SN Soc Sci (2021) 1:212
https://doi.org/10.1007/s43545-021-00218-2

ORIGINAL PAPER

Exploring the effects of rapid urbanization on wetlands: insights from the Greater Accra Metropolitan Area, Ghana

George Kofi Danso[1] · Stephen Appiah Takyi[1] · Owusu Amponsah[1] · Ata Senior Yeboah[1] · Rexford Osei Owusu[1]

Received: 23 February 2021 / Accepted: 21 July 2021 / Published online: 20 August 2021

Abstract

Wetlands are important ecological resources that provide immense socioeconomic and ecological services. Despite these services, their sustainability, especially in the cities in the Global South, is undermined by anthropogenic activities such as farming, sand and salt winning, among others. The region's rapid urbanization is expected to exacerbate the threats. However, in the Ghanaian context, only few studies have explored the effects of rapid urbanization on the availability and sustainability of this important environmental resource. To address this research vacuum, the present study employed mixed-methods to explore the effects of urbanization on the wetland ecosystem in the Greater Accra Metropolitan Area (GAMA) of Ghana. There results indicate a negative statistical association between rapid urbanization and the availability of wetlands in GAMA. Additionally, the results of the study have shown that land-use activities along wetlands undermine the quality and sustainability of this environmental resource. Given this context, the study recommends that the appropriate institutional regimes (such as the Environmental Protection Agency, Town and Country Planning Department and Accra Metropolitan Assembly) institute strict buffer restrictions along these wetlands to mitigate human encroachment as well as intensify awareness campaigns to expose people to the values and benefits of this important ecosystem.

Keywords Urbanization · Wetlands · Sustainability · Ecosystem · Accra · Ghana

✉ Ata Senior Yeboah
ata.yeboah63@gmail.com

[1] Department of Planning, Faculty of Art and Built Environment, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana

Introduction

The world is rapidly urbanizing. Approximately half of the world's population live in urban areas (Agarwal et al. 2007; Dallimer et al. 2011; Park and Peterson 2010; Thomas 2008; United Nations Human Settlements Programme 2011; Woltjer 2014). As evidence suggests, rapid urbanization has widespread effects on the natural environment and on the livelihoods of people living in urban peripheries (Takyi 2016a, b; Aberra and King 2005; Torrey 2004; Pauchard et al. 2006; Oduro 2010). Some scholarly works (see for e.g. Chirisa 2010; Waldman et al. 2017; Abass et al. 2018; Afriyie et al. 2014) provide ample evidence to support the assertion that the natural environment is greatly affected by peri-urbanism, which involves the transformation of rural areas to urban areas. The process of urbanization results in the rapid change of large amount of agricultural lands, rural fringes and wetlands to other urban land uses; thus, leading to encroachment on the natural environment as well as its concomitant development control problems (Gantsho 2008; Naab et al. 2013; Mensah 2014; Korah et al. 2018; Nonterah et al. 2015; Asomani-Boateng 2019). The United Nations Population Fund [UNPF] (2007) observes further that the extension of the urban boundary into urban peripheries adversely affects the availability of productive land and environmental resources such as wetlands resulting from the encroachment on important ecosystems.

In the view of Natural Resources Conservation Service (2012), wetlands are natural or artificial areas with hydrophytic soil, hydrophytic vegetation and wetland hydrology indicators. Essentially, wetlands include swamps, marshes, bogs and many bottomland hardwood areas (Natural Resources Conservation Service 2012). They act as open spaces, ensure a balance in the ecosystem and serve as habitat for some endangered animal species (Greb et al. 2006; Ryan and Ntiamoa-Baidu 2000; Ekumah et al. 2020). They also provide habitat for high concentration of birds and flood prevention as well as storm protection (McInnes and Everard 2017; Vázquez-González et al. 2019; Shutes et al. 2010). Despite these benefits, they have been degraded and encroached upon; partly attributable to anthropogenic activities such as rapid urbanization and urban sprawl (Ajibola et al. 2012; Wuver 2006). As evidence suggests, wetlands in Ghana serves as an ecological zone with abundant ecological resources, which serve as a source of food and nesting for migratory birds, marine turtles, different fish species and aquatic plants (Gbogbo 2007; Attuquayefio and Gbogbo 2001; Owusu 2007).

In Ghana, rapid population growth in major cities has significantly contributed to land-use transformations and the loss of valuable wetlands in urban areas (Nonterah et al. 2015). That is, as human settlements continue to expand, there are alterations in the quality of the environment due to certain unsustainable human-induced activities, geared at enhancing the livelihoods of people. Attuquayefio and Gbogbo (2001) add that wetland loss and degradation in Ghana is an undeniable reality and human activities are chiefly to blame for its deterioration. Anku (2006) maintain that uncontrolled urbanization, rapid population growth, fuel wood gathering and salt and sand mining among others are the major factors that

threaten the availability and sustainability of wetlands in Ghana. Anku (2006) notes further that these threats include rapid conversion of wetlands for housing development, rapid slum development, mining, land and soil degradation as well as water pollution. Some empirical evidence (see Kumi et al. 2015; Opoku 2013) indicate that wetlands in most Ghanaian cities have been encroached upon while their water bodies have been filled with solid waste.

Despite the potential threats of rapid urbanization to the sustainability and availability of wetlands in the Ghanaian context, there remains a paucity of empirical research investigating the profound implications of urbanization on wetlands. It is important to note that some scholarly works (see for e.g. Nonterah et al. 2015) have investigated the ecohydrology of wetlands in urban Ghana, prospects of conserving urban wetlands in Ghana (Attuquayefio and Gbogbo 2001) and urban wetland planning and management in Ghana (Asomani-Boateng 2019). However, these studies failed to provide adequate empirical evidence on how the nature and magnitude of uncontrolled urban growth poses a threat to the sustainability of wetlands in the urban landscape in Ghana. Additionally, there is insufficient scholarly evidence on the nexus between wetlands loss and the rapid rate of urbanization from a developing country context. Empirical studies on the nexus between urbanization and wetlands tend to focus considerable attention on developed nations (see Turner 1991; Wood et al. 2013). It is important to note that these studies have limited contextual relevance for countries in the Global South due to differences in social, economic, cultural and environmental contexts. This lack of valuable information may constrain the ability of environmentalists and policy-makers in designing and implementing well-targeted policy interventions that are geared towards mitigating and/or curtailing the detrimental impacts of human-induced activities on wetlands in urban areas in Ghana. That is, the limited evidence on the urbanization-wetlands nexus from the developing country context served as a motivation for the present research. Against this background, the specific objectives of the research are (a) to investigate the relationship between urbanization and wetland loss in the Greater Accra Metropolitan Area (GAMA), (b) to explore land-use activities along wetlands (c) to examine the environmental effects of urbanization on wetlands.

The study contributes to the literature in at least two ways. First, unlike earlier studies that focussed considerable attention on the ecohydrology, planning and management of urban wetlands, the present research provides valuable insights into the profound effects of rapid urbanization on the wetland ecosystem. This is envisaged to broaden academic discourse as well as adding onto the existing body of literature on wetlands in Ghana and by extension, Sub-Sahara Africa. Also, the novelty of the research findings is expected to constitute a basis for the (re)design and implementation of well-targeted policy interventions geared at mitigating the detrimental impacts of rapid urbanization on wetlands in the Ghanaian context. It is important to emphasize that in Ghana, there exists a national policy document on wetlands dubbed "National Wetlands Conservation Strategy", which was formulated in 1999. Essentially, the policy seeks to promote the efficient utilization of wetlands for purposes of farming, grazing, fishing, timber production and salt-winning as well as conserve the ecosystem and biodiversity and sustain the productive gains of wetlands (Ministry of Lands and Forestry 1999). Relevant policy initatives include;

Ghana Coastal Wetlands Management Programme, Lower Volta Mangrove Project and the West and Central African Regional Seas Programme (Ministry of Lands and Forestry 1999). These key policy initiatives/interventions sought to integrate wetlands management into the broader context of environmental management. Also, because the characteristics and manifestations of urbanization in Sub-Sahara Africa exhibit commonalities, (see Zhang et al. 2007) the findings and policy implication of the study could have considerable contextual relevance for other countries in the global south. In addition, the research findings will be beneficial to stakeholders such as city authorities, policy-makers, environmental advocates, researchers and NGOs who will use the results of this study for their development works and interventions.

Conceptual briefings on urbanization-wetland linkages

Kitchin and Thrift (2009) suggest that wetlands are a hybrid of terrestrial and aquatic environments and constitute a variety of landforms that are submerged by water and augur well for unique vegetations that are best suited to the conditions of wetlands. Pritchard (2010) adds that wetlands as areas of marsh, fen, vegetable soil or water with a depth not greater than six metres. It can either be natural or artificial, permanent or temporal, static or flowing and could contain either fresh or marine waters (Pritchard 2010). Mccartney et al. (2010) also point out that wetlands are natural rainwater harvesters, acting as ponds into which surface and/or groundwater flows from the catchment surrounding the area. Wetland ecosystems make up 6% of the global land area but are one of the most endangered environmental resources in the world (Turner 1991; Woodward and Wui 2001; Bai et al. 2005).

Wetlands are special ecological resources that provide vital ecosystem services which cannot be substituted by any urban infrastructure (Pritchard 2010; Georgiou and Turner 2012; Marton et al. 2015). Wetlands provide a large number of goods and services to people in their vicinity or to communities outside of the wetlands; thus, making them a highly productive ecosystem (see for e.g. Barbier et al. 2011; Zedler and Kercher 2005). Globally, the yearly monetary value of wetland ecosystem services stands at about US$47 trillion (Davidson et al. 2019). Davidson et al. (2019) posit further that wetlands constitute about 15% of the global natural areas; however, this unique ecosystem is estimated to deliver about 43.1% of the global ecosystem services monetary value. This staggering global statistic underscores the enormous benefit the wetlands ecosystem provides on a global scale. In the global contexts, wetlands are regarded as "producers" and "preservers" of fossil fuels upon which the world relies on today (Mitsch and Wu 2018). To a larger extent, wetlands provide fishes, pasture land and constitute and integral element in the art, mythology and religion of people (Du Toit et al. 2021; Ivčević et al. 2021). Put together, worldwide, wetlands offer hydrological, chemical and biological functions as well as support biodiversity (Kumar et al. 2021; Fan et al. 2021). In some developing countries, wetlands offer profound ecological, social and economic roles to their economies. In Zambia for example, wetlands are estimated to provide around 5% of Gross Domestic Product (GDP)

(Wood et al. 2013). Mccartney et al. (2010) also provides an account in Tanzania where the wetlands in the Kilombero Valley provide the poorest households with up to 80% of their cash income.

Wetlands serve as natural habitats for wildlife species while at the same time provide ecosystem services by helping to purify running water and protect the shores of water bodies against erosion and storm (Costanza et al. 1997). The International Water Management Institute (2014) also notes that wetlands play an important role in protecting hydrological cycle; thus, helping to conserve ground water especially in cities. Overall, wetlands offer a wide range of important services to human society, including fisheries production, storm buffers, increased water quality, tourism and other cultural and spiritual benefits (United Nations Environment Programme [UNEP] 2006).

It is widely acknowledged in the conventional literature that rapid and uncontrolled urbanization could pose a detrimental impact on the sustainability of the wetland ecosystem (Deegan and Buchsbaum 2005; Ajibola et al. 2012). For instance, Ajibola et al. (2012) notes that building in wetlands affects the wetland ecosystem through direct habitat losses, hydrological changes and water alteration. Deegan and Buchsbaum (2005) add that urbanization leads to direct habitat loss, alters hydrology and sedimentation regimes and changes nutrient and chemical pollutants dynamics in the context of wetlands. Wetland degradation resulting from urbanization has also increased risks of coast and tidal storms, which have undesired environmental consequences for both human and natural systems (Ajibola et al. 2012). Azous and Horner (2000) note that urbanization could have both direct and indirect impacts on wetlands. Typically, housing and other infrastructural development activities impact wetlands by resulting in habitat loss, hydrological alterations and reduces water quality (Murungweni 2013). Azous and Horner (2000) also detail out some indirect impacts of urbanization on wetlands. These include eutrophication and sedimentation. At the landscape level, Azous and Horner (2000) observe that urbanization could affect wetlands through the destruction of extensive wetland areas via drainage modification and/or fragmentation. Some authors (see Zedler and Kercher 2005; Faulkner 2004) also indicate that urbanization impacts wetlands in the form of hydrology, water quality alterations, soil degradation and depletion of biological resources. Figure 1 provides a conceptual framework on the effects of urbanization of wetlands.

It is evident in the foregoing review that urbanization (through urban expansion and rapid population growth) could have detrimental implications for the sustainability of wetland ecosystems. From the facts presented thus far, it is explicit that uncontrolled urban expansion could lead to direct habitat loss and hydrological alteration in the context of wetlands. However, there is a paucity of research investigating the effects of urbanization on wetlands in the Ghanaian context and by extension the developing country context. It is in light of this research gap that the present study seeks to explore how rapid and uncontrolled urban growth threatens the sustainability of wetlands.

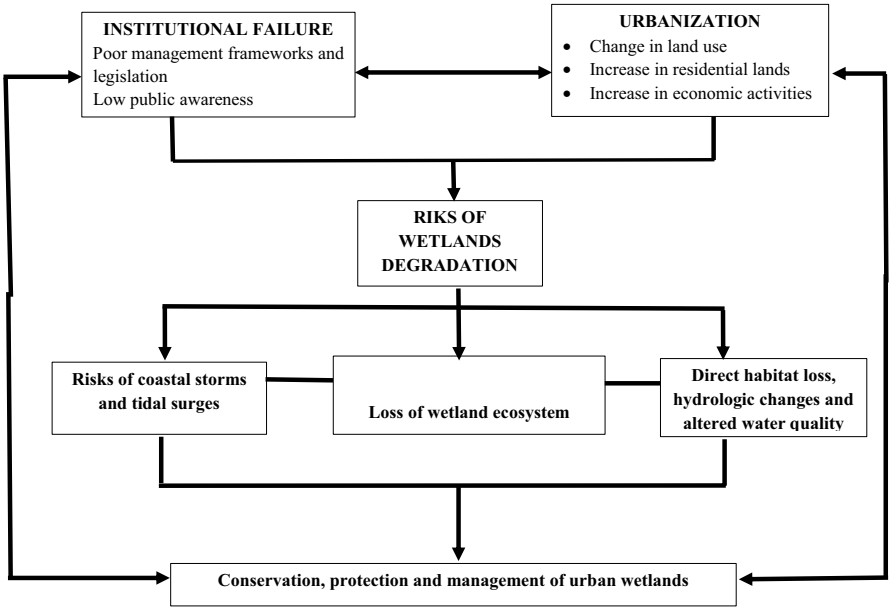

Fig. 1 Conceptual framework on urbanization-wetland linkage

Study area and methods

Study area

Geographically, the study focuses on the GAMA (see Fig. 2) in the Greater Accra Region of Ghana. The GAMA is arguably the most urbanized Metropolitan area in Ghana and among one of the rapidly growing areas in the West African sub-region (Afeku 2005; Grant 2009; Korah and Cobbinah 2017; Gaisie et al. 2019). Following from the above, it is envisaged that the manifestations of urbanization (via rapid urban growth and expansion and incessant population increase) would have some detrimental impacts on wetlands management and sustainability in the city. The Accra Metropolitan Area also exhibits similar characteristics as most metropolitan areas within the West African Sub-region (Takyi 2016a, b) and thus, making the findings and policy implications of the current study relevant for other jurisdictions in the Sub-Saharan African region. Additionally, the GAMA is endowed with coastal wetlands that are mainly ecosystems of saltwater and are associated with flood plains and large river bodies that connect to the sea (Wiegleb 2016). It is important to note that the GAMA has a population of about 3.7 million which constitute close to 96% of the total population in the Greater Accra Region of Ghana (Ghana Statistical Service 2012). This makes the Metropolitan Area the largest and most densely populated urban centre in Ghana (Oteng-Ababio et al. 2013).

The GAMA was selected for the present study because as evidence suggests, (see for e.g. Ryan and Ntiamoa-Baidu 2000) it has the largest wetlands in Ghana. For instance, GAMA has a total wetland area exceeding about 25 km^2 in total

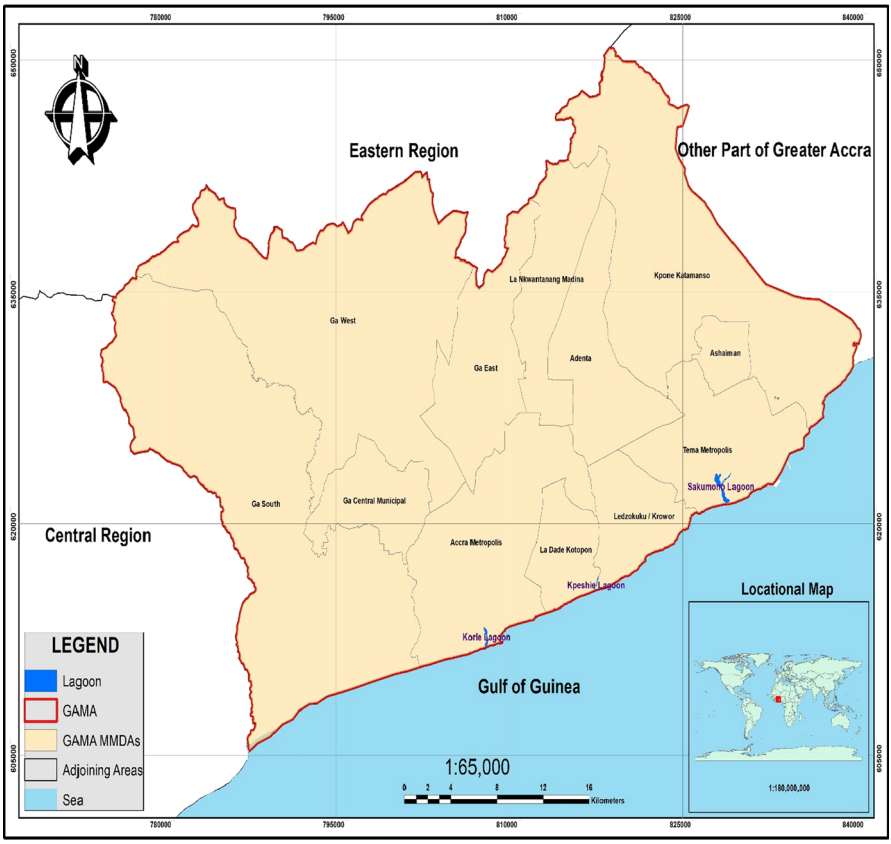

Fig. 2 Map showing an overlay of wetlands in the Greater Accra Metropolitan Area (GAMA)

land size. Moreover, GAMA is endowed with marine resources such as marshes, seas and lagoons, thus, making it an important wetland ecosystem. It is important to indicate that human and industrial activities are located closer to these marine resources and for that matter to the wetland ecosystem in the Metropolis. As evidence suggests, GAMA is the most urbanized area in Ghana in terms of population and physical expanse (Ghana Statistical Service 2012). The over-reliance of inhabitants on these wetlands, the enormous human–environmental interaction and the potentially deteriorating conditions of wetlands in GAMA make it prudent to investigate the effects of urbanization on wetlands. Given this context, it is anticipated that the rapid rate of urbanization in the Metropolis will have some detrimental impacts on the management and sustainability of wetlands in the area, thus, justifying the choice and subsequent focus on GAMA. This study will provide deeper insights into how human-induced activities pose a threat to wetlands as well as how best to respond to these problems from a policy perspective.

As highlighted in the work of Anku (2006), the three largest wetlands located in GAMA are; Sakumono Lagoon, Kpeshie Lagoon and the Korle Lagoon. For

purposes of the present study, we focussed on all the three wetlands in GAMA. Table 1 provides an overview and/or description of the main wetlands studied.

Study methodology

The descriptive research design was employed for the present study. As observed by Nassaji (2015), descriptive research design emphasizes the vivid description of a phenomenon and evaluates its qualities in an effort to ascertain how and why things occur in a particular manner. The data used in the study were mixed (both quantitative and qualitative). Mixed-method entails a synthesis of both qualitative and quantitative data. As highlighted in the work of Lund (2012), the mixed-method approach helps in overcoming the limitations inherent in applying a purely quantitative or qualitative approach. Taken together, mixed-methods help in obtaining a hybrid set of data, thus, providing a more robust form of data for purposes of analysis. Given this context, the mixed methods approach was deemed appropriate for exploring the effects of rapid urbanization on the availability and sustainability of wetlands in GAMA.

This research also relied on both primary and secondary sources of data. The secondary data were obtained from census reports from the Ghana Statistical Service, key national policy documents relating to the management and sustainability of wetlands (such as the National Wetland Policy and the Ghana National Wetland Conservation Strategy) as well as Annual Progress Reports of key stakeholder institutions such as the Accra Metropolitan Assembly. These documents provided valuable information on the availability, management regimes, current state and challenges encountered in the management of wetlands in the study area. Also, several published scholarly articles were relied upon to provide a solid conceptual underpinning for the study. The primary data was collected through the administration of interview guides, semi-structured questionnaires and reconnaissance surveys. We interviewed people living 200 m away from the selected wetlands by using semi-structured questionnaires. A survey questionnaire was administered to residents located in close proximity (200 m) to the wetlands. The survey questionnaire focussed on the potential environmental impacts as well as the various land uses along the wetlands. It is worthy to indicate that the questionnaire captured sociodemographic profile of respondents such as age, gender, occupation and educational level. We focussed on people living in close proximity (200 m) to the wetlands because their relative closeness to these areas provides them with ample first-hand knowledge of the conditions of these unique ecosystems. Also, because these people are much closer to these wetlands, they are better positioned to report accurately on the changing state of these areas. To provide deeper insights from the perspective of institutions, we recruited stakeholders from the Environmental Protection Agency, Game and Wildlife Department and the Accra Metropolitan Assembly. These stakeholders were interviewed by using semi-structured interviews. The semi-structured interviews allowed us to go beyond what has been captured in the interview guides, thus, allowing us to obtain content-rich and relevant data for the research. These institutions were selected and contacted because of their extensive knowledge and experience on wetlands in the Metropolis. The interview script focussed on issues such as

Table 1 Description of selected wetlands in the Greater Accra Metropolitan Area

Name of wetlands	Description	Total area (km^2)
Sakumono Lagoon	Designated as Ramsar Wetland site in 1992 Coastal Brackish Lagoon Open Lagoon, surrounding flood plains, fresh water marsh and coastal savanna grassland	13.4
Kpeshie Lagoon	Heavily silted and polluted It used to serve as a major fishing ground Open Lagoon, surrounding flood plains, fresh water marsh and coastal savanna grassland	4.42
Korle Lagoon	Korle Lagoon Ecological Restoration Project launched in 1999 Large amount of untreated waste disposed into the lagoon Open Lagoon, surrounding flood plains, fresh water marsh and coastal savanna grassland	2.9

nexus between urbanization and wetlands and the observed environmental impacts of urbanization on wetlands. On the average, each interview lasted about 45 min. We applied the intelligent verbatim approach to transcribe the recorded interviews, allowing us to take out irrelevant responses.

A face-to-face survey was implemented along the three major wetlands (Sakumono, Kpeshie and Korle Lagoons). The convenience sampling technique was employed to recruit residents that were readily available. The approach allowed us to save resources and time as well as cover a wider population. Overall, we selected and interviewed 120 respondents (on the basis of convenience sampling) living along the selected wetlands (see Table 2 for a background of survey participants). These respondents were people either residing, building residential or commercial properties and/or undertaking agricultural activities in and/or along the selected wetlands in GAMA. The selection of the 120 respondents for the study was as a result of time and resource constraints faced by the researchers. Therefore, to provide content-rich data for the study, we triangulated responses from the surveys with that of institutional interviews. In spite of the relatively limited sample size, the study offers valuable insights into the sustainability and management of wetlands from a developing country context.

A limitation of the study relates to the use of convenience sampling. The convenience sampling approach makes it extremely easier to focus on subjects that are readily available, prompt and uncomplicated, thus, saves valuable economic resources and time. However, the approach has its own limitations such as biases arising out of the selection of respondents. To overcome the biases in the convenience sampling approach, we used the approach along with probability sampling (stratified probability sampling). That is, the target respondents were divided into homogenous subgroups based on their age, sex and places of residence and then predetermined proportion of the strata were selected into the sample (Etikan et al. 2016).

Regarding the analytical methods adopted for the study, the quantitative data was analysed with the aid of SPPS (version 24). Using the SPSS software, we generated

Table 2 Background characteristics of survey participants

Variable	Group	Percentage
Gender	Male	57.6
	Female	42.4
Educational attainment	No qualification	10.3
	JHS/SHS	43.8
	Diploma or higher	45.9
Age	0–20	7.6
	21–40	28.9
	41–60	43.3
	61 and above	20.2
Distance from residence to the wetland	Less than 1 km	78.0
	1 km and above	22.0

$N = 120$

JHS Junior High School, *SHS* Senior High School

tables and descriptive statistics (such as frequencies, averages and percentages) for purposes of analysis. We analysed the interview transcripts with the aid of hand coding. In the first place, we scanned through all relevant sections of the interview transcript to obtain a fair and better appreciation of the content of the interviews. Following this, we closely read each of the transcripts. With our research objectives at the background, we applied the ground approach to code crucial sentences and constructs. We again carefully read the interview transcripts to identify statements that were recurring. Given this context, the links between codes were categorized, allowing the researchers to identify relevant themes. To ensure the validity of our results, the process was iterated until our results become relatively stable.

Results and discussion

Relationship between urbanization and wetland loss in GAMA

As already indicated, the present study focussed on three wetlands in GAMA namely, Sakumono Lagoon, Kpeshie Lagoon and Korle Lagoon. We focussed on the population data as well as the total land sizes of the wetlands in GAMA between 1960 and 2010. It is important to note that the Sakumono Lagoon falls

Table 3 Nexus between population growth and wetland loss in the Tema Metropolitan Area

Year	Population	Land area of wetland (hectares)
1960	27,127	1850.09
1970	102,431	1757.59
1984	190,917	1669.71
2000	298,432	1519.44
2010	402,637	1340

Ghana Statistical Service and the Tema Metropolitan Assembly

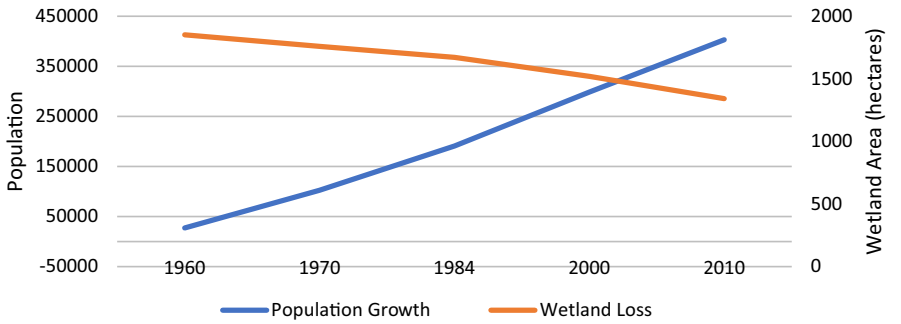

Fig. 3 Relationship between urbanization and wetland loss in the Tema Metropolitan Area (Sakumono Lagoon)

under the jurisdiction of the Tema Metropolitan Area, whereas the Kpeshie and Korle Lagoons come under the Accra Metropolitan Area.

Table 3 provides an overview of the relationship between urbanization (via population increase) and wetland loss in the Tema Metropolitan Area.

Figure 3 also provides a pictorial overview of the relationship between rapid urbanization and wetland loss in the Tema Metropolitan Area.

Regarding the Accra Metropolitan Area (viz the Kpeshie and Korle Lagoons), Table 4 provides a summary of the relationship between urbanization and wetlands loss.

Similarly, Fig. 4 provides a pictorial overview of the nexus between urbanization and wetland land loss in Accra Metropolitan Area.

From the data presented above on both the Tema and Accra Metropolitan Areas, it is conspicuous that there is a negative association between urbanization and wetlands loss in GAMA. As population rises, there is a sharp decline in the available stock of wetlands in the areas studied. Typically, in the Tema Metropolitan Area, as population increased from 27,127 in 1960 to 402,637 in 2010, there was a considerable decline in the stock of wetland from 1850.09 hectares in 1960 to 1340 hectares in 2010, thus, representing a 38% decline in the available wetlands. Also, in the Accra Metropolitan Area, as population increased from 338,396 in 1960 to

Table 4 Relationship between urbanization and wetland loss in the Accra Metropolitan Area

Year	Population	Land area of wetland (Hectares)
1960	338,396	1560.4
1970	636,667	1357.5
1984	969,195	935.5
2000	1,658,937	535.1
2010	1,848,614	285.0

Ghana Statistical Service and the Accra Metropolitan Assembly

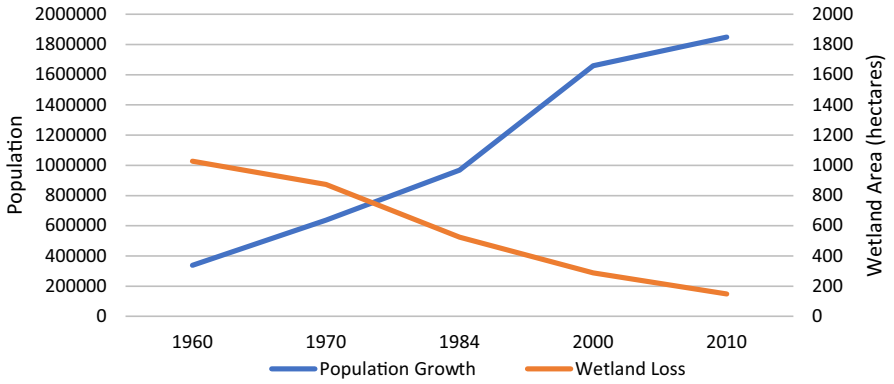

Fig. 4 Relationship between population growth and wetland loss in the Accra Metropolitan Area (Kpeshie and Korle Lagoons)

1,848,614 in 2010, there was a considerable decline in the available stock of wetlands from 1560.4 hectares in 1960 to 285.03 hectares in 2010. Taken together, the two Metropolitan Areas had experienced a tremendous fall in their available wetlands, basically attributable to rapid urbanization. This finding tallies with earlier empirical studies (see for e.g. Kumi et al. 2015; Asomani-Boateng 2019; Ekumah et al. 2020; Anku 2006) that indicated that over-exploitation in the context of developmental activities and increasing human population was the main reason for the decline of wetlands in Ghana. Also, some studies (see Anku 2006; Kumi et al. 2015) have suggested that Ghana's wetlands are being increasingly threatened by urbanization, high population growth, sand winning and other industrial activities. The present study reveals that prominent among the reasons for the loss of wetlands in GAMA were the rapid conversion of wetlands to housing and infrastructural developments and the emergence of slums on these unique ecosystems.

For example, this statement from an official of the Physical Planning Department of the Accra Metropolitan Assembly underscores this finding;

> There has been a rise in developmental activities through rapid human settlement expansion as well as commercial and industrial activities. Due to the difficulty in accessing lands (through higher land rent) for various uses in the city centre and its peripheries, people take advantage of the availability of wetlands and the lower economic values attached to these lands. This phenomenon has thus resulted in a massive human encroachment on the wetland ecosystem in the Metropolis.

Some studies (see Ankrah 2018; Kumi et al. 2015; Yeboah et al. 2013) also attribute the underlying cause of wetland decline to the desire of urban dwellers to obtain a livelihood from these wetlands. As found in the present study, about 36% of survey respondents indicated that agricultural, sand wining and industrial activities were undertaken on the wetlands and these human-induced activities were altering the natural forms of the wetland ecosystem, thus, culminating in a substantial decline in their availability.

Therefore, it is important for the appropriate regulatory authorities (i.e. the Environmental Protection Agency, Metropolitan, Municipal and Districts Assemblies, and the Land Use and Spatial Planning Authority) to enforce strict buffer restrictions on these unique ecosystems to protect them. These institutions must collaborate and institute strict regulatory regimes to restrain human encroachment on wetlands. Human activities such as sand wining, housing development and industrial activities must be reasonably situated further away (say 300 m) from these ecosystems to curtail and/or mitigate the potential harms posed by anthropogenic activities to the wetland ecosystem. This will guarantee the preservation and sustainability of wetlands, thus, maximizing the ecosystem services derived from wetlands.

Land-use activities along wetlands in GAMA

From the survey, we found that the dominant land uses along the wetlands in the Tema and Accra Metropolitan Areas were mainly residential, commercial,

agricultural and industrial activities. In the context of the Tema Metropolis, the survey revealed that about 72% of land uses along the Sakumono Lagoon were residential, 10.6% were commercial, while agricultural and industrial activities accounted for 10.9% and 6.5% of the total land uses, respectively.

Additionally, the results from the land use analysis of the Kpeshie Lagoon in the Accra Metropolis showed that residential land use was the most predominant, representing about 50% of the total land uses along the wetland. As highlighted in one of the institutional interviews, the increase in residential development along the Kpeshie Lagoon is basically attributable to the high demand for land for housing development due to the lower economic values the custodians of the land (traditional authorities) placed on these wetlands. Also, migrants from other parts of the country that had moved to the Accra Metropolis in search for greener pastures took advantage of the lower land rent to develop their settlements along the Kpeshie Lagoon. Apart from residential land uses, commercial, agricultural and industrial land uses constituted 33.3%, 12.5%, and 4.2%, of the wetland area respectively.

On the other hand, the results of the study revealed that along the Korle Lagoon, the predominant land use was commercial, making up about 55% of the total wetland area. Residential and industrial activities made up 40% and 5% of the overall land uses, respectively.

Consistent with the literature (see for e.g. Opoku 2013; Kagblor 2010; Campion and Owusu-Boateng 2013; Ameyaw and Dapaah 2017), we found that wetlands in GAMA have been encroached upon by humans for residential, commercial, industrial and agricultural activities due to rapid urban expansion and population growth. Also, another factor that had resulted in the proliferation of human activities along the wetlands was the lower economic values the Traditional Authorities (responsible for the sales of these lands) placed on these wetlands. As highlighted in the work of Okumah et al. (2020), environmental resources that are poorly valued may be perceived as not useful for productive undertakings and as a result might be common to find people exhibiting negative environmental attitudes in relation to such resources. This might potentially explain the relatively lower economic values attached to these wetlands. Due to higher cost of lands at the centres and some peripheries of the Metropolis (Antwi and Adams 2003; Gough and Yankson 2000), most low and middle-income earners take advantage of the cheaper land prices in these wetlands to purchase lands and develop their places of abode. Similarly, some investors had also taken advantage of the lower prices of lands in the wetlands to develop their commercial and industrial enterprises. As reported in the work of Takyi et al. (2020), because of the lower economic values attached to wetlands, some low and middle-income urban residents that are unable to afford lands in formal and well-planned residential neighbourhoods in the city purchase lands in these areas. Our study results are in harmony with the findings of Takyi et al. (2020) as most of the wetlands around the Korle and Sakumono Lagoons were encroached upon by urban poor in their quest for an affordable place of abode. There were a substantial number of unauthorized structures (such as wooden shacks) that had emerged on these wetlands for both commercial and residential purposes.

Taken together, encroachment on wetlands through residential, commercial, industrial and agricultural activities may have adverse implications for the

sustainability of the wetlands in the cities (Maltby 1991; Rahman et al. 2010). Also, some unsustainable agricultural practices such as slash and burn methods, over application of pesticides and inorganic fertilizers and excessive water harvesting for irrigation were posing a serious threat to the wetland ecosystem in GAMA.

Given this context, it is imperative on the Environmental Protection Agency to intensify its awareness creation campaigns on the ecological services provided by wetlands to residents and most especially, the Traditional Authorities. This will increase their knowledge regarding the benefits, values and functions of wetlands and will thus stimulate the uptake of positive attitudes towards wetland ecosystems. This is envisaged to culminate in the reduction and/or mitigation of the rate at which these wetlands are sold and converted into other land uses. Ultimately, this will result in the preservation and sustainability of wetlands in GAMA and hence enabling people to optimize the ecological functions offered by these unique ecosystems.

Environmental effects of urbanization on wetlands

From the institutional interviews, field observations and household surveys conducted, we categorized the environmental effects of urbanization on wetlands into three main themes. First, was the reduction in the size and quality of the wetlands. Next, we found that urbanization had led to the loss of habitat of some endangered animal species such as birds and turtles as well as loss of the flora and fauna in the wetland ecosystem. Lastly, we found that urbanization had resulted in the pollution of water resources in the wetlands. As noted in some studies (see for e.g. Lee et al. 2006), urbanization exerts enormous pressure on the wetland ecosystem via the modification of the hydrological and sedimentation regimes, and the release of chemical pollutants into water resources that surrounds the wetlands.

Urbanization result in rapid conversion of wetlands into residential, commercial and industrial land uses and this reduces the size and quality of these wetlands (Azous and Horner 2000; Lee et al. 2006). Consistent with our study results, we found that a major environmental threat posed by incessant urbanization on wetlands was the visible reduction in the size of the available wetlands as well as the alterations in its quality owing to human-induced activities such as unsustainable farming methods, sand wining and discharge of industrial waste into the wetlands.

Further, we established that water resources surrounding the wetlands were polluted due to anthropogenic and industrial activities. Industries such as fabric and food processing factories were located just along the wetlands and these industries discharged their organic waste, lubricants, chlorine and dyes into the water resources. Essentially, these negative environmental practices reduce the quality of water in the wetland and could have detrimental health implications on residents downstream who rely on such water resources for their domestic and agricultural activities. Also, the discharge of industrial effluents and waste into the wetlands could be harmful to aquatic life in these unique ecosystems. This finding supports that of Ajibola et al. (2012) who asserts that pollutants from industries could have direct and indirect detrimental impacts of the flora and fauna surrounding wetlands.

What makes the discharge of industrial waste into the wetlands more alarming is the fact that these industrial wastes released into the water resources are not treated, and thus, could have serious health implications on people who rely on the polluted water for various purposes.

This statement from an official of the Environmental Protection Agency corroborates this finding;

> Most often than not, industries that undertake their productive activities closer to these wetlands regard this important environmental resource as wastelands and as a result, dispose their solid and liquid waste into them. What makes the situation more worrying is the fact that these industries barely treat their waste before discharging them.

Given this context, it is envisaged that as rapid urbanization and industrialization occur, there is the likelihood of an increase in the amount of pollutants released into this vital environmental resource, which will have enormous negative implications for its quality of water. Deegan and Buchsbaum (2005) note that intensification in the use of pesticides, insecticides and chemical fertilizers on farms along wetlands could result in the accumulation of toxic chemicals that are unfit for human consumption. These harmful chemicals could pose a potential threat to some aquatic animal species. Also, during heavy downpours, these chemicals could be washed into other adjoining water resources and might result in the reduction in the quality of the water, especially, for domestic purposes. On this basis, it is important that the Environmental Protection Agency undertakes sensitization campaigns to increase awareness on the detrimental impacts of industrial activities and unsustainable farming methods on the wetlands. This will promote positive attitudes that will sustain the benefits derived from this vital environmental resource.

Put together, the current study has provided valuable insights into the relationship between urbanization and wetlands loss, land-use activities along wetlands as well as the effects of urbanization on the wetland ecosystem from the Ghanaian context. Specifically, we found that there was a negative association between urbanization and wetlands loss. That is, as human settlements expand and population grows, there would be a considerable decline in the stock of available wetlands. Based on the research findings, context-specific and synergistic policies could be designed and implemented to ensure the sustainable management of this valuable ecosystem in the face of rapid urban growth. The study's findings could also be extrapolated to other developing nations due to commonalities in environmental, social, economic and cultural dimensions. Additionally, the findings of the present study could have enormous contextual relevance for the environmental management scholarship in the developing country context. Due to the complexities of environmental attitudes and behaviours, future studies could employ multivariate statistical techniques (such as structural equation modelling) to establish the mechanisms through which various factors interact to affect the sustainability and availability of wetlands.

Now, we turn our attention to discuss some limitations and/or drawbacks of the research. The data analysed in the study was based on a survey that focussed on people that lived in close proximity (about 1 km) to wetlands. Given that a considerable number of Ghanaians fall outside this bracket, we do not intend to generalize our

research findings. Readers should therefore note this when interpreting our findings. Also, because this was a self-reported survey, memory and social desirability biases could have affected the results.

Conclusion

Wetlands are important environmental resources given the crucial ecological services they provide. Specifically, wetlands provide habitat for some animal species, conserves the hydrological cycle and helps in the protection of ground water. However, due to the limited knowledge on their values, functions and benefits, this important environmental resource is not well managed. Due to this limited knowledge, it is common to find people exhibiting attitudes that are counterproductive to the sustainability of wetlands. Specifically, the study found that rapid urbanization via human settlement expansion and high rates of population growth have detrimental implications on the availability and sustainability of this important environmental resource. Overall, the findings of the present study have shown that wetlands in GAMA are under intense pressure from urbanization. The results demonstrated further that there is a negative association between urbanization and wetland loss. That is, as cities rapidly urbanize, the stock and quality of wetlands reduce considerably. In this light, it is imperative for institutions such as the Environmental Protection Agency and the Physical Planning Departments within GAMA to institute and ensure compliance with buffer restrictions to mitigate the human footprints on these wetlands. Additionally, the Environmental Protection Agency must be well-resourced to carry out sensitization campaigns on the need and relevance of protecting and sustaining the wetland ecosystem.

Data availability Authors do not have the permission to share the underlying data.

Declarations

Conflict of interest The authors have no conflicts of interest to declare that are relevant to the content of this article.

Ethical statement No ethical approval was required, although, we obtained an oral approval from the Department of Planning, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana to undertake the research. We followed research ethics in conducting the study. For example, we explained the purpose of the research to the participants. We assured respondents of anonymity and confidentiality. Respondents were at liberty to withdraw from the interview at any point.

References

Abass K, Adanu SK, Agyemang S (2018) Peri-urbanisation and loss of arable land in Kumasi Metropolis in three decades: evidence from remote sensing image analysis. Land Use Policy 72:470–479

Aberra E, King R (2005) Additional knowledge of livelihoods in the Kumasi peri-urban interface (KPUI), Ashanti Region, Ghana. Development Planning Unit
Afeku K (2005) Urbanization and flooding in Accra, Ghana, Doctoral dissertation, Miami University
Afriyie K, Abass K, Adomako JAA (2014) Urbanisation of the rural landscape: assessing the effects in peri-urban Kumasi. Int J Urban Sustain Dev 6(1):1–19
Agarwal S, Satyavada A, Kaushik S, Kumar R (2007) Urbanization, urban poverty and health of the urban poor: status, challenges and the way forward. Demogr India 36(1):121
Ajibola MO, Adewale BA, Ijasan KC (2012) Effects of urbanisation on Lagos Wetlands. Int J Bus Soc Sci 3(17):310–318
Ameyaw Y, Dapaah GS (2017) The effect of encroachment on ecosystem services provided by the Owabi Wetland and Wildlife. Int J Environ Sci Nat Resour 4(1):11–21
Ankrah J (2018) Climate change impacts and coastal livelihoods; an analysis of fishers of coastal Winneba, Ghana. Ocean Coast Manag 161:141–146
Anku KS (2006) Managing wetlands in Accra, Ghana. African Regional Workshop on Cities. Ecosystems and Biodiversity. Nairobi, 21
Antwi AY, Adams J (2003) Rent-seeking behaviour and its economic costs in urban land transactions in Accra, Ghana. Urban Stud 40(10):2083–2098
Arkkelin D (2014) Using SPSS to understand research and data analysis
Asomani-Boateng R (2019) Urban wetland planning and management in Ghana: a disappointing implementation. Wetlands 39(2):251–261
Attuquayefio DK, Gbogbo F (2001) Prospects of conserving wetlands along the Mukwe Lagoon at Nungua in the Greater Accra Region of Ghana. West Afr J Appl Ecol. https://doi.org/10.4314/wajae.v2i1.45564
Azous A, Horner RR (eds) (2000) Wetlands and urbanization: implications for the future. CRC Press, Boca Raton
Bai JH, Ouyang H, Yang Z, Cui B, Cui L, Wang Q (2005) Changes in wetland landscape patterns: a review. Prog Geogr 24(4):36–45
Barbier EB, Hacker SD, Kennedy C, Koch EW, Stier AC, Silliman BR (2011) The value of estuarine and coastal ecosystem services. Ecol monogr 81(2):169–193
Barbier EB, Georgiou IY, Enchelmeyer B, Reed DJ (2013) The value of wetlands in protecting southeast Louisiana from hurricane storm surges. PLoS ONE 8(3):e58715
Campion BB, Owusu-Boateng G (2013) The political ecology of wetlands in Kumasi, Ghana
Chirisa I (2010) Peri-urban dynamics and regional planning in Africa: implications for building healthy cities
Costanza R, d'Arge R, De Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'neill RV, Paruelo J, Raskin RG (1997) The value of the world's ecosystem services and natural capital. Nature 387(6630):253–260
Dallimer M, Tang Z, Bibby PR, Brindley P, Gaston KJ, Davies ZG (2011) Temporal changes in greenspace in a highly urbanized region. Biol Lett 7(5):763–766
Davidson NC, Van Dam AA, Finlayson CM, McInnes RJ (2019) Worth of wetlands: revised global monetary values of coastal and inland wetland ecosystem services. Mar Freshw Res 70(8):1189–1194
Deegan LA, Buchsbaum R (2005) The effect of habitat loss and degradation on fisheries. The decline of disheries resources in New England: evaluating the impact of overfishing, contanmination, and habitat degradation. MIT Sea Grant College Program. pp 67–96
Du Toit MJ, Du Preez C, Cilliers SS (2021) Plant diversity and conservation value of wetlands along a rural-urban gradient. Bothalia-Afr Biodivers Conserv 51(1):1–18
Ekumah B, Armah FA, Afrifa EK, Aheto DW, Odoi JO, Afitiri AR (2020) Assessing land use and land cover change in coastal urban wetlands of international importance in Ghana using Intensity Analysis. Wetlands Ecol Manag 28:271–284
Entwistle C, Mora MA, Knight R (2018) Estimating coastal wetland gain and losses in Galveston County and Cameron County, Texas, USA. Integr Environ Assess Manag 14(1):120–129
Etikan I, Musa SA, Alkassim RS (2016) Comparison of convenience sampling and purposive sampling. Am J Theor Appl Stat 5(1):1–4
Fan J, Wang X, Wu W, Chen W, Ma Q, Ma Z (2021) Function of restored wetlands for waterbird conservation in the Yellow Sea coast. Sci Total Environ 756:144061
Faulkner S (2004) Urbanization impacts on the structure and function of forested wetlands. Urban Ecosyst 7(2):89–106

Gaisie E, Kim HM, Han SS (2019) Accra towards a city-region: devolution, spatial development and urban challenges. Cities 95:102398
Gantsho M (2008) Cities as growth poles: implications for rural development. Maputo, Mozambique. Seminar
Gbogbo F (2007) The importance of unmanaged coastal wetlands to waterbirds at coastal Ghana. Afr J Ecol 45(4):599–606
Georgiou S, Turner RK (2012) Valuing ecosystem services: the case of multi-functional wetlands. Routledge
Ghana Statistical Service (2012) 2010 population and housing census: summary report of final results. Ghana Statistical Service, Accra
Ghana Statistical Service (2014) 2010 population and housing census. District analytical report, Accra Metropolitan Assembly. Ghana Statistical Service, Accra
Gough KV, Yankson PW (2000) Land markets in African cities: the case of peri-urban Accra, Ghana. Urban Studies 37(13):2485–2500
Grant R (2009) Globalizing city: the urban and economic transformation of Accra. Syracuse University Press, Ghana
Greb SF, DiMichele WA, Gastaldo RA (2006) Evolution and importance of wetlands in earth history. Special Papers-Geol Soc Am 399:1
International Water Management Institute (2014) Wetlands and people. Colombo
Ivčević A, Statzu V, Satta A, Bertoldo R (2021) The future protection from the climate change-related hazards and the willingness to pay for home insurance in the coastal wetlands of West Sardinia, Italy. Int J Disaster Risk Reduct 52:101956
Kagblor C (2010) A spatio-temporal study of urbanization and flooding in the Greater Accra Metropolitan Area (GAMA) of Ghana. Unpublished Masters' thesis submitted to the Department of Geography and Resource Development, University of Ghana, Legon, Accra
Kitchin R, Thrift N (2009) International encyclopedia of human geography. Elsevier
Komey AN (2015) Institutional adaptation to climate change and flooding in Accra, Ghana (Doctoral dissertation, Ohio University)
Korah PI, Cobbinah PB (2017) Juggling through Ghanaian urbanisation: flood hazard mapping of Kumasi. GeoJournal 82(6):1195–1212
Korah PI, Nunbogu AM, Akanbang BAA (2018) Spatio-temporal dynamics and livelihoods transformation in Wa, Ghana. Land Use Policy 77:174–185
Kumar R, Ganapathi H, Palmate S (2021) Wetlands and water management: finding a common ground. In: Chadha G, Pandya AB (eds) Water governance and management in India. Springer, Singapore, pp 105–129
Kumi J, Kumi M, Apraku A (2015) Threats to the conservation of wetlands in Ghana: the case of Songor Ramsar site. J Sci Res Rep 6(1):13–25
Lee SY, Dunn RJK, Young RA, Connolly RM, Dale PER, Dehayr R, Lemckert CJ, McKinnon S, Powell B, Teasdale PR, Welsh DT (2006) Impact of urbanization on coastal wetland structure and function. Austral Ecol 31(2):149–163
Lin Q, Yu S (2018) Losses of natural coastal wetlands by land conversion and ecological degradation in the urbanizing Chinese coast. Sci Rep 8(1):1–10
Lund T (2012) Combining qualitative and quantitative approaches: some arguments for mixed methods research. Scand J Educ Res 56(2):155–165
Maltby E (1991) The world's wetlands under threat. In: Hansen J (ed) Concerns environmental. Springer, Dordrecht, pp 109–136
Marton JM, Creed IF, Lewis DB, Lane CR, Basu NB, Cohen MJ, Craft CB (2015) Geographically isolated wetlands are important biogeochemical reactors on the landscape. Bioscience 65(4):408–418
McCartney M, Rebelo LM, Senaratna Sellamuttu S, De Silva S (2010) Wetlands, agriculture and poverty reduction (vol. 137). Iwmi
McInnes RJ, Everard M (2017) Rapid assessment of wetland ecosystem services (RAWES): an example from Colombo, Sri Lanka. Ecosyst Serv 25:89–105
Mensah CA (2014) Destruction of urban green spaces: a problem beyond urbanization in Kumasi city (Ghana). Am J Environ Protect 3(1):1–9
Ministry of Lands and Forestry (1999) Managing Ghana's wetlands: a national wetlands conservation strategy. Republic of Ghana
Mitsch WJ, Wu X (2018) Wetlands and global change. Soil management and greenhouse effect. CRC Press, Boca Raton

Murungweni FM (2013) Effect of land use change on quality of urban wetlands: a case of Monavale wetland in Harare. Geoinfor Geostat. https://doi.org/10.4172/2327-4581.S1-015
Naab FZ, Dinye RD, Kasanga RK (2013) Urbanisation and its impact on agricultural lands in growing cities in developing countries: a case study of Tamale in Ghana. Mod Soc Sci J 2(2):256–287
Nassaji H (2015) Qualitative and descriptive research: data type versus data analysis
Natural Resources Conservation Service (2012) US Department of Agriculture Natural Resources Conservation Service. 2012. The PLANTS Database
Nonterah C, Xu Y, Osae S, Akiti TT, Dampare SB (2015) A review of the ecohydrology of the Sakumo wetland in Ghana. Environ Monit Assess 187(11):671
Oduro CY (2010) Effects of rapid urbanization on livelihoods in the peri-urban areas of Accra, Ghana. Unpublished PhD Thesis, Florida State University
Okumah M, Yeboah AS, Bonyah SK (2020) What matters most? Stakeholders' perceptions of river water quality. Land Use Policy 99:104824
Opoku JA (2013) Effects of human encroachment on Wetlands in Ghana: The case of Sakumono Ramsar site (Doctoral dissertation, University of Cape Coast)
Oteng-Ababio M, Arguello JEM, Gabbay O (2013) Solid waste management in African cities: sorting the facts from the fads in Accra, Ghana. Habitat Int 39:96–104
Owusu EH (2007) The ornithological importance of the Amansuri Community Nature Reserve in the Western Region of Ghana. J Sci Technol (Ghana) 27(3):72–85
Park N, Peterson C (2010) Does it matter where we live? The urban psychology of character strengths. Am Psychol 65(6):535
Pauchard A, Aguayo M, Peña E, Urrutia R (2006) Multiple effects of urbanization on the biodiversity of developing countries: the case of a fast-growing metropolitan area (Concepción, Chile). Biol Cons 127(3):272–281
Pritchard D (2010) Managing wetlands: frameworks for managing wetlands of international importance and other wetland sites. Ramsar Handbooks for the Wise use of Wetlands, 18
Rahman MM, Rahman MR, Asaduzzaman M (2010) The aggression of human activities on Chalanbeel a threat on wetland environment: study on Natore-Rajshahi Region of Bangladesh. J Sci Found 8(1–2):151–159
Ryan JM, Ntiamoa-Baidu Y (2000) Biodiversity and ecology of coastal wetlands in Ghana
Schuijt K (2002) Land and water use of wetlands in Africa: economic values of African wetlands
Shutes RBE, Revitt DM, Scholes LN (2010) Constructed wetlands for flood prevention and water reuse
Takyi SA (2016a) Comparative study of capital city elements: the case of Ghana and Nigeria. Afr Geogr Rev 35(2):168–191
Takyi SA (2016b) Evolution of park planning in the City of Vancouver. Focus 12(1):11
Takyi SA, Amponsah O, Yeboah AS, Mantey E (2020) Locational analysis of slums and the effects of slum dweller's activities on the social, economic and ecological facets of the city: insights from Kumasi in Ghana. GeoJournal. https://doi.org/10.1007/s10708-020-10196-2
The United Nations Population Fund (2007) UNFPA Annual Report
Thomas S (2008) Urbanisation as a driver of change. Sustain City V 5:95
Torrey BB (2004) Urbanization: an environmental force to be reckoned with. Population Reference Bureau, 1
Turner K (1991) Economics and wetland management. Ambio 20(2):59–63
United Nations Environment Programme (2006) Marine and coastal ecosystems and human well-being: a synthesis report based on the findings of the millennium ecosystem assessment
United Nations Human Settlements Programme (2011) Cities and climate change: global report on human settlements. Routledge
Vázquez-González C, Moreno-Casasola P, Peláez LAP, Monroy R, Espejel I (2019) The value of coastal wetland flood prevention lost to urbanization on the coastal plain of the Gulf of Mexico: An analysis of flood damage by hurricane impacts. Int J Disaster Risk Reduct 37:101180
Waldman L, Bisht R, Saharia R, Kapoor A, Rizvi B, Hamid Y, Arora M, Chopra I, Sawansi KT, Priya R, Marshall F (2017) Peri-urbanism in globalizing India: a study of pollution, health and community awareness. Int J Environ Res Public Health 14(9):980
Wiegleb V (2016) A literature review on wetlands in Accra
Willoughby N, Grimble R, Ellenbroek W, Danso E, Amatekpor J (2001) The wise use of wetlands: identifying development options for Ghana's coastal Ramsar sites. Hydrobiologia 458(1–3):221–234
Woltjer J (2014) A global review on peri-urban development and planning. J Reg City Plan 25(1):1–16

Wood A, Dixon A, McCartney M (eds) (2013) Wetland management and sustainable livelihoods in Africa. Routledge

Woodward RT, Wui YS (2001) The economic value of wetland services: a meta-analysis. Ecol Econ 37(2):257–270

Wuver AM (2006) The impact of human activities on biodiversity conservation in a coastal wetland in Ghana. West Afr J Appl Ecol. https://doi.org/10.4314/wajae.v9i1.45690

Yeboah SA, Allotey ANM, Nani E (2013) Environmental effects of socio-economic activities on Songor Ramsar Site in Ada, Ghana. J Environ Issues Agric Dev Ctries 5(2):10

Zedler JB, Kercher S (2005) Wetland resources: status, trends, ecosystem services, and restorability. Annu Rev Environ Resour 30:39–74

Zhang ZL, Zhen F, Liu H (2007) Characteristics and driving factors of the urbanization in Africa since the 1990s. Trop Geogr 5:871