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AN ASSESSMENT OF URBAN VEGETATION ABUNDANCE IN ACCRA METROPOLITAN AREA, GHANA: A GEOSPATIAL APPROACH

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Abstract

The essential role played by urban vegetation in making urban areas livable is often overlooked in many developing cities. This is the case of Ghana where its capital, Accra is developing at the expense of urban vegetation. This study was conducted at the metropolitan area of Accra to estimate how the extent of vegetation cover has changed in the period of 1986-2013, using remote sensing satellite data from Landsat TM and ETM+. Furthermore, views of key informants were assessed on changes in the livability of the city of Accra which may be attributed to loss of urban green vegetation in the city. It was found that between 1986 and 2013, 42.53 km^2 of vegetation was lost representing 64.6% of total vegetation in 1986. The rate of change in vegetation cover between 1986 and 1991 measured around 2.14% of the total land area annually. This however, reduced in the subsequent years measuring 0.26% between 2002 and 2008. Key informants interviewed, also believe that the loss of vegetation in the city creates livability concerns relating to ecosystem functioning, temperature rise and air quality. It is therefore recommended for urban planners and decision makers to address three critical concerns of resilience, sustainability and livability, which are the missing links in the city development agenda.

Keywords: remote sensing, GIS, Spectral Angle Mapper, urban vegetation, resilience, sustainability

INTRODUCTION

The role of vegetation in urban environment has become increasingly significant to planning managers and decision makers over the past few decades. This is mainly attributed to the rapid expansion of population and urban boundaries. Urban vegetation is an important pointer to urban sustainability, environmental conservation and urban planning processes of a city. Urban vegetation provides numerous benefits to urbanites living in these areas. It is therefore imperative to incorporate vegetation in the planning of urban landscapes. Whereas the developed world has a better understanding benefits of integrating urban vegetation and open space into the urban milieu for livability sake, emerging cities of Africa are rapidly expanding at the expense of urban vegetation. Williams et. al (2014) wrote on the topic "Our cities need more trees and water, not less, to stay livable". They acknowledged the new awareness on the part of government agencies of Australia for their quest for smarter city designs to curb boiling summers. Shirazi and Kazmi (2016) on the other hand wrote about the socio-environmental impacts of the loss of urban trees and vegetation in Lahore, Pakistan. They articulated the planning failure, which has led to loss of vegetation in the urban environment. They further reviewed public perception on loss of urban vegetation and open space and their implications for urbanites. This story is not different from other developing cities, including Accra, Ghana.

Ghana, like most developing countries, is undergoing rapid urbanization. Indeed, data published by the Ghana Statistical Service (GSS, 2002; 2012) indicated that the urban population increased from 23.1% in 1960 to 44% in 2000 and then to 50.9% in 2010. It was projected that the total population of Accra, the capital city will be more than doubled within the next decade (Owusu, 2013). Rapid urbanization is seen as an inevitable process which results from economic development and rapid population growth (Rimal, 2011). This places more pressure on existing urban structures including housing and transportation. Rapid urbanization, in many cases, lead to urban sprawl, which is known to convert vegetated lands to uncontrolled and unplanned residential and other urban land uses.

Ghana's development drive has focused on the exploitation of their natural environment for human betterment with less consideration for the associated negative environmental impacts, particularly on green environment and opened spaces, which in turn impacts human life negatively. The net effect is the emergence of large urban centers such as Accra with an economic landscape dominated by buying and selling on open streets and urban sprawl, which threatens the sustainability of the city. Whiles many authors have tried to articulate the impact of ongoing urbanization on urban sprawl, waste management and land use and cover change in Accra Metropolitan Area (AMA) (Owusu 2013; Adaku, 2014; Stow et al., 2011; Appiah et al., 2014; Attua and Fisher, 2010), it is still unclear as to how this has impacted on the abundance of vegetation in the city. Perhaps what will highlight the gravity of planning failure is to estimate how much vegetated areas have been converted to other uses and how much land is still under vegetation cover (vegetation abundance). This study seeks to address this gap by utilizing Geographic Information System (GIS) and remote sensing to estimate the extent of vegetation abundance by calculating land area under vegetation in 1986, which still remains vegetated in 2013 in AMA (from 1986 – 2013), and assess the implications for living in the city. The specific questions addressed in this study are:

1. How much land area of AMA was under green vegetation cover in 1986?
2. As of 2013, how much land cover remains under green vegetation cover?
3. What are the implications for vegetation cover loss?

THE NEED FOR URBAN VEGETATION

Researchers have different ways of categorizing urban vegetation. Some classify it as urban forest, parks and green spaces, gardens and lawns, wall or roof plants, and wetlands (Guntenspergen, 2010). Others identify it as roadside trees, greenbelts in streets, green areas in parks, grasslands and aquatic green spaces (Huang et al., 2012). More simply, some have divided urban vegetation into three types: relict (or remnant) i.e. natural communities retained as they were before urbanization weed communities occupying new urban habitats, and artificial green spaces (Ohsawa and Da, 2010). Another way of looking at urban vegetation is according to its three main types: natural plants, semi natural plants, and introduced plants. Natural plants are those that existed before city construction. The major component of semi natural vegetation in cities is the anthropochory community (comprising companion plants). This relies closely on anthropogenic (human) interference under urban habitats and plays a special role in composing urban vegetation, mainly grasses. Introduced plants can be categorized into roadside trees, urban forests, parks, gardens, street greenbelts, and so on. No matter which classification one chooses, urban vegetation plays an important role in supporting urban environment and the urban ecosystem functioning making it livable for the people. Some of the key roles of urban vegetation and for that matter the need for urban vegetation are discussed below:

1. *Urban Vegetation in Carbon Sequestration:* Carbon sequestration means capturing carbon dioxide (CO_2) from the atmosphere or capturing anthropogenic (human) CO_2 from large-scale stationary sources like power plants before it is released to the atmosphere. Once captured, the CO_2 gas is put into long-term storage (Pacala and Socolow, 2004). In photosynthesis, plants take in CO_2 and give off the oxygen (O_2) to the atmosphere as a waste gas. The plants retain and use the carbon to live and grow. When the plant withers or dies, part of the carbon from the plant is preserved (stored) in the soil.

2. *Urban Vegetation in Air Filtering*: Urban vegetation also increases air quality by removing and storing harmful airborne gases (Dwyer et al., 2014) and by physically trapping particles, such as dust from the atmosphere (Beckett et al., 2000). Plants help to clean the air of pollutants, such as particulate matter. The pores of leaves remove dangerous compounds, such as nitrogen oxide, sulphur dioxide, carbon monoxide, and ozone from the air. Nowak et. al., (2006) found that in the US, urban trees remove about 711,000 metric tonnes of air pollutants every year, which confers an estimated \$3.8 billion of economic value.

3. *Urban Vegetation in Reducing Heat*: Vegetation can reduce temperature or the heat island effect. The heat island effect is basically an area within the "urban environment that's a lot warmer than the rural area surrounding it" (National Geographic 2013). The excess heat is caused by impervious surface's ability to hold and radiate heat, as well as energy created by cars, public transit, buildings and people throughout the urban landscape. Increasing the amount of canopy cover would absorb heat from the environment, making it a much more comfortable and regulated climate to live in.

4. *Urban Vegetation in Recreational and beautification function*: Urban vegetation also provides a social value to the urban landscape. The aesthetic value of vegetation can enhance residents' satisfaction, attachment and sense of responsibility, thereby, improving their overall well-being (Groenewegen et al., 2015). Urban greenery is often the host of many outdoor leisure activities for urbanites and can also provide opportunities for education and encourage physical activity. Access to urban green spaces is usually free to all, which is why they promote social inclusion and provide opportunities for social interaction (Swanwick et al., 2013).

5. *Urban Vegetation in Microclimate and ecosystem stability*: Ecologically, vegetation plays extremely important roles in reducing storm water runoff, acting as an absorbent for pollutants, microclimate regulation (Harlan et al., 2006; Jenerette et al., 2007) and reducing temperatures within cities. According to De Groot et. al. (2002), vegetation may also retain and store water; this allows for natural drainage which reduces surface runoff and, therefore, reduces the risk of flooding in urban areas. Another benefit of vegetation in an urban environment is that it provides habitat for wild life and, therefore, can help maintain and enhance biological and genetic diversity (Attwell, 2000). People with better access to urban parks live longer (Mitchell and Popham, 2008), exercise more (Bai et. al. 2013; Thompson 2013), have better social cohesion (Kazmierczak, 2013), and report better health generally (van Dillen et al., 2012)

STUDY AREA

This study was conducted in the AMA, Ghana. AMA is bounded by the Gulf of Guinea in the south, by the University of Ghana in the north, by Tema Township in the east and by Korle Lagoon in the west. Figure 1 shows the map of the study area.

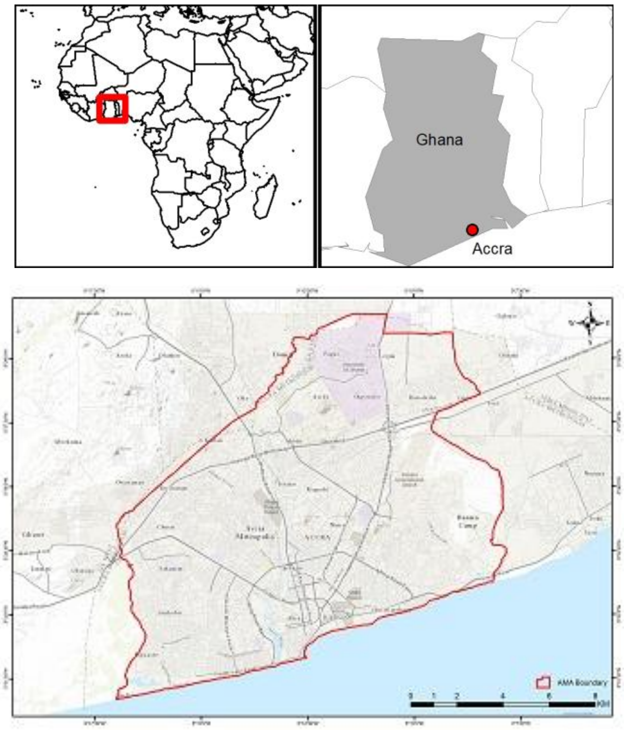

Fig. 1 Location of the study area – Accra Metropolitan Area

The total built-up area is about 25 km east to west and about 12 km north to south (Owusu and Asante, 2013). Topography is generally low-lying and undulating in some areas. The higher elevation parts are about 240 meters above sea level. The rest of the area is about 60 meters above sea level. The drainage catchment area extends from the eastern boundary of the Nyanyanu river catchment on the west of Greater Accra regional boundary to river Laloi, east of Tema Municipal Area. The AMA is the most urbanized district in the Greater Accra Region. It has an estimated population of 1,848,614 of which 887,673(48.02%) are males and 960,941(51.98%) females in 2010 (Ghana Statistical Service, 2012). It also has the highest literacy rate of 85.1%. Over 68% of the population aged 15 years or older is economically active. A lot of commercial activities are concentrated within the AMA with almost all major businesses in Ghana having their headquarters located there. The daily influx of people from dormitory towns makes the daytime population figures far higher than the domicile population estimate.

AMA lies in the coastal savannah agro-ecological zone. There are two rainy seasons. The average annual rainfall is about 730mm, which falls primarily during the two rainy seasons. The first begins in May and ends in mid-July. The second season begins in mid-August and ends in October (AMA, 2013). There is little variation in temperature throughout the year. The recorded average temperature in the coolest month (August) is 24.7oC and the hottest month (March) is 28^{o}C. Due to the area's proximity to the equator, it practically experiences a uniform temperature all year round. Relative humility is very high. It ranges from the daily minimum of 65% during mid-day to as high as 95% during the night. The local wind direction is predominantly West-South-West to North-North-East. Wind speed normally ranges between 8-16 km/hr. There are evidence suggesting that the present vegetation found around the metropolitan area have been altered and could possibly be attributed to both climate and anthropogenic factors. Much of the area is believed to have been covered by dense forest, which remnants could still be found surviving within the area (AMA 2015). There is very little variation in temperature throughout the year. The mean monthly temperature ranges from 24.7°C in August (the coolest) to 28°C in March (the hottest) with annual average of 26.8°C. As the area is close to the equator, the daylight hours are practically uniform throughout the year. Relative humidity is generally high varying from 65% in the mid-afternoon to 95% at night. The predominant wind direction in Accra is from the WSW to NNE sectors. Wind speeds normally range between 8 to 16 km/hr. High wind gusts usually occur with thunderstorm activity. There is evidence to suggest the vegetation of the metropolitan area has been altered in the more recent past century by climatic and other factors. Much of the metropolitan area was believed to have been covered by dense forest of which only a few remnant trees survive (AMA, 2015).

Climate factors, combined with the topography and human activities, particularly cultivation, have imposed new vegetation structure similar to those of the southern Sahel, Sudan and Guinea Savannas north of the Accra plains. The vegetation of the study area can be grouped into three (3) broad zones; comprising of the shrub land, grassland and the coastal lands. The shrub lands occur commonly around the Western outskirts and the northern slopes towards Aburi Hills. It has dense clusters of short trees and shrubs, with an average height of around 5 meters. The grasslands are a mixture of grass species similar to those found in the undergrowths of forests. They are very short, barely exceeds 1 meter above ground. Ground herbs are found on the edge of the shrub. They include species, which normally flourish after fire.

The coastal zone comprises two vegetation types, wetland and dunes. The coastal wetland zone is highly productive and an important habitat for marine and terrestrial-mainly bird life. Mangroves, comprising two dominant species, are found in the tidal zone of all estuaries sand lagoons. Salt tolerant grass species cover substantial low-lying areas surrounding the lagoons. These grasslands have an important primary production role in providing nutrients for prawns and juvenile fish in the lagoon systems. In recent times, wetlands are however being encroached upon (AMA, 2015). The dune lands have been formed by a combination of wave action and wind. They are most unstable but stretch back several hundred meters in places. There are several shrub and grassland species, which grow and play an important role in stabilizing dunes. Coconuts and palms grow well in this zone, providing protection and an economic crop. Most of the coconuts were planted in the 1920s but it is estimated that over 80% of those plantations have disappeared as a result of felling, disease and coastal erosion. The loss of these trees is one of the principal reasons for the severity of erosion in some areas.

METHODS

Assessment of urban vegetation abundance and change using remote sensing

There are diverse methods for assessing urban vegetation. The earliest method for urban vegetation investigation was manual statistics within a city boundary (Francis, 1987). The investigation results were usually shown by a total index or distribution indices in terms of a whole city or neighbourhood of the city, respectively. Obviously, this method is quite inefficient, imprecise, and time consuming. With the advancement in technology, urban vegetation can now be monitored, mapped and analyzed using remote sensing and GIS techniques. Some commonly used remote sensing techniques in urban vegetation analysis include Normalized Differenced Vegetation Index (NDVI), vegetation cover change detection, land cover classification (Villa et al., 2012; Rahman et al., 2011; Li et al., 2011). Satellite remote sensing is undoubtedly, one of the most effective tools for monitoring vegetation cover and change because it can guarantee the availability of extensive datasets of large spatial (up to global coverage) and temporal (back to the 1970s) coverage. Landsat TM or ETM+ data are the most popular satellite remote sensing data sources on an urban scale (Villa et al., 2012). In a study by Rahman et al. (2011), the pattern and nature of the interrelationship between urban sprawl and urban vegetation loss in Dhaka, Bangladesh was shown using NDVI analysis. Another study by Li et al. (2011) indicates vegetation change trends based on regression model by fitting simple linear regression through the time series of the integrated NDVI in the growing season for each pixel and calculating the slopes.

This study used Landsat TM and ETM+ data and applied spectral angle mapper algorithm (Table 1) to assess the urban vegetation abundance in AMA.

Table 1 Landsat Satellite Images used for the study

Satellite	Image acquisition Date	Spatial Resolution	Path/row
Landsat 5 Thematic Mapper (TM)	December 1986	30 m	196/ 053
Landsat 5 Thematic Mapper (TM)	January 1991	30 m	196/ 053
Landsat 7 Enhance Thematic Mapper (ETM+)	December 2002	30 m	196/ 053
Landsat 7 Enhance Thematic Mapper (ETM+)	February 2008	30 m	196/ 053
Landsat 7 Enhance Thematic Mapper (ETM+)	December 2013	30 m	196/ 053

Data source and preparation

The images used in this study were Landsat 5 Thematic Mapper (TM) images, and Landsat 7 Enhance Thematic Mapper (ETM+) Images. Table 1 shows details of image data acquired for the study. The images were downloaded from United States Geological Survey (USGS) web page.

The Landsat calibration converts Landsat TM, and ETM+ digital numbers to spectral radiance or exoatmospheric reflectance (reflectance above the atmosphere) using published post-launch gain and offset values (Landsat Calibration Manual) (Chander et al., 2004; Micijevic, 2016). The Landsat Standard Calibration was followed. The resultant image was imported into FLAASH for atmospheric correction. Using Envi 5.3 software (ITT Visual Information Solutions, 2009); and spatially referenced before sub-setted to AMA boundary.

Image processing and analysis

The digital image processing method used in this study is classified as a supervised classification algorithm called Spectral Angle Mapper (SAM). The SAM algorithm is based on the assumption that, a single pixel in an image selected represents a single ground cover material (pure pixel), and can be uniquely assigned to only one feature class (provide end member spectra). The SAM algorithm is calculated based on the spectral similarity between two spectra. The spectral similarity can be obtained by considering each spectrum as a vector against the total number of bands. The SAM algorithm determines the spectral similarity between two spectra by calculating (Equation 1) the angle between the two spectra, treating them as vectors in a space with dimensionality equal to the number of bands (Rowan and Mars, 2003; Kruse et al., 1993; Van der Meer et al., 1997). Smaller angles between referenced and observed end member spectrum indicate a closer match to the referenced spectrum, whilst a wider angle indicates great difference between referenced and observed spectrum. Pixels further away than the specified maximum angle threshold in radiance are not classified. This technique, when used on calibrated reflectance data, is relatively insensitive to illumination and albedo effects. Equation 1 shows the calculation that the SAM algorithm (Kruse et al., 1993):

$$a = \cos^{-1}\left(\frac{\sum_{i=1}^{nb} t_i r_i}{\sqrt{\sum_{i=1}^{nb} t_i^2}\sqrt{\sum_{i=1}^{nb} r_i^2}}\right) \quad \text{(Eq. 1)}$$

SAM is a physically-based spectral classification that uses an n-D angle to match pixels to reference spectra. End member spectra used by SAM can come from ASCII files or spectral libraries, or one can extract them directly from an image (in-scene spectra). In this study, in-scene spectrum from pure pixel was used. This means that the in-scene spectra were matched with each pixel and the SAM algorithm classified each pixel based on its similarity to the end member spectrum used. Figure 2 shows the workflow of the study methodology and technical approach.

Change Mask

The change mask was built in this study to show locations that were vegetated from the base year and remains vegetated at the end of the study period. It is important to note that some locations change from vegetated surface to build (cleared) and change back to vegetation. In such situations all those areas were considered built hence the building of a change mask for extraction of locations that have remained vegetated from beginning till the end. The change analysis was built in ArcGIS environment using raster calculator tool under the spatial analyst menu.

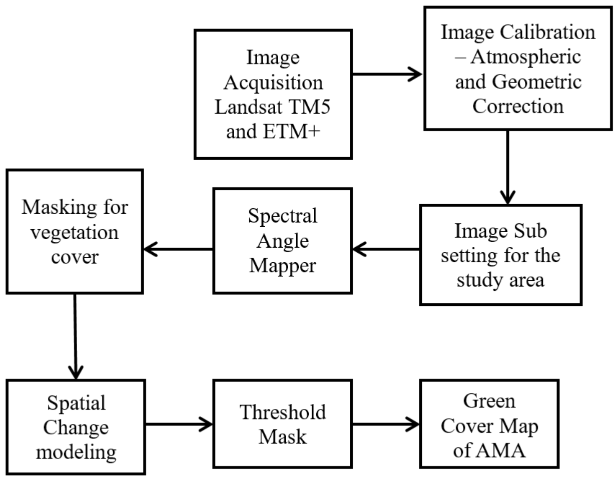

Fig. 2 Flow chart of workflow of data processing and analysis

Using the vegetation abundance image generated with SAM the change was modeled by spatial analysis. First the base year image was reclassified into vegetated and nonvegetated using Boolean classifier. Base year was 1986 (SAM1) reclassify into 1 and 0. The second year 1991 (SAM2) was also reclassified into 10 and 0 vegetated and non-vegetated, the third years (SAM3) also reclassified to 100 and 0, the fourth year (SAM3) reclassified to 1000 and 0 and the final years (SAM5) reclassified to 10000 and 0. The final change modeling was as follows:

SAM1+SAM2+SAM3+SAM4+SAM5 (Eq. 2)

The output generated were pixels with values classified as follows: 1; 0; 10; 11; 000; 100; 101; 111; 1010; 1000; 1111; 0000 etc. The position of the zero (0) indicates whether the location has changed from being vegetated at the beginning or which year it was converted from vegetation and the position of one (1) indicates when it became vegetated or has remain vegetated from the beginning (Fig. 3).

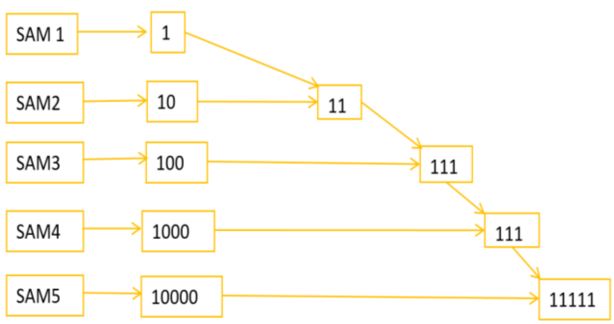

Fig. 4 The spatial modeling for identifying pixels that remained vegetated (1986-2013)

The final map for the periods were overlaid with towns and major road networks of the city which was validated with field visit to 20 selected locations. The field visit was to provide some form of accuracy assessment and we also used existing high resolution image (mainly historical) to support the validation and we found that the analysis achieved 90% accuracy.

Key informants' perception on livability of the city

The study sought the views of the general public on livability of the city of Accra, which may relate to the loss of urban vegetation. In all, 50 key informants were contacted using snowballing method for selection within five communities. The communities include East Legon, Abeka, Achimota, Cantonments and Osu. The criteria for selection include living in Accra for a minimum of 35 years, being of sound mind and willingness to express your view and also being recommended by another key informant. The selection process began with a representative of the District Assembly of the community (known as the Assemblyman or Assemblywoman), who recommends the respondent and once interview is completed, a respondent is asked to recommend the next suitable candidate. Table 2 shows the composition of respondents and their communities.

Table 2 Key informants and their respective communities of residence

Community	Male	Female	Total respondents
East Legon	8	2	10
Abeka	6	4	10
Achimota	5	5	10
Cantonments	6	4	10
Osu	7	3	10

Although the key informant interviews were male dominated, we do not think sex composition necessarily changed the outcome of the study. Structured questions relating to livability were asked in local Akan language and the responses were both recorded and written down for analysis and latter interpreted qualitatively.

RESULTS

Green areas (vegetated areas) covered about 38.01% of the total land area of AMA in 1986 (Fig. 4). This was reduced to 25.15% in 1991, representing 12.85% reduction in green areas. By 2002, the total green areas left were 17.18% and were subsequently reduced to 15.39 in 2008. It is important to note that the period 1991 and 2002 was 11 years instead of the regular 6 years used for all other period. This was due to unavailability of

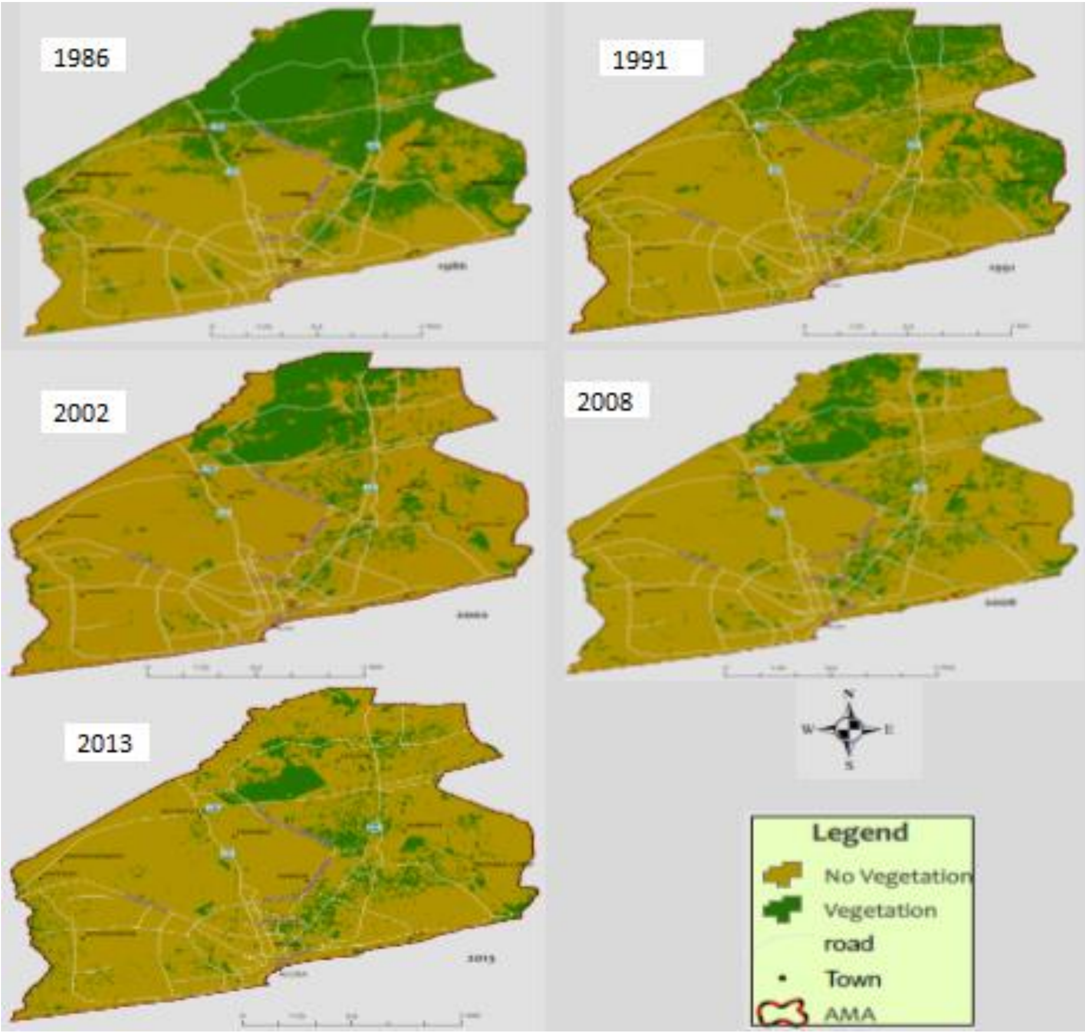

Fig. 4 Green Areas of AMA for 1986, 1991, 2002, 2008 and 2013

usable Landsat images within the required interval. As of the ending year 2013, AMA had only 13.45% of its total land area of 173km^2 left covered with greens. Figure 4, contains five images of 1986, 1991, 2002, 2008 and 2013. The images show land area covered by vegetation within and by the end of the study period. The study used change modeling to estimate areas considered as never changed. This is because there were areas that started as vegetation cover and changed to bare surface and later become vegetation again.

Figure 5 shows green cover statistics that represents never changed from green areas. It is important to differentiate between green cover areas and never changed areas since there are places or locations that changed several times. In 1986, 20.25% of the area was considered green areas or vegetated areas. This decreased to 13.36% in 1991 (within 6 years) and then further decreased to 6.37% by 2002, i.e. a period of 11 years. The vegetated areas further reduced to 6.20% 2008, although it seems like a very small margin over a period of 6 years. By the end of the study period of 2013, only 4.84% of the total land area remained vegetated, which are the areas that have never changed from being vegetated since 1986.

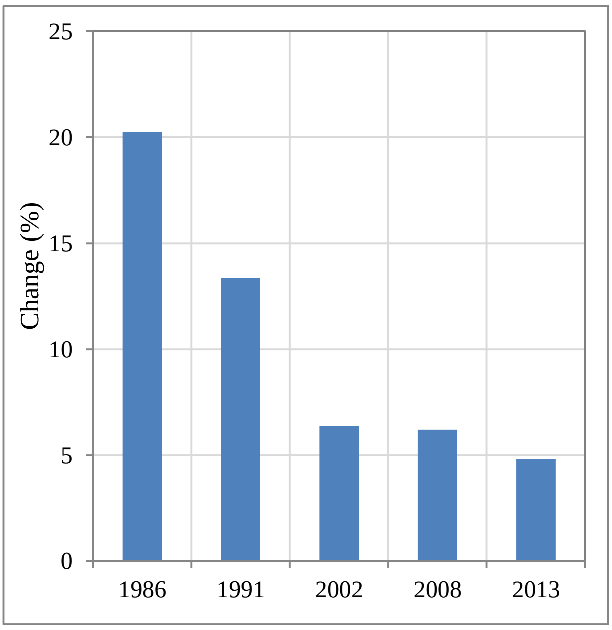

Fig. 5 Green Cover Statistics of AMA between 1986 and 2013: Extent of green cover (%) compared to the whole study area

The rate at which green cover reduced in AMA between 1986 and 1991 was shown in Figure 6. It decreased by about 2.1% per annum and reached the peak around the year 2000. By the year 2001, the vegetation of the area had reached the lowest of the times such that roughly about 6.37% of the land was left under vegetation.

Between 2002 and 2008 the rate of vegetation reduction was close to negligible. It was as low as 0.2% which suggests that there were very little open green lands to be converted to other urban land uses. The rate of vegetation reduction in 2008 and 2013 shows that there was as low conversion as 0.03 which implies no conversion of any more lands. On the ground, what was observed was infillings, which are minor conversions within existing residential and commercial areas mostly by investment capitals and external forces. Moreover, more vertical growth was observed as more high-rise buildings began emerging in the city center and emerging business enclaves.

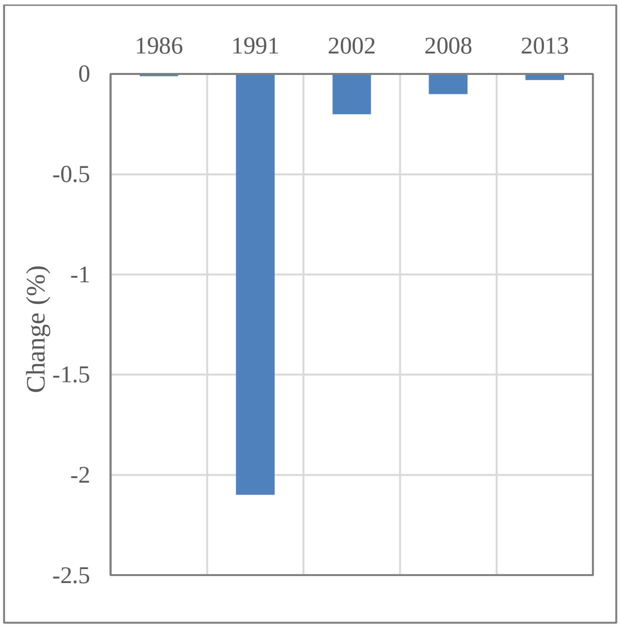

Fig. 6 Rate of green cover change (%) between 1986 and 2013

DISCUSSION AND CONCLUSION

This study was conducted with the aim of assessing vegetation abundance and change from 1986 to 2013. The data analysis shows that AMA has lost almost all the vegetation cover, leaving just about 4%. Greater part of the vegetation loss occurred between 1986 and 2002. Interestingly this period coincides with the period when Ghana embarked on Economic Recovery Program (ERP) and its associated trade liberalization which many people believe was the catalyst for Ghana's urbanization and vegetation loss. This period was characterized by conversion of green spaces, including farmland into urban uses – residential and commercial.

Localities of green cover in AMA as of 2013 include the Achimota forest reserve area (a large patch of green in the northern part of the image in Figure 4, 2013) and areas along water bodies in the metropolis. The study also shows that, areas such as Cantonments, Ridge and Legon still have some vegetation although it has reduced dramatically from the base year of 1986.

This large scale conversion of urban green spaces into other urban land uses, including paved surfaces have significant implications for the livability of Accra, which could be best explained by its residents. The study therefore dwells strongly on the opinions expressed by the key informants on the livability of the city. The key livability concerns they expressed include the rising heat, the frequency and severity of floods and air pollution. Others include concerns about the observed reduction in the rainy days, though they said they have observed increase in the intensity of rains. Even though these are views expressed by some 50 residents during field data collection, it is difficult to relegate local observations to the background. This is because they live with the problem. Also the livability concerns they expressed concur with views expressed in other studies from countries that have experienced similar conversion of urban vegetation (Gairola and Noresah, 2010; Shirazi and Kazmi, 2016). Shirazi and Kazmi (2016) wrote about the socio-environmental impacts of the loss of urban trees and vegetation in Lahore, Pakistan. Their study reviewed public perception and the story is similar to key informant's views from Accra, Ghana.

This study recommends that for AMA to address problems relating to loss of vegetation and city's livability, there is the need to take a second look at the development plans implemented. There is the need for a shift in the city's development paradigm to address what David Maddox calls the city we want, which in his view must address three major challenges, including city's resilience, sustainability and livability (Maddox, 2013). Whereas these three themes of city resilience, sustainability and livability have been in the past development agenda of the AMA, they have been pursued individually. The past three decades saw sustainable development as the order of the decade. This shifted to building resilient cities and we are now talking of livable cities. There is the need for better understanding that sustainability can be achieved without resilience and livability, even though they may seem implicit. Being a resilient city does not necessarily guarantee sustainability and livability. It is therefore important for the city of Accra to think smart and look at the city's development from these three perspectives – resilience, sustainability and livability. These will include building with the environment and living with the environment, including greens and open space management. However, AMA's biggest challenge, in achieving these recommendations including the fact that it is a resource-poor city with limited human and financial resources; lack of control over land and its development and above all favoritism and nepotism, and these have prevented effective enforcement of city bylaws and development plans to the latter.

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