per annum. The average annual rainfall is about 750 mm. The municipality lies in the semi-deciduous forest zone. It is covered with short trees, shrub and grassland (Dickson and Benneh 1995). Trees cluster with height averaging 5 m and some short grasses that barely exceed 1 m. The population of the municipality was 108,422 as of 2010 and 94.1%

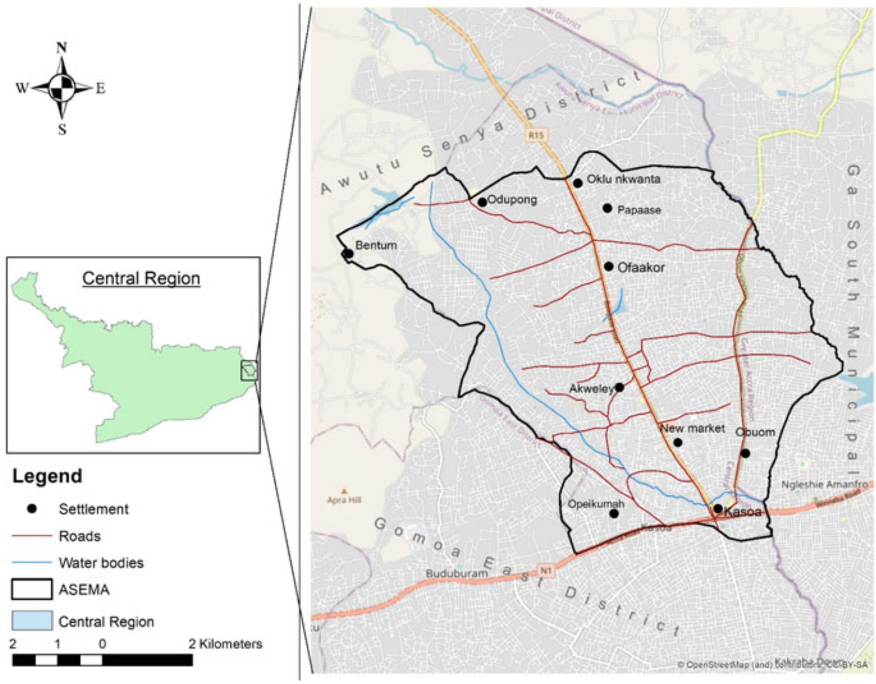

Fig. 11.1 Map of Awutu Senya East Municipal Assembly. *Source* Authors' construct

of the population live in urban areas as compared to 5.9% in the rural areas (GSS 2012). According to the Ghana Statistical Service (2012), a significant number of its population are migrants from most parts of the country. About 69.4% of the total population are economically active and engage in agriculture, service production, sales, craft and related trade works. There has been a very significant shift from farming to manufacturing and service production in the district owing to the taking over of agricultural land for residential and commercial activities (GSS 2012).

Materials and Methods

The study was carried out using an integrated method of remote sensing and social survey to assess the effects of increased urbanisation, urban sprawl on the vegetal cover and other elements of the earth system. The study used Landsat 4, Landsat 5 TM and Landsat 7 ETM+ images that were acquired in the years, 1986, 2002 and 2021 with attributes specified in Table 11.1. We chose 1986 as the base year for our analysis because there were no data (aerial photographs or satellite images) of the study area beyond this year. The study was conducted in 2021, hence the use of 2021 image. These images were acquired in the dry season, December, January and February, during which cloud cover is low hence the resultant images are good for LULC analysis. The selected images within the period had cloud cover of less than 10% thus, they were found to be suitable for the study. The Landsat 4 image of 1986 was a Landsat Multi-spectral Scanner (MSS) with spatial resolution of 60 m while the others were of 30 m. The images were downloaded from the United States Geological Survey (USGS) webpage. The path and row of the images are 193 and 056. Other data used included the district and regional shapefiles of Ghana that were made available on the rsgis.ug web portal for download.

The pre-processing, processing, classification and change detection processes of the data acquired were carried out in ENVI 5.3 software and ArcGIS 10.8 which are illustrated systematically in Fig. 11.2. The pre-processing of the images involved gap filling of 2002 and 2021 images to remove gaps of scan line off, subsetting of Awutu Senya East Municipal area using the district shapefile and layer stacking of bands. The images were calibrated to convert Landsat TM and ETM+ digital numbers to spectral reflectance above the atmosphere. The study combined bands 3, 4, 5 and the following false colours were assigned to them; 5 (red), 4 (green) and 3 (blue). The images were classified into four land cover classes using the supervised algorithm.

Table 11.1 Landsat MSS/ETM+/images and their attributes

Landsat product	Acquisition date	Path/row	Spatial resolution (m)	Source
Landsat TM 4	22 December 1986	193/056	60	USGS
Landsat 7 ETM+	3 February 2002	193/056	30	USGS
Landsat 8	12 January 2021	193/056	30	USGS

The classes included vegetation (shrubs, grasses, forest) represented by green colour, built-up (residential facilities, shops, offices, paved roads) denoted by yellow colour, bareland (burnt land, cleared surfaces and unpaved roads) represented by red colour and blue for water bodies such as rivers, dams and ponds. This was done using the spectral angle mapper based on the assumption that a single pixel selected represents a single ground cover material and can be uniquely assigned to only one feature class (Owusu 2018; Chu et al. 2018). Google Earth and training sites were used for the classification and the final validation of the classified images. Classified 1986 Landsat MSS image was resampled to 30 m using 2021 Landsat ETM+ image as the output reference image (Kusimi 2015). Change detection between 1986 and 2002, 2002 and 2021, and 1986 and 2021 were performed to find out the changes that had occurred over time using the change detection statistics algorithm in ENVI. This algorithm makes it possible to detect the changes that had occurred and the classes into which the changes occurred. The image processing techniques are shown in Fig. 11.2. Classified images and images of changes in LULC were presented as maps whereas statistics of the coverages of the various classes and the changes in LULC classes were presented as tables.

The study also used a social survey method to assess the perception of residents about the effects of depletion of the vegetal cover and the transformations in the environment. A questionnaire was administered to the public to seek their views and perception on the causes and impacts of the changing land use and land cover using Google form. The questionnaire was administered to residents who were enthused about the research and willing to answer questions concerning the research. Questions revolved around urbanisation, its impact on vegetation and the cascading environmental impacts. Respondents were guided when they were unable to fill the forms by themselves. Probing questions were asked when respondents provided additional information not stated on the questionnaire. The snowball method of sampling was used to select 250 respondents for the study. The municipality was divided into three

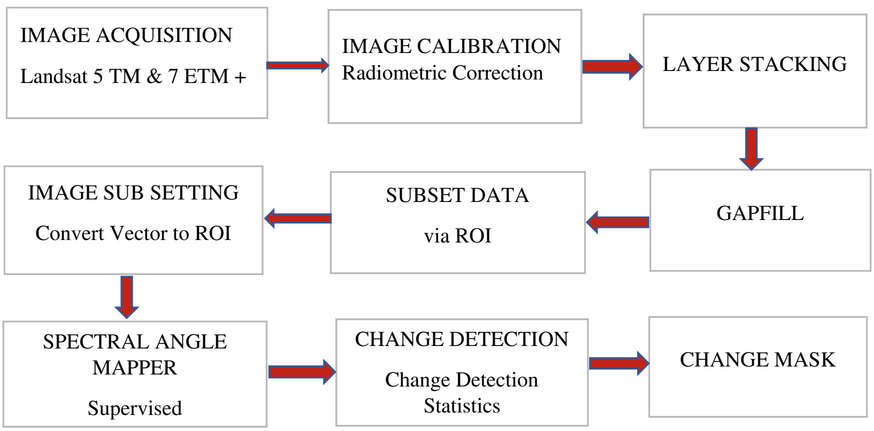

Fig. 11.2 Flowchart of data processing

main localities for the purpose of sampling. They are Kasoa in the southern locality, Ofaakor in the central zone, and Papaase and Oklu Nkwanta in the northern zone (Fig. 11.1). The selection of individuals to be interviewed begun with a 58-year-old resident who recommended respondents. The individuals that were selected mostly involved people that were of sound mind and have stayed in the municipality for at least 25 years and are aware of the transition in the district. Once the interview of respondents was done, they recommended suitable residents to be interviewed. Key informant interviews were held with the municipal planning officer and four (4) assemblymen. The questionnaires were analysed in Google into charts.

Results and Discussion

Land Use and Land Cover Types

Figures 11.3, 11.4 and 11.5 show the classified Landsat images of 1986, 2002 and 2021. Area coverage of the classes of the respective years is illustrated in Table 11.2, whereas the percentage coverage of each land mass for the respective years is shown in Fig. 11.6. In 1986, vegetation covered about 30.41 km^2 of the total land cover of the municipality, representing 53.5% land area. Vegetal cover was plentiful at the northern, north-western, south-western and some dotted portions across the rest of the municipality (Fig. 11.3). Bareland was the second most dominant feature covering 20.1 km^2 land area, forming 35.4% of the landscape. Bareland straddled southwest to northeast through the central part. Built-up covered 5.6 km^2 constituting 9.7% of the land mass. It is overriding at the south-eastern part with a westward trajectory. Water bodies covered only 0.8 km^2 of land area in the municipality forming less than one and a half (1.4%) of the surface area (Table 11.2 and Fig. 11.6).

In 2002, the area covered by bareland increased extensively to 35.1 km^2 representing 61.7% of land mass. Built-up also increased significantly to about 14.9 km^2 forming 26.1% of land area. Area occupied by vegetation and water bodies decreased to 6.6 km^2 and 0.3 km^2 representing 11.6% and 0.6%, respectively (Table 11.2 and Fig. 11.6). Bareland and built-up were now widespread across the locality with vegetation limited to the north-western tip of the municipality (Fig. 11.4). In 2021, the total land area covered by built-up increased to about 40.1 km^2 representing 70.6% of the study area (Table 11.2 and Fig. 11.6). Built-up had not only sprawled across the entire municipality but also intensified as the built environment pixels' density have increased across the landscape as shown in Fig. 11.5. Vegetation increased marginally by 2.1 km^2 from 6.6 km^2 (11.6%) in 2002 to 8.7 km^2 (15.3%) in 2021, and this is shown by the thinly covered greenish colour across the landscape (Fig. 11.5). Bareland decreased drastically to 7.8 km^2 forming 13.7% land mass. Water bodies also suffered a decline to 0.24 km^2 being 0.4% of the total land area (Table 11.2 and Fig. 11.6).

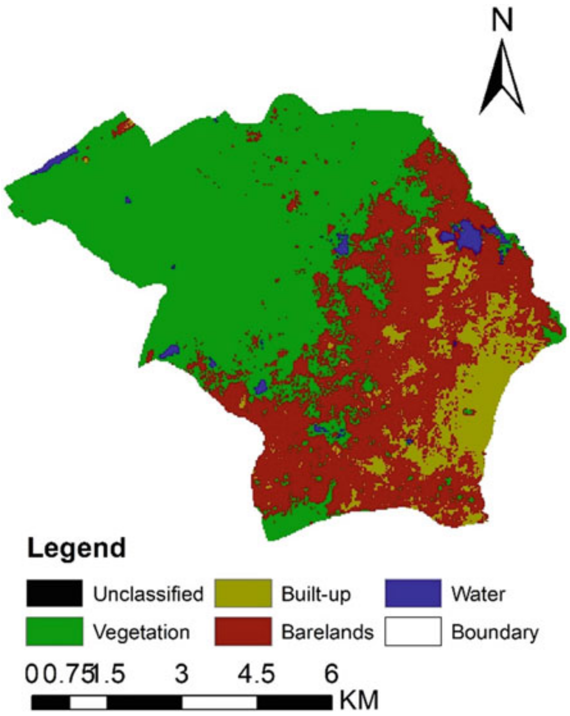

Fig. 11.3 Classified landsat MSS 1986 image

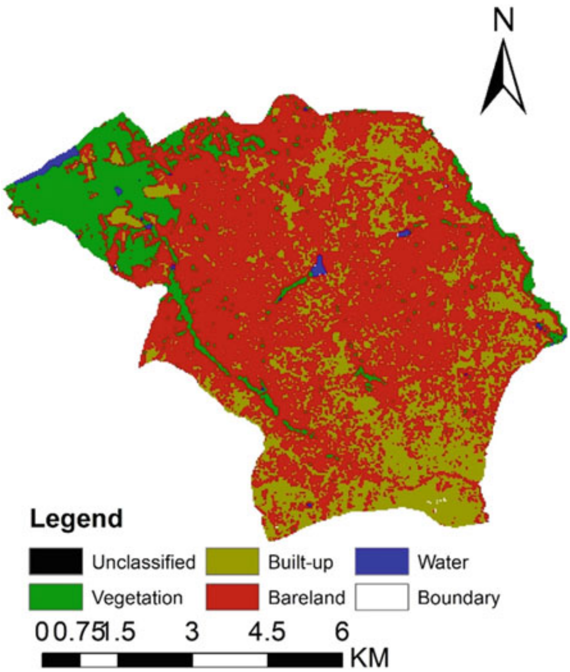

Fig. 11.4 Classified landsat ETM+ 2002 image

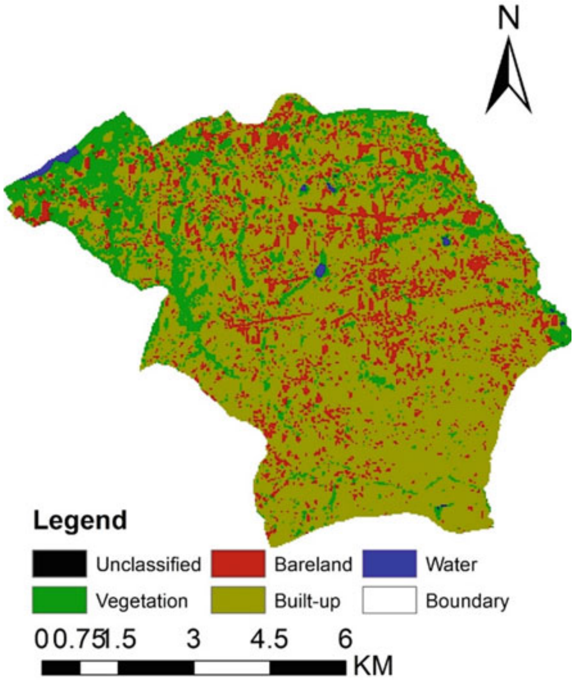

Fig. 11.5 Classified landsat ETM+ 2021 image

Table 11.2 Spatial coverage of land use and cover classes of 1986 and 2021 (km^2)

Land use and cover	1986	2002	2021
Vegetation	30.40	6.6	8.7
Built-up	5.55	14.9	40.1
Bareland	20.13	35.1	7.8
Waterbodies	0.8	0.3	0.24

Land Cover Change Detection

Change Detection 1986 and 2002

The changes in LULC between 1986 and 2002 of the Awutu Senya East Municipality were widespread. The changes are mapped in Fig. 11.7, and the percentage changes in the classes are shown in Fig. 11.6 while the change matrices of the classes are illustrated in Table 11.3. Whereas vegetation had declined in coverage from 53.5 to 11.6% (30.4–6.6 km^2), built-up coverage encountered over 100% growth from 9.7 to 26.1% (5.6–14.9 km^2) (Table 11.2 and Fig. 11.6). Vegetation and water bodies lost 23.8 km^2 and 0.5 km^2, respectively, of their coverage to other land classes while bareland and built-up gained 9.3 and 14.9 km^2, respectively, of the landscape of other LULC types (Table 11.3). The municipality lost about 78.3% (23.8 km^2) of its

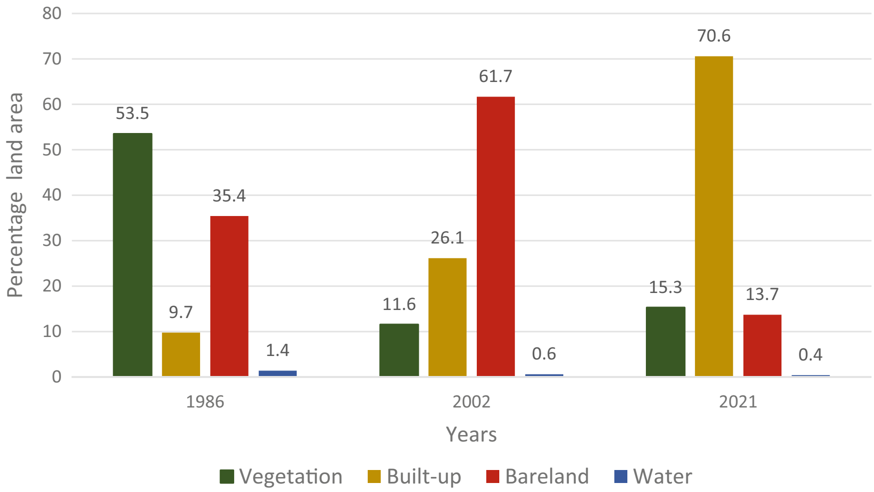

Fig. 11.6 Percentage coverage and changes of land use and land cover types 1986, 2002 and 2021. *Source* Extracts of classified images of 1986, 2002 and 2021

vegetative cover to other land classes; built-up gained 4.6 km^2, bareland 19.7 km^2, and water bodies 0.19 km^2. Only about 6.01 km^2 of vegetation, 2.83 km^2 of built-up, 12.18 km^2 of bareland and 0.13 km^2 of water bodies, respectively, remained unchanged during the period (Table 11.3). About 23.8 km^2 of vegetal cover depleted at annual rate of 1.49 km^2 whiles built-up growth rate was 0.58 km^2 per annum within the period. Figure 11.7 shows a visual representation of the land cover changes that occurred in the municipality between 1986 and 2002. The green, yellow, pink and blue areas represent the vegetation, built-up, bareland and water bodies, respectively, that existed in 1986. The red portion represents the areas that were converted to bareland. The larkspur blue and the quetzal green portions represent the expanded areas of built-up and vegetation, respectively.

Change Detection 2002 and 2021

Table 11.2 and Fig. 11.6 show that vegetation and built-up classes gained while bareland and water classes decreased between 2002 and 2021. Table 11.4 and Fig. 11.8 portray the changes in the indices of the classes and the resultant map between the years 2002 and 2021. Results of the image difference between 2002 and 2021 showed that the vegetal cover grew marginally by 2.1 km^2 (3.7%) but built-up expanded by 25.2 km^2 (44.5% increment) at annual growth rate of 1.32 km^2 per annum (Tables 11.2 and 11.4; Fig. 11.6). Bareland and water resources lost land masses of 27.3 and 0.1 km^2, respectively (Table 11.4). Despite the gains made by vegetal cover, its lost

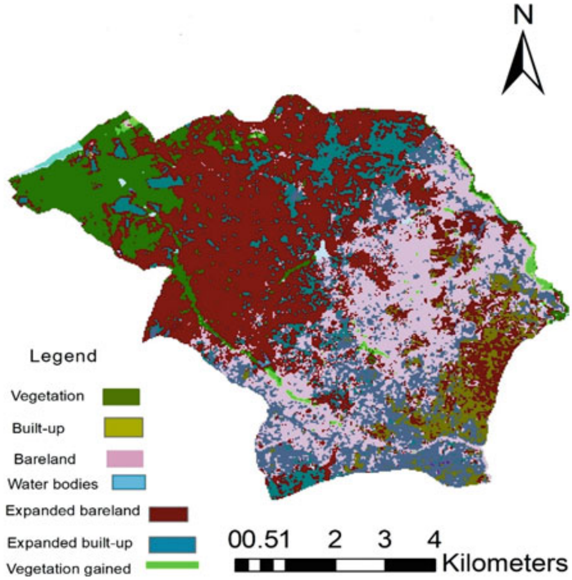

Fig. 11.7 Change detection between 1986 and 2002. *Source* Image differencing between 1986 and 2002 images

Table 11.3 Changes in LULC between 1986 and 2002

	Classes	1986 (km^2)			
		Vegetation	Bareland	Built-up	Water
2002 (km^2)	Vegetation	6.01	0.49	0.02	0.07
	Bareland	19.65	12.18	2.70	0.53
	Built-up	4.55	7.41	2.83	0.08
	Water	0.19	0.03	0.00	0.13
	Total changes	−23.82	9.32	14.93	−0.45

to built-up was still the greatest 2.6 km^2 as compared to 0.6 km^2 to bareland and 0.02 km^2 to water (Table 11.4).

Secondly, vegetative cover was the second dominant land cover (0.67 km^2) after bareland (2.25 km^2) that was transformed to built-up (Table 11.4). About 25.5 km^2 of

Table 11.4 Changes in LULC between 2002 and 2021

	Classes	2002 (km^2)			
		Vegetation	Bareland	Built-up	Water
2021 (km^2)	Vegetation	3.38	4.51	0.67	0.14
	Bareland	0.57	4.98	2.25	0.01
	Built-up	2.62	25.54	11.95	0.03
	Water	0.02	0.03	0.01	0.17
	Total changes	2.12	–27.26	25.28	–0.12

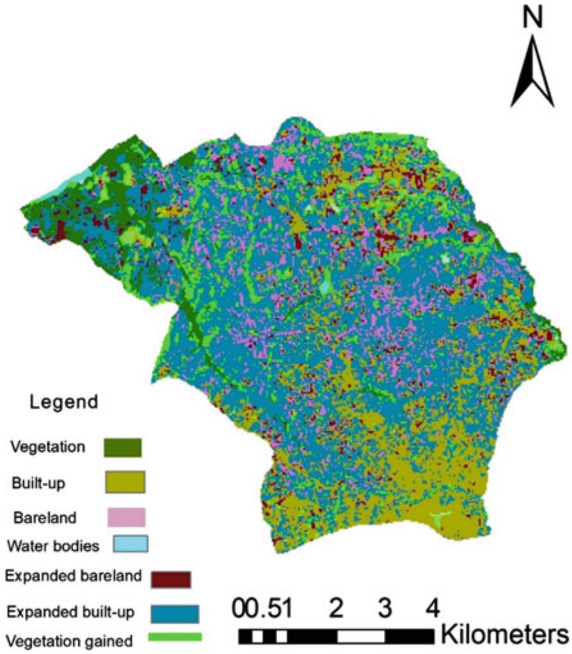

Fig. 11.8 Change detection between 2002 to 2021. *Source* Image differencing between 2002 and 2021

bareland was converted to built-up while 4.5 km^2 was to vegetal cover. These changes are represented visually on Fig. 11.7. About 3.38 km^2 of vegetation, 4.98 km^2 of bareland, 11.95 km^2 of built-up and 0.17 km^2 of water bodies remain unchanged between the period (Table 11.4). Bareland conversion was at 1.44 km^2 per annum during the period.

Change Detection 1986 and 2021

There were massive changes in LULC as displayed by Figs. 11.6 and 11.9 and change matrices in Table 11.5 between 1986 and 2021. Except built-up that increased in coverage throughout the period, other LULC classes diminished (Tables 11.2 and 11.5 and Fig. 11.6). Built-up increased by 34.6 km^2 signifying over 622% increment between the period. It derived a lot of conversions from vegetation 19 km^2 and bareland 16 km^2 classes (Table 11.5). Vegetative cover decreased dramatically by 21.7 km^2 within the 35 years span and almost 19 km^2 of the vegetal cover was changed into built-up and about 4.2 km^2 into bareland (Table 11.5). About 12.3 km^2 of bareland, as well as 0.6 km^2 of areas covered by water bodies were also changed to other LULC types particularly built-up. About 15.9 and 0.45 km^2 of bareland and water bodies were transformed to built-up (Table 11.5). The changes in LULC are depicted in Fig. 11.9. In all, 7.16 km^2 of vegetative cover, 2.9 km^2 of bareland, 4.82 km^2 of built-up and 0.12 km^2 of surface area of water bodies remained unconverted over the period (Table 11.5). The rate of transition of vegetal cover and bareland from 1986 to 2021 was 0.63 km^2 and 0.35 km^2 per annum, respectively, as against 0.99 km^2 growth in the built environment.

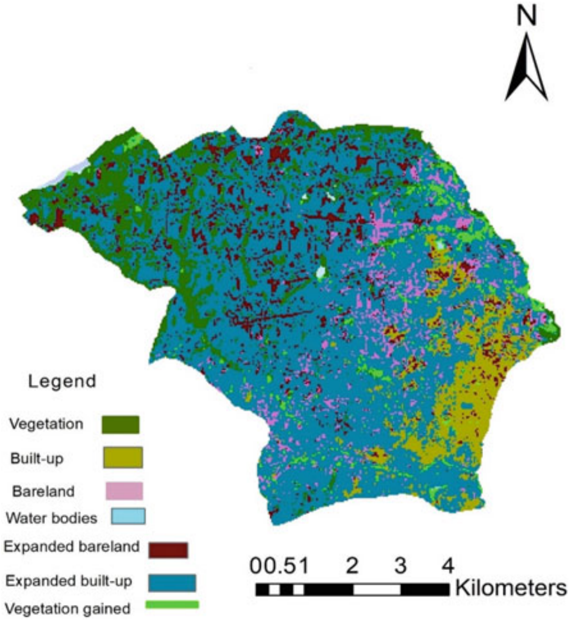

Fig. 11.9 Change detection between 1986 and 2021. *Source* Image differencing between 1986 and 2021

Table 11.5 Changes in LULC between 1986 and 2021

	Classes	1986 (km^2)			
		Vegetation	Bareland	Built-up	Water
2021 (km^2)	Vegetation	7.16	1.31	0.07	0.17
	Bareland	4.18	2.90	0.66	0.06
	Built-up	18.97	15.90	4.82	0.45
	Water	0.10	0.02	0.00	0.12
	Total changes	−21.7	−12.33	34.60	−0.57

Perception on the Causes and Effects of Landscape Transformation

Results of questionnaire analysis showed that more than 90% of the respondents affirmed that the municipality has gone through urban expansion and is mainly because of population increase due to in-migration. About 93% of the respondents stated that there has been a decrease in vegetative cover over the years. This is a comment on vegetal cover decline from a 57-year-old man who have stayed in the municipality for more than 30 years,

> Kasoa was not as we see it today. The area was occupied with abundant vegetation cover consisting of forest, shrubs, bushes and numerous farmlands with very few buildings that were dispersed within the various locality.

Results from the questionnaire analysis further revealed that the causes of devegetation included, human settlement development, construction of roads, parks and recreational facilities, animal grazing, increased demand for forest resources and the building of shops and offices for commercial purposes (Fig. 11.10). As demonstrated statistically by LULC classes and change matrices in Tables 11.2 and 11.5 and Fig. 11.6, the built environment expanded exponentially within the period which negatively impacted on the land cover of other classes. Trees were heavily logged to provide lumber for building and construction as well as farming leading to deforestation. Agricultural lands at the periphery and green spaces of gardens in the city centre have been converted to built-ups over the period. It was also reported that lots of herbs were harvested for herbal medicinal purposes. Livestock production in Ghana including cattle is pastured-based (Obese et al. 2013). This uncontrolled grazing system is associated with overgrazing which destroys vegetal cover and causes soil degradation. It was reported by some residents and confirmed by the municipal planning officer that cattle population and pastural activities have been on the increase over the years and this had also contributed to the degradation of the vegetative cover. Bushfires were also said to be another cause of the degradation of the vegetation. The bush is often set ablaze in the dry season to obtain fresh pasture or for game according to residents. A respondent in her account of the changes and causes of the vegetal and landscape transformation stated this:

> there was a pond around Opeikuma from which we used to fetch water, this has been reclaimed for the building of houses and shops.

All participants were of the view that the loss in vegetal cover have had an impact on their life and the environment. The impacts they enumerated included increase in urban heat, environmental degradation, decrease in farmlands, less amount of rainfall among others (Fig. 11.11). Most respondents (32.1%) perceived that there was increase in urban heat. A respondent shared this:

> We needed no fans in our rooms in the past but because of the heavy conversion of trees and other vegetative cover, there has been an increased in urban heat and one is compelled to use fans or air conditioner in the room now.

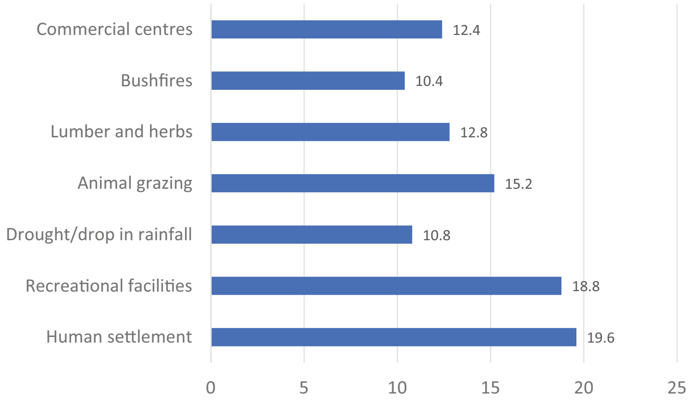

Fig. 11.10 Causes of depletion of vegetative cover

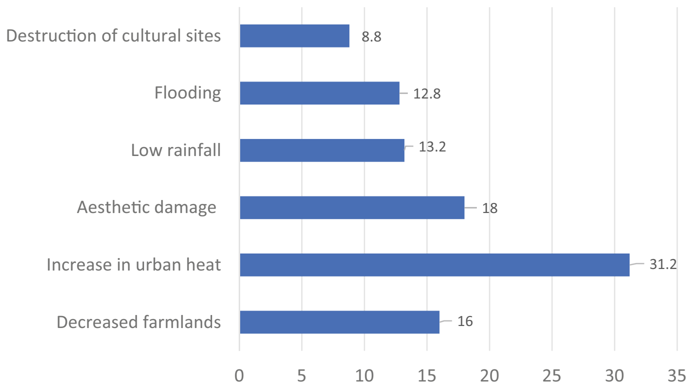

Fig. 11.11 Impacts of the decline in vegetative cover

Some respondents (18%) believed that the beauty and aesthetics that the vegetation provided to the municipality was no more owing to the disappearance of the vegetative cover (Fig. 11.11). Other respondents (13.2%) also complained that rainfall amounts have decreased and have become irregular over the years. These perceptions of respondents relate to the annual statistical data of rainfall and temperature of Accra between 1960 and 2011 from Ghana Metrological Agency. Though both the rainfall and temperature graphs in Fig. 11.12 depict fluctuating levels, the trendlines however show a rising pattern for temperature and a declining trend for rainfall. The trendline shows a drop in rainfall from about 900 mm in 1962 to below 800 mm in 2011 while temperatures have risen from 26 °C in 1960 to nearly 28 °C in 2011 (Fig. 11.12).

Flooding was another climatic impact of vegetal cover degradation noticed by about 13% of the respondents. It was explained during interviews that, though rainfall amounts are decreasing however, the development of properties close to the Okrudu

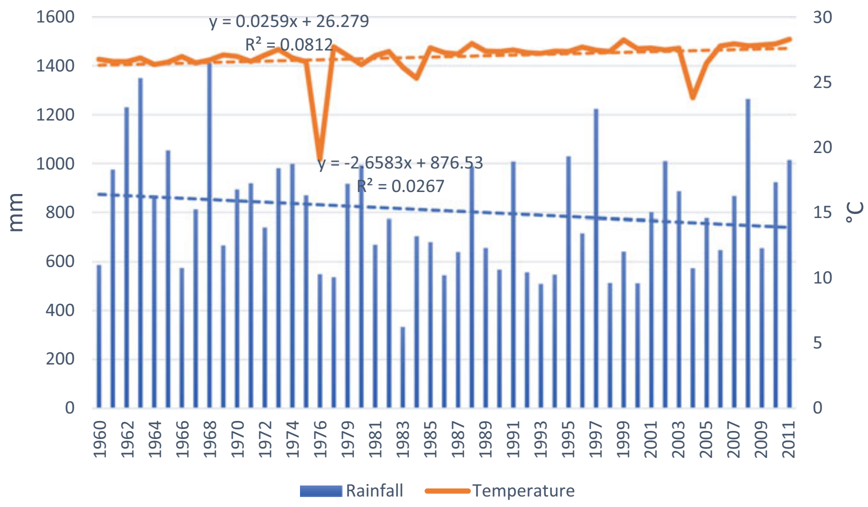

Fig. 11.12 Pattern of rainfall and temperature of Accra from 1960 to 2011

River, in water ways, floodable areas and poor waste management which causes solid waste to choke drains, have been causing floods in most localities of the municipality when it rains. This is backed by the report of Ghana Statistical Service survey which indicated that, the most widely used method of solid waste disposal in the municipality is burning and open disposal accounting for 43.4% (Ghana Statistical Service 2014). Some respondents constituting 8.8% stated that several sacred groves used as shrines have been transformed into built environments owing to urban sprawl, densification and compact building/infilling of physical developments (Fig. 11.11).

Discussion

Within 35 years, there have been significant transformations in the biophysical landscape of the locality. Built-up increased intensively and extensively at the expense of vegetation and bareland with water resources being the least affected. The rate of transformation of vegetal cover and bareland from 1986 to 2021 was 0.63 km^2 and 0.35 km^2 per annum, respectively, as against 0.99 km^2 growth in the built environment. This is because of the rapid increase in population of the Greater Accra Region resulting in a spillover effect on the municipality. Accra's population has increased from 491,817 in 1960 to 5.4 million in 2021 resulting in an increased in population density from 167 persons/km^2 in 1960 to 1678 persons/km^2 in 2021 (Ghana Statistical Service [GSS] 2013, 2021). This has caused a drift of people from Accra-Tema metropolitan areas to the Awutu Senya East Municipality and its environs for lands for housing among others. Consequently, the population of the municipality has also risen from 863 in 1970 to 131,721 in 2020 (GSS 2014; Yankson and Bertrand 2012).

According to GSS (2014), about 78% (84,579) of the population of the municipality are migrants from other parts of the country excluding Central Region and 28% (23,672) of them are from the Greater Accra Region alone. The resultant impact of the rising urbanisation and urban development is the grabbing of available lands for residential and commercial activities resulting in urban sprawl, depletion of vegetal cover and the conversion of other land cover types as portrayed by the 2002 and 2021 classified images. Similarly, a long-term observation by Hasan et al. (2022) suggested that urbanisation had propelled a decrease in green space and enhanced LST in an urbanised city in Bangladesh.

Though the forests were destroyed by other anthropogenic activities like logging and burning to clear land for agriculture or livestock grazing, these agricultural and grazing lands were later transitioned into urban space as revealed by the study. The four-year medium-term development plan of the municipality estimated the number of cattle being kept in the municipality between 2014 and 2017 to be about, 2,100 (Awutu Senya East Municipal Assembly 2017). The causes and nature of urban expansion that had led to the increase in urban sprawl and intensification/densification and the associated impact on vegetation and other components of the landscape in the Awutu Senya East Municipality is not very different from that of other peri-urban cities elsewhere in the world particularly in the developing countries as postulated by the urban densification/compact city concepts. Likewise, Siddique and Uddin (2022) found that area coverage such as forest cover, *agricultural land* and vegetation cover decreased from 68.34% in 1990 to 36.51% in 2020 in Chattogram city, Bangladesh. The decrease in the LULC was mainly due to the expansion of built-up areas which grew more than 600% over the period at the expense of other LULC types. There have also been some observations regarding the effects of urban sprawl and intensification (i.e. urban heat, loss of farmable lands, damage to urban aesthetics etc.) in literature. Some studies have shown that a reduction in urban green space have led to an increased in the land surface temperature (LST) and expansion in green spaces have resulted in minor decreases of LST of cities (Shin and Lee 2005; Hasan et al. 2022; Sun and Chen 2017; Yang et al. 2017). Also, according to Dong et al. (2022), significant decreasing trends of UGS coverage from 12.23 $\pm$ 0.32% in 2003 to 7.69 $\pm$ 0.22% in 2015 resulted in the decrease of the coverage of cooling spaces from 32.55 $\pm$ 0.76% in 2003 to 24.39 $\pm$ 0.60% in 2015.

However, urban green space is said to be increasing in coverage in some cities of China and Europe (Zhao et al. 2013). This is due to deliberate public policies on urban planning and development and urban greening constructions and development (Pauleit et al. 2005; Zhao et al. 2013) which is akin to the initiative of the municipality which saw an increase in vegetal cover from 6.6 to 8.7 km^2 between 2002 and 2021. According to the planning officer of the municipality, urban green policy under the auspices of the central government dabbed Green Ghana program which was adopted by the municipality and intensified in recent years has led to the greening of the municipality.

Limitations of the Study

From the social survey analysis, urban heat was one of the environmental concerns that emerged as the impacts of the declining cover of urban vegetative cover. It would have been prudent to do urban heat/land surface temperature analysis using remote sensing to validate the claims or perceptions of the respondents. However, this was impossible as there was not enough time to carry this analysis. This was an undergraduate dissertation which was time-bound, and amidst the COVID-19 pandemic, the academic calendar was restructured with a very shortened time framework for academic activities.

Conclusion and Recommendations

The study provides a quantitative assessment of urban sprawl and landscape transition of the locality using remote sensing analysis as well as a qualitative perspective on the socio-environmental impacts of these changes through a social survey technique. Increased in anthropogenic activities owing to rising population was found to relate to urban sprawl and intensification of the built environment causing a decrease in vegetal cover and bareland classes. Vegetation and bareland experienced greater transformations in their landscapes than water. Generally, vegetal cover dwindled between 1986 and 2021 from 53.5% of land mass coverage to 15.3% although it experienced a marginal regeneration of tree cover between 2002 and 2021. Bareland also experienced a fluctuating pattern with a net loss like vegetative cover. It increased from 35.4% in 1986 to 61.7% in 2002 and declined to 13.7% of total land mass in 2021. Built landscape however, assumed a rising trend throughout the period. It increased from 9.7% in 1986 to 26.1% in 2002 and to 70.6% in 2021. Water resources also declined throughout the period but the loss is negligible. Most conversions of vegetation in the municipality were into built-up and bareland. Built-up also gained lot of land conversions (16 km^2) from bareland. The transformation of vegetal and bareland covers into built-up has resulted in the massive urban sprawl of the locality between the period under study. Thus, the main driving force of the transformation of the vegetation and other LULC types in the area is urbanisation which caused an increase in the built-up environment. The perceived impacts of these changes by the people are destruction of urban aesthetics, increased in urban heat and flooding. The results of the study provide good information for urban planning in the Awutu Senya East Municipality which will be useful to policymakers, city authorities, the local people and other stakeholders in the municipality.

Urbanisation will continue within the peri-urban enclaves of Accra-Tema metropolitan areas for a while hence the need to adopt measures to curb the cascading impact of urban growth. Sustainable urban development polices on urban greening and the enforcement of land use plans need to be strictly adhered, to curb uncontrolled physical development/sprawling of the locality. Thus, besides National Green Ghana program, residents should be educated and encouraged to plant trees to increase the green space in the municipality to minimise urban heat and also increase the vegetative aesthetics of the locality. For instance, the central business area could be redeveloped into vertical structures to create space for parks and other green belt developments like city gardens. As observed by Pauleit et al. (2005) and Zhao et al. (2013), urban green space is said to be increasing in coverage in some cities of China and Europe due to deliberate public policies on urban planning and development and urban greening constructions and development. Such expansions in green spaces are likely to decrease LST of the locality as detected by Sun and Chen (2017). Lastly, it is recommended that similar studies in the locality should carry out land surface temperature analysis of the municipality to validate the perceptions on increasing urban heat/LST of the study area over the years.

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