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ENVIRONMENTAL CHANGE AND IMPORTANCE OF ENVIRONMENTAL EDUCATION

Ogochukwu, F. Igu
Departement of Vocational Education, Alex Ekwueme Federal University, Ndufu-Alike Ikwo

Nwabueze, I. Igu
Department of Geography and Meteorology, Nnamdi Azikiwe University, Awka

Abstract

Environmental change (land use change and climate change) impacts are growing in scale across tropical landscapes, yet, information on their dynamics and suitable awareness are poorly captured. This study focused on elucidating the dynamics of environmental change in Anambra east local government area, as well as the need for environmental education in managing the ecosystem. LANDSAT images for 1988, 2003 and 2018 were used to show the dynamics for the zone, its drivers and their varying temperatures. Land uses experienced dynamics over the study period; agricultural land use and forests recording the highest changes. Agricultural land use increased from 16.98 sq km to 142.62 sq km in 1988 and 2018, respectively, while forests shrunk from 183.05 sq km to 65.64 sq km in 1988 and 2018, respectively. Mean surface temperature of the zone equally increased from 29°C in 1988 to 35°C in 2018; thus showing how the regional climate could be affected by such impacts. The study showed the need to utilize education to address the environmental concern in the region. Adopting formal and informal methods of environmental education, creating awareness and developing feasible policies on conservation were advocated for addressing the climate change concern of the zone.

Keywords

Introduction

Forest ecosystems are undergoing changes across the globe and its biodiversity lost at alarming rates. This is much pronounced across tropical landscapes where an estimated 350 million hectares were lost to deforestation, while 500 million hectares were degraded last century (Lamb, Erskine, and Parrotta, 2005). Such trends have continued across much of the tropics and this have continuously affected its biogeochemical cycles as well as vast households whose livelihood depends on the ecosystems. The balance between what is needed or gotten from ecosystems and what their intactness should provide in terms of regulating and stabilizing the earth's processes (such as climate regulation and carbon sequestration) have remained a known science that is yet to be turned to reality and practiced. Much of tropical forest ecosystems have been modified and converted to other uses apart from forestry or wildlife. This is particularly pronounced across Africa where its abundant land is used for agricultural production (Schoneveld, 2014). Such have increased in scale among the land owners (who seem to be interested due to their quest for food production) and then among investors interested in agriculture, due to the low cost of land (rarely exceeding US$5 per annum; Schoneveld, 2013). As the demand for biofuels increased over the years, much of Africa's land have equally been devoted to crops used for producing biofuels as well as the cultivation of food especially sugar cane, oil palm and more lately, rice (Schoneveld, 2014). These have been planted on large scale; and by implication have taken over much forest lands which were cut down (deforested) to accommodate the agricultural lands.

Though what is being cultivated vary at regional and local scales, the extent of land being cultivated is generally on the increase. With the world population expected to double by 2050 (Tilman, Balzer, Hill, and Befort, 2011), more pressure on forest ecosystems are envisaged and needs concerted attention. As the need to feed more persons are growing in scale and more pressure on meeting the dietary needs of a vast population are mounting up, much forest locations and their surrounding landscapes will be expectedly lost at the same proportion. This is equally compounded by the awareness and quest to assume financial independence by a great part of the populace who are willing to sell off or lease forest lands, engage in exploitative lumbering (cutting of trees for sale) as well as degrading of forest and wetland ecosystems to get money. These will become more compounded by growing human population which will cause an unprecedented loss in biodiversity (Johnson, Balmford, Brook, Buettel, Galetti, Guangchun and Wilmshurst, 2017), worsen land tenure issues and make land management to be more complex (D'Amato, Catanzaro, Damery, Kittredge, and Ferrare, 2010; Igu, 2016).

Anomalies arising from such vast changes in the environment are responsible for both direct and indirect climate change impacts across the globe and require concerted actions. Climate change education is hence needed to provide the needed information on climate change to both direct users and stakeholders involved in ecosystem resource exploitation. The overall aim of such education is to create a civilized human being who takes care of himself and his culture, the earth and protecting possibilities for future generations (Salonen and Åhlberg 2012) by promoting sustainable use of the resources. Such knowledge is vital not only in promoting the need to manage environmental resources (such as forest resources, land and the varied ecosystem services of such landscapes), but also understanding the concept of climate change and how they are escalated by anthropogenic activities. Climate change concerns such as this have been ongoing for quite a long time with much hope on scientists and stakeholders o provide suitable guidelines for addressing such concerns. While some degree of success has been made, there is the need to broaden the discussion on the subject and address misconceptions on the subject. Addressing such concerns by engaging disciplinary, multidisciplinary and interdisciplinary perspectives (Ho and Seow, 2017) will likely enable better grasp, application, involvement and better communication to concerned parties. Such initiatives are much needed across Nigeria and south east region in particular so as to tackle the glaring menace of forest cover loss (and its consequent climate change impacts) holistically.

Based on the foregoing, this study focused on understanding the dynamics of environmental change in an agricultural region (where land use change and climate change is pronounced) and forthwith presents the need to promote environmental (climate) change education at such local scale. It furthermore, elucidated the current drivers and projected patterns of change in the landscape and provided highlights on the need to promote suitable awareness and how best to engage the local community in addressing such concerns.

Materials and methods

Study area

The study region is located within the humid tropics where mean annual rainfall varies between 1500mm to 22500mm. Temperature condition of the area is high with mean annual temperature range of 27^0 C to 28^0 C and a peak of about 35^0C between February and April (Monanu, 1975). It is characterized by a thick sequence of shale and sandstones formed in the Paleocene age. Soils that typify the zone are lithosol, juvenile soil, ferralitic soils and hydromorphic soils that formed under the dominant influence of the prevailing factors of geological formations of the study area (Ofomata, 1975). It is known for its fertile soils which are seen as the underlying factor for much of the agricultural activities that dominate the zone. Crops such as yam, rice, maize and legumes are produced in large quantities in the region. Rice production has dominated the zone for a long time and with the establishment of the Anambra-Imo River basin authority, it has received much impetus and greater output. Anambra east local government area is a land abundant zone used for agricultural activities over the years. Other activities aside agriculture such as trading and agro-allied industries has equally grown in magnitude across the zone.

Data collection

The medium resolution satellite data were downloaded from USGS Earth Explorer using the LANDSAT dataset module. The Thematic Mapper (TM) image was downloaded for 21st December, 1988. The Enhanced Thematic Mapper plus (ETM+) image was downloaded for 24th October, 2003 and the Operational Land Imager (OLI) for 28th December, 2018. The Landsat satellite data have 30m spatial resolutions, and the TM and ETM+ images have spectral range of 0.45-2.35 micrometer (µm) with bands 1 to 7 and 8 respectively, while the Operational Land Imager (OLI) extends to band 11.

Image Classification

For the Landsat TM, ETM+ and OLI, a False Colour Composite (FCC) operation was performed using the ArcGIS 10.4 software and the images were combined in the order of band 5, 4 and 1 for Landsat TM and ETM+ while that of Landsat OLI was in the order of band 6, 5 and 3 due to change in sensor. The images were then clipped to the boundary of Anambra east. A supervised classification scheme with the Maximum Likelihood Classification algorithm was used for the classification. The supervised classification was performed by creating a training sample, and based on spectral signature curve and visual interpretation. The following land-use classes were created: Water body, Farms and Sparse Vegetation, Built-up Areas, Bare Surface and Thick Vegetation.

Land Conversion Rate and Land Absorption Coefficient

Land Conversion Rate (L.C.R) is the measure of compactness which indicates a progressive spatial expansion of a city while Land Absorption Coefficient (L.A.C) is a measure of change in the consumption of new urban land by each unit increase in urban population (Paria and Bhatt, 2012).

The Land Conversion Rate (L.C.R) and Land Absorption Coefficient (L.A.C) were determined for the study area using the equations as shown below:

$$LCR = A/P \quad \text{------------------------------------} \; 1$$

where, A is the Areal extent of the study area in sq km

P is the Population

$$LAC = (A_2 - A_1)/(P_2 - P_1) \quad \text{------------------} \; 2$$

where, A1 and A2 are the areal extents for the early and later years, while P1 and P2 are their population, respectively.

The growth rate used for estimating the population of Anambra east LGA was determined to be 2.67%. The equation used is given as:

$$P_t = P_o \times 〖(1 + r/100)〗^{(t)} \quad \text{---} \; 3$$

Here, t = number of years; Pt= Population after 't' years; Po= Population at the start; r = the annual growth rate.

Land surface temperature

Land surface temperature of the zone for the three years: 1988, 2003 and 2018 were extracted from the Landsat remote sensing lab.gr site for the month of January or December of the previous year where the January data was unavailable. Mean temperature for 1988 was downloaded for 22nd January, that of 2003 was downloaded for 30th December and that of 2018 was downloaded for 1st January.

Future Projection

Markov Chain Analysis being a convenient tool for modelling land use change was employed for understanding the future patterns of land use change in the zone since its process allows the future state of a system to be modelled purely on the basis of the immediately preceding state. It describes land use change from one period to another and uses this as the basis to project future changes (Zubair, 2006). This was used to predict the land use land cover (LULC) situation in each LULC type for the year 2028 based on the 2003-2018 scenarios in Anambra east. The 10 (ten) year LULC projection for the future was done using Markov chain model incorporated in the IDRISI-SELVA software. The change between 2003 and 2018 was used as the basis for the prediction. The results were displayed in a table, and were converted to square kilometres from pixel count. This was done to enable easy discussion.

Results and discussion

Land use and land cover changed significantly over the years under review. These are presented in the following imageries:

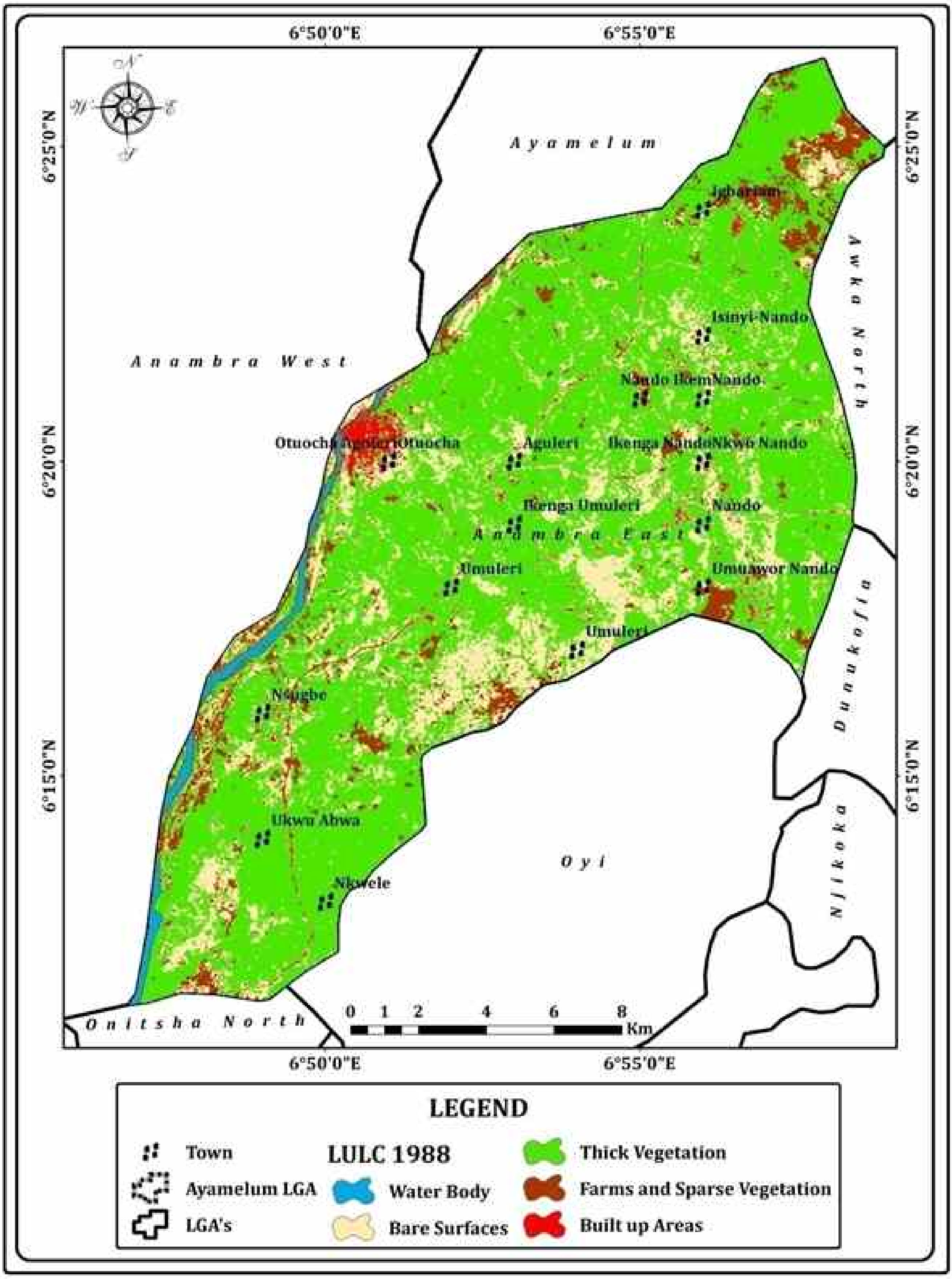

Fig 1 Land use and land cover change for 1988

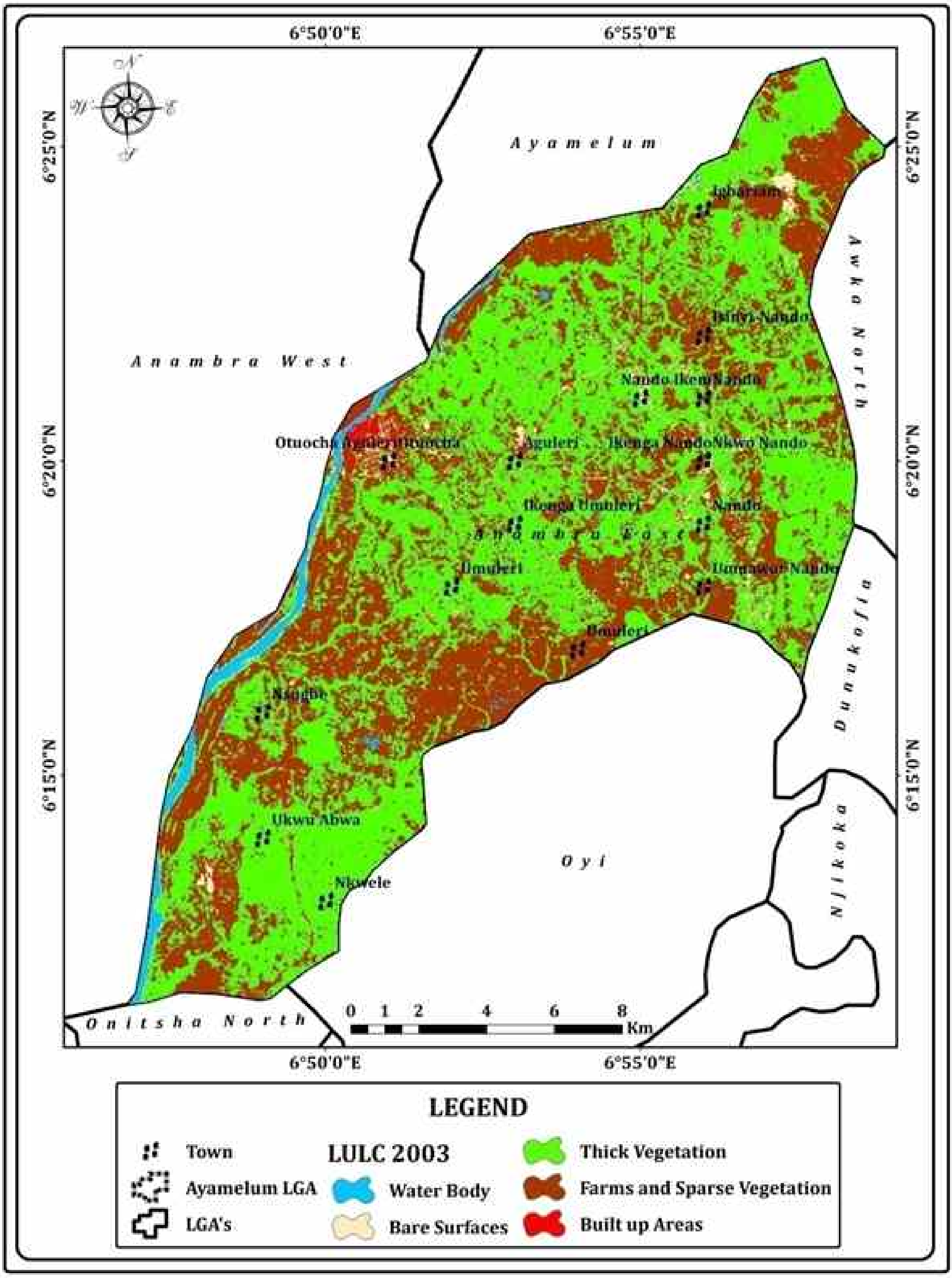

Fig 2 Land use and land cover change for 2003

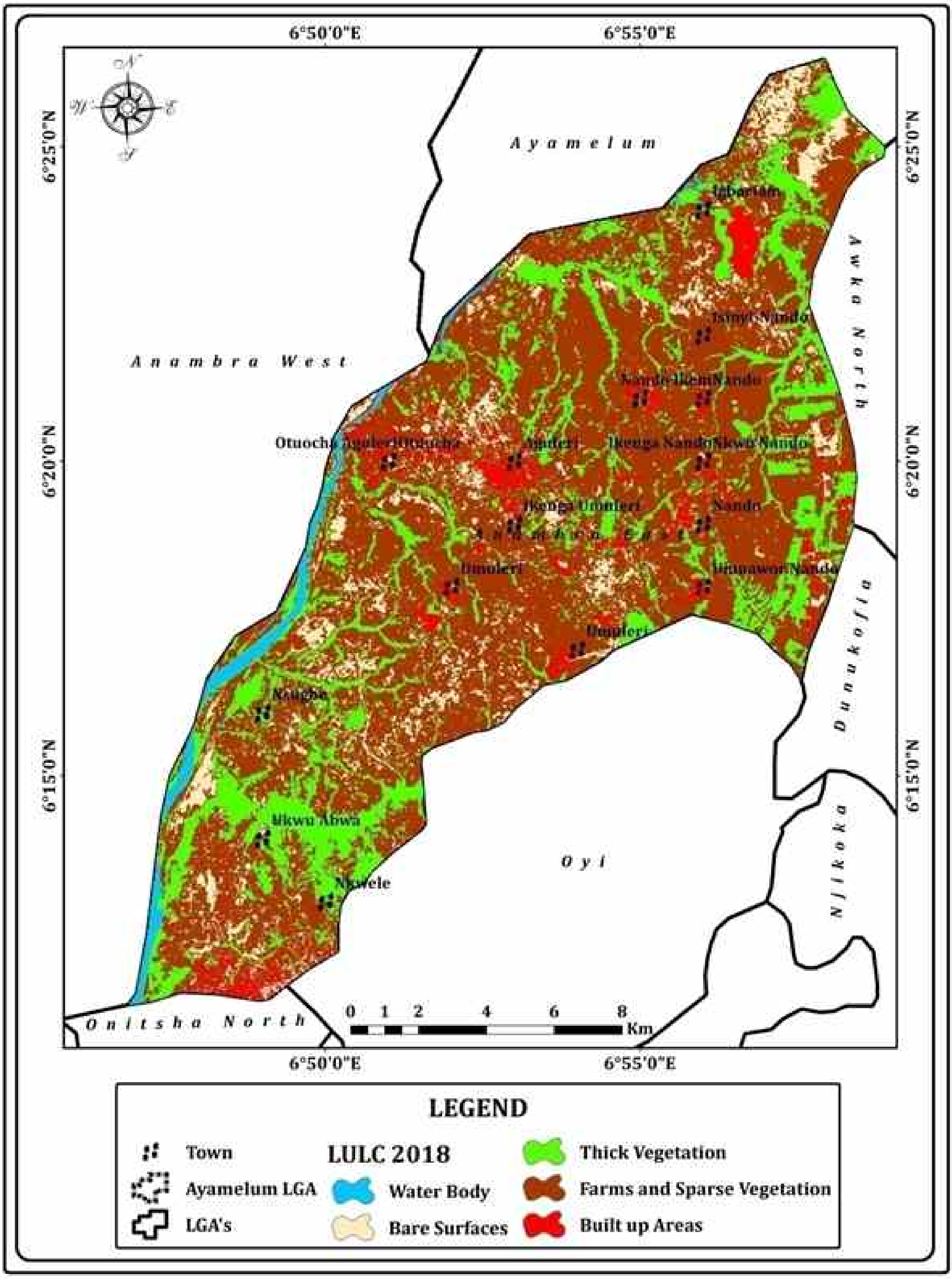

Fig 3 Land use and land cover change for 2018

A summary of all the changes encountered throughout the period is given in the table below:

Table 1 Total detection for land use and c over changes from 1988 – 2018

Category	1988-2003	2003-2018	1988-2018
Water body	1.34	0.2	1.53
Bare surface	-44.39	16.64	-27.75
Thick vegetation	-39.09	-78.32	-117.41
Farms and sparse vegetation	74.98	50.66	125.64
Built up areas	7.16	10.72	17.89

The study area experienced changes in its land use and cover within the study period. Thus, from the initial year (1988) till 2018, all the categories of land use and cover were not static (table 1). The changes were not so pronounced in for water body and bare surface, were average for built up areas, but quite glaring for thick vegetation (forests) and farms/sparse vegetation (agricultural landscapes). Built up areas experienced changes over the study period (though not significantly like thick forest and farmlands) and increased from 1988 to 2018 (fig 3-5). This meant that as the population of inhabitants increased in the zone, there was need to build up more housing units to accommodate the people. However, this cannot be compared to the housing pressure in urban and peri-urban centres where much change to built up areas takes only a short while. This further explains why the land conversion rate and land absorption coefficient as at 2018 were only 0.000116432 and 0.000218163, respectively (table 2).

Table 2 LCR and LAC for 2018

Land conversion rate (LCR)	0.000116432
Land absorption coefficient (LAC)	0.000218163

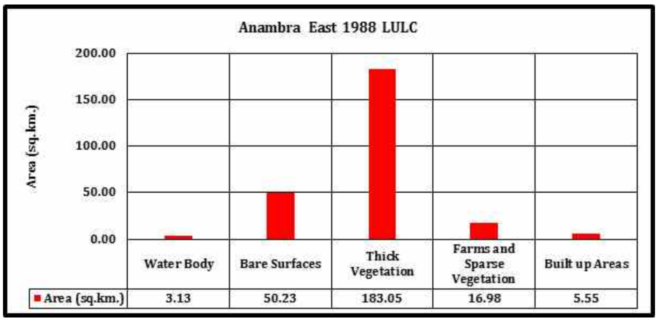

Fig 4 Extent of land occupied by the different land uses/cover for the year 1988

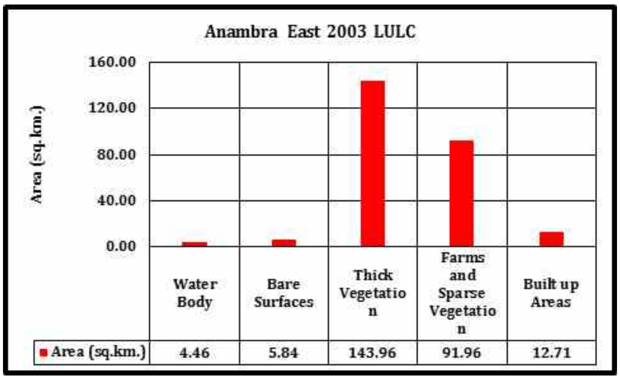

Fig 5 Extent of land occupied by the different land uses/cover for the year 2003

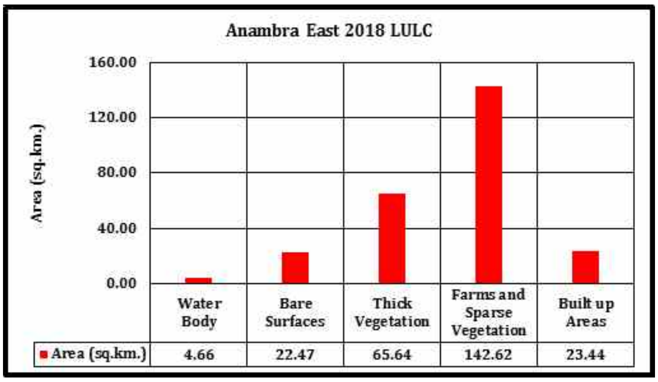

Fig 6 Extent of land occupied by the different land uses/cover for the year 2018

Much of the vegetation (forest landscapes) were lost (fig 1-3); up to 117.41 sq km (table 1). This meant that up to 117.41sq km of forest lands were displaced or taken over by other land uses/cover. Such loss in vegetation in the zone which was progressive from 1988 (1988- 2003; -39.09 sq km) to 2018 (2003-2018; -78.32 sq km) was the highest loss in land use/cover in the zone and shows the magnitude and extent of forest cover loss the zone experienced. Forest ecosystems are lost in such proportion across much of tropical landscapes due to different forcing and interests of the land owners. As more forest cover is lost over time in the zone, much of the biodiversity (especially the endemic ones) will become threatened or may even become extinct.

Even though tropical ecosystems contain the bulk of global biodiversity, this is only found in ca 10% of terrestrial land surface (Lewis, 2006). Hence, as biodiversity are lost at such small landscapes or local scales as in the study area, it adversely affects the totality of the species stock across the tropics.

Agriculture was seen to grow in scale within the study period and occupied much of the land (fig 1-3). Starting from 16.98sq km., it grew to 142.62sq km. in the base year (fig 4-6) and remained the leading land use/cover of the zone. Agricultural activities contributed much to the land use change in the region and indeed are reckoned as a major contributor to forest cover loss and degradation across most parts of the tropics (Enaruvbe and Atafo, 2014). Population increase was seen to contribute to the growth of agriculture in the zone. Built up area (an index of population growth) increased over the study period (fig 4-6) and was equally responsible for the loss of forest lands in the region. As is common with other tropical zones, increase in population would normally put pressure on the resources of a region; and in this case, the forest resources. As the world's population continues to grow and agricultural productivity increases simultaneously, there is need to design policies targeted at reducing the pressure put on forests as a result of the teeming population and their varied needs. Such guidelines will emphasize agricultural intensification instead of expansion as is normally practiced in many agricultural landscapes in the region.

Projected change in land use and cover (table 3) showed that agricultural activities/land use (farms and sparse vegetation) will probably constitute the bulk of land use/cover in the nearest future (up till 2028). Modifications in land use are ongoing processes that continue at different proportions across different spatial scales (local, regional and national), but needs to be given much attention as the years go by, so that environmental changes and its associated impacts could be within manageable limits.

Land surface temperature for the zone showed that the mean surface temperature rose from 29°C in 1988 to 35°C in 2018. Such increase in temperature evidently showed that climate variability is setting in across the zone due to the enormous loss of vegetal cover. This needs to be regulated by reserving some relics of forests, afforesting the zone and promoting measures that will reduce much pressure on the forests.

Table 3 Projected land uses and cover change for 2028, being the next 10 years from 2018

Given Class Below:	Probability of changing to in sq. km.				
	Water Body	Built up Areas	Bare Surface	Farms and Sparse Vegetation	Thick Vegetation
Water Body	0.32	0.36	0.34	3	3.14
Builtup Areas	0	19.58	2.9	4.36	0.15
Bare Surface	0.03	14.38	16.72	11.14	7.73
Farms and Sparse Vegetation	1.42	21.2	4.79	32.42	23.57
Thick Vegetation	0.06	13.18	8.04	20.75	30.96

Implications of environmental change and need for environmental education

Environmental change (land use change and climate change) increased in scale and will likely continue in future across the study region, hence the need to address it. Our environment is meant to provide varied ecosystem services: provisioning, regulating, supporting and cultural services, but in most tropical landscapes such as the study area, emphasis is put on the immediate benefits (provisioning services) and little or no thoughts on the role of the environment in regulation or support. With such perception, direct and indirect benefits (forest resources, land for agriculture, settlements and income accruing from land rent) are focused on solely and the consequences are bound to impact the environment (at times not immediately). As the coping mechanisms in the area are tampered, impacts associated with land use/cover change such as carbon emissions (due to forest loss and agricultural activities) and increased annual flooding (being a flood risk zone) will continue unabated in the zone. Increment in surface temperature will likely continue (even beyond 35°C reported for 2018) under such scenarios and could become a main index for climate variability if not addressed. Ensuring that the associated impacts of environmental change are known and quantified will be useful in designing coping mechanisms for the region.

Understanding the science, details and anomalies presented by environmental change are important steps to addressing its concerns. However, combining such insights with policies and awareness are needed strategies that must be adopted to effectively handle its growing impact. A good start will be to give proper orientation and education on the environment to people and stakeholders within the region. Teachers and students alike need to understand the concepts of environmental change and be able to translate it to reality. Workshops and seminars targeting tutors that teach environmental related courses, as well as other teachers, are advocated. Ensuring that the tutors have a good grasp and practical knowledge of the concepts will promote better transfer of knowledge to the pupils. Moving this beyond the classroom setting is equally important and key in achieving realistic goals of environmental change mitigation and adaptation. This will require organizing symposiums beyond the school environment and targeting household heads, community leaders and every forest user. Since these categories of people decide directly or indirectly how forests in communities are used, getting them to understand and accept that forests within their region are degrading and needs to be protected or used judiciously are vital strides to achieving the aim of reducing the associated impacts of environmental change.

Developing policies on effective forest management techniques and teaching the public such guidelines are highly needed. Such measures need to be effective, feasible and realistic within the zone. Since it is vital that such guidelines should be operational within the local context for its effectiveness to be ensured, engaging the stakeholders and community leaders in designing such measures is important. Adopting effective strategies which are being used in other regions such as climate-smart and conservation agricultural techniques (Thierfelder, Chivenge, Mupangwa, Rosenstock, Lamanna, and Eyre, 2017) and adapting them to the local context are to be much promoted. Climate-smart and conservation agriculture is focused on achieving: 'adaptation to climate change effects and increasing resilience, mitigating climate impacts by sequestering carbon, and increasing productivity and income sustainably'. To ensure that such will be achievable, maximum cooperation with community members should be facilitated. When that is ensured, managing current climate variability (or environmental change) of the region can be enhanced by engaging in agro-forestry techniques, setting aside some reasonable forest stock to enhance carbon sequestration.

Conclusion

Environmental change in the region was more pronounced through the land use/cover changes. Forest loss was seen to be much pronounced, while agricultural land use had much gain compared to other categories like built up areas, bare surfaces and water body, in decreasing order. As agriculture and need for land became more pronounced following population increase, much of the forests were lost; with negative consequences for environmental change such as increase in mean surface temperature. Promoting environmental education, awareness and adopting effective policies were seen to be essential in order to tackle the probable challenges of environmental change in the region.

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