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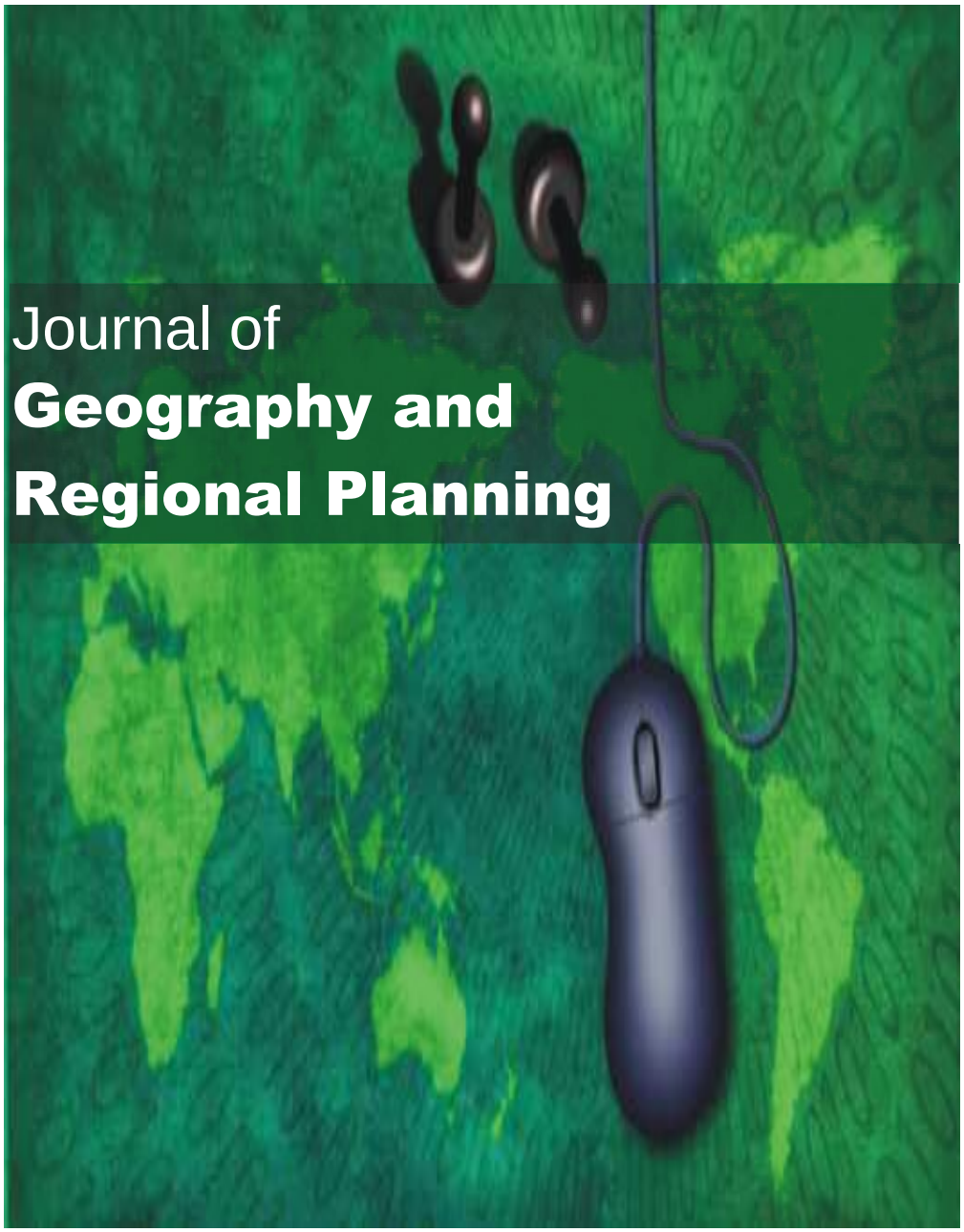

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Planning: The town planners' perspective

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The concept of planning has been a subject of territorial debates amidst various disciplines and at all conclusions; everyone is a planner in his/her own right. It is against this background of oversimplification that this study attempts to explore the various meaning and scope of planning both from the general percept and town planners' viewpoint. It relates the discus to Nigeria environment where the requisites, roles and challenges of urban planning within this domain were extensively explored. The paper which benefitted from a review of extant literature on the subject matter answer numerous questions inclusive of what it takes to be a town planner and what is expected of town planners.

Key words: Planning, urban and regional planning, town planner, Nigeria.

INTRODUCTION

The concept of planning remains a central theme to different disciplines, individuals and occurrences. This is because at every stage, planning of one form or the other is either single-handedly or repeatedly carried out; its stages can be as complicated as repeatedly done in multifaceted activities. With reference to this, the term planning has received diverse definitional responses from both professionals of different disciplines and individuals of varying capacities (Arimah, 2002). Despite these definitional and conceptual responses, the question of what is planning still suffices in many discussions. This semantic confusion may not be far from planning being the midpoint of abstraction and reality (Falade, 2003; UNDP, 2008).

With the concept of planning generically defined as the first bold step at envisioning and actualizing a predefined end, every individual is a planner of different activities for different functions (Awake, 2005). Indeed, planning is a continuous activity and in a bid to plan, one plans. The involvement of everyone in planning has aided its mere reduction as well as the absence of rigid definitional lines between the various forms and types of planning. This has left one with the questions like what is planning, who are planners, what do planners do and how does one becomes a planner? These questions will be the objectives of this paper and such will be answered with particular reference to town planning. In a bid to achieve these objectives, this paper explores the various definition of planning and drives it home to urban and regional planning. It finally discusses the prerequisite and roles of town planners without neglecting the various challenges faced by the profession in Nigeria.

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PLANNING: THE MANY MEANING

Planning is a word of numerous interpretations and a profession in many professions. It means different things to different people; hence, its definition varies with scope and school of thought of the user of the word. Planning cut across different forms of life and it is done at every stage of the same. The diversified nature of the concept makes one to conclude that planning is big and complicated. It is an abstraction that has no clearly identifiable meaning except in the context of its usage. Thus, there is event planning, social planning, economic planning and town planning amidst others. While an event planner may view planning as the process of aligning activities and programmes through the use of resources to stage and actualize a desired function, an economic planner will conceptualize planning as the allocation of scarce resources at ones disposal for yielding greatest satisfaction and a social planner will view the same concept as the equitable allocation of resources to achieve a balance and dynamic society (UNFPA, 2004). Indeed, everyone is a planner in his/her own right.

The simplest definition of planning as provided by Wikipedia (2015) is the process of thinking about and organizing the activities required to achieve a desired goal. This definition posits planning as just a cognitive activity like thinking and discussing with less emphasis on the implementation of such plans. This standpoint although has been the confluence of definition of scholars and administrators about planning (Beauregard, 2003). The reduction of planning by the early scholars could have been informed from their economics background which deals solely with the allocation of resources between competing ends. Another viewpoint of this early epoch explains planning to be the utilization of available facts and situations as they are to find a way to solve problems. Generally, planning is a fundamental activity of every man which reflects his will and ability to engage in the shaping of his future and realities. It involves working out, in a broad outline, the things that need to be done and methods for doing them to accomplish a set purpose (Gulick, 1937; Newman, 1958; Ogbazi, 2002). It is inclusive of the ability to predict and predetermine future conditions through control of present actions.

Planning is a rational activity based on utilization of knowledge. This perspective was illustrated by Merriam (1941) in Ogbazi (2002) who defined planning as an organized effort to utilize intelligence in the determination of national policies, the purpose, being allocation and distribution of resources. Planning consists of a systematic, continuous, forward-looking application of the best intelligence available, to programme of common affairs in the public field. Despite the plurality of various definitions, the basic characteristics of the planning of any form include it being futuristic, involving the allocation of scarce resources and time specific. Then relating to this paper one is left with the onus of conceptualizing town planning.

PLANNING BY TOWN PLANNERS

The advent of town planning in the industrial revolution era features the attraction of different research interests from allied disciplines on the subject matter. These interests have yielded numerous definitions for the term. Policy from different government at different instances and the purpose for which planning was made also factored its definition per time.

Physical planning is concerned with the general pattern of landuse, the character and location of public buildings and structures, the design of streets, the location and development of transits and transportation system and all other physical facilities which are necessary or desirable to promote the economic betterment, comfort, convenience and general welfare (Webster, 1961). It is the art and science of ordering the use of land, character and siting of buildings and communication routes so as to secure the maximum practicable degree of economy, convenience and beauty (Lewis, 1969). It is a physical design of something which already exists or might exist in the future and this sort of plan is a representation, in a geographical or spatial sense, of actual physical structures or elements (Bruton, 1974). Friedman (1964) perceived planning as the primarily way of thinking about social and economic problems. He went further to explain that planning is deeply concerned with the relation of goals to collective decisions and strives for comprehensiveness in policy and program.

Mba (1992) defined planning as a profession that uses the research methods of social sciences for information gathering, analysis and plan preparation. NITP (1993) though synonymous to Lewis (1969) defined planning as the spatial ordering of land use both in the urban and rural settings for the purpose of creating functionally efficient and aesthetically pleasing environment for living, working, circulation and recreation. Ogbazi (2002) defined planning as a future oriented process of developing and implementing policies, designs and programmes of action to meet the needs and goals of our communities and to realize the potentials of the society. Agbola (2005) defined the concept as the direction of development and use of land to serve the economic and the social welfare of communities with respect to convenience, health and amenity. The above definition posits town planning as a central diagnose to plethora of urban problems. Town planning, although not far from the rational application of human cognitive ability which is the orient of general planning, it extends to include all set of methodologies of decision making that identifies goals and ends, determines the means and programmes directed at achieving the ends with the aid of systematic based models. Town planning is an act of shaping and

guiding the physical growth of the towns by creating buildings and environment to meet various needs such as social, cultural, economic and recreational thereby providing equal and balanced healthy platform for both rich and poor to live, work and to play or relax, thus bringing about the social and economic wellbeing for the majority of mankind (Kehinde, 1998). Town planning aims at achieving redistribution of resources and its associated access within all classes of the society.

The dynamism of urban formation has tilted the definition of physical planning from just a predictive activity to both predictive and reactionary. Planning as against the fundamentals of its ancient properties now includes element of citizen participation, stakeholder's involvement, negotiation and political relationship. Town planning is an attempt to formulate the principles that should guide in creating a civilized physical background for human life whose main impetus is thus foreseeing and guiding change (Falade, 2003). It is a mediation of space and making of place. Agbola (2006) defined planning as taking decisions to influence the course of future changes in a settlement and/or in a region for the maximum benefits of those people residing there. He described it further as an art and science of both space allocation (allocating adequate space for each of the various activities to be performed in the area) and location (evolving a landuse pattern which makes all human activities in the area functionally related). They revealed meaningful planning as a general approach to decision making, future oriented exercise, an activity with many alternatives and the choice of one alternative among several others. All these facts depend on the past experience, the present situation, anticipated future and the resources (human and materials) available at the time of implementation. Jelili (2014) defined planning as the multi-sectoral, multi-disciplinary objectives, multi-interest and ever adjustable approach to influencing the physical and socio-economic growth of urban and regional systems. He viewed it further as all processes of predetermining, shaping and encouraging a well-coordinated urban socio-economic and physical growth in a sustainable manner. In all, an activity becomes urban planning when it is resource allocating, people inclusive, controls the trend and quantum of all manners of growth and development to achieve sustainability, future oriented, space and time defined. Hence, conceptualizing urban planning is more descriptive than definitional.

Having defined planning, the concept of what town planners do suffice, this will enable the distinction of boundary between planning and other allied professional the question then is what do planners do?

TOWN PLANNERS AND THEIR ROLES

Town planning (generally used for both urban and rural planning) is a profession that offers a wide range of opportunities for people with many talents and aspirations. Planners work to ensure that cities have what they need to grow and prosper including places where people can live and would want to be. The name of the profession, "Town Planning," is straightforward and descriptive. Urban planners plan for the future of urban areas while they also plan for their rural counterparts. But this literal description of the work of a Town planner only scratches the surface of the role of urban planners. Town Planning as a modern profession is a relatively small but growing field. In 2006, Department of Labour reported 34,000 jobs held by Urban and regional planners (Bureau of Labour Statistics, 2009). U.S News (2009) rated urban and regional planning as one of the best career. Fifteen percent increase in planning jobs between 2006 and 2016 is faster than average for all occupations (Bureau of Labour Statistics, 2009). Town planners may either work at local government areas, state government and federal government level and at different parastatals. However, physical planners being a culmination of different planning specialists ranging from regional planners, rural planners and physical planners are efficient in handling of diverse environmental problems. With the extent of advancement in urban planning knowledge, there are hybrid planners which have been taught the basis of all segments of planning. These are products of most planning schools in Nigeria whose example includes Ladoke Akintola University of Technology, Ogbomoso, Oyo State. In general, the following elucidates what planner does.

Allocation of residences

Planners estimate the number of households to be housed in the coming years and recommend where, within the community land, should be set aside for homes to be built. In the process, planners work with communities to determine the proportion of homes that will be single-family houses, duplexes, or multi-family housing and the proportion that will be targeted for home ownership versus rental. Planners also work on policies affecting the price of housing in a community, to ensure that low-income and moderate-income residents (like store clerks, restaurant staff, nursing assistants, and teachers) have comfortable and affordable housing available to them.

Determination of economic flow

In addition to working to identify the best places within a community for locating factories, shopping areas, and offices, planners also work to attract jobs to communities. Economic development planners study the local economy to identify needs and create programs to fill those needs. For example, planners work with employers and local

educational institutions to make sure that the students receive training in the skills required by local industries or by the industries that the community would like to locate there.

Transportation facilities (Roads, Rail, Airports, and Seaports)

Planners study transportation systems to determine when additional transportation facilities are needed, where they should be built, and the mix of transportation options that should be available. Planners collect and analyze information to find out whether the growth and prosperity of a region is hampered because the transportation network does not provide sufficient access to some locations in the community or because congestion is creating excessive delays in getting from one place to another. Planners know that industry needs an efficient transportation system for moving raw materials in and manufactured products out. While the number of cars per person has steadily increased since the nineteenth century, planners work to create a balanced transportation system in which residents can choose to live in areas that are designed to make biking, walking, and transit (buses, light rail, and commuter rail) more successful.

Sanitation and waste management

Planners work with civil engineers to ensure that basic urban infrastructure, sewer and water, will be available as a community grows. How a community grows can have a dramatic effect on the cost of providing sewer and water services. For example, laying out a neighborhood with large lots served by sewer and water requires more spending on pipes and requires more maintenance by the city in the future. Planners work with communities to understand the effects of land use decisions on the cost of providing sewer and water services and to modify land use policies as needed. Planners also work with hydrogeologists and civil engineers to develop plans for the sustainable use of sources of drinking water, to ensure that the supply of water will remain sufficient in the future.

Community development

Some planners focus on community organizing and community development, seeking to increase social justice, reduce poverty, and “build vital and thriving under-resourced communities” (National Congress for Community Economic Development, 2009). Most planners working on community development work in areas with high levels of poverty and low levels of education, employment, and income, whether in central city neighborhoods, suburbs, or rural areas. They provide assistance to small businesses, bring resources to the community for improving the quality of affordable housing, and develop programs for increasing the skills and job readiness of residents.

Energy provision

Planners have always worked with energy utilities to predict future energy demands and to locate sites for new energy facilities, such as power plants, natural gas pipelines, or petroleum storage areas. Today, increasingly, planners are at the forefront in identifying ways in which communities can reduce their energy needs and plan for the future of renewable energy.

LEVELS OF TOWN PLANNING

Various levels of planning have been identified in the existing literature from different perspectives. But in the context of Urban and Regional Planning, the following are the notable levels of planning especially in Nigeria.

International planning

It is the planning efforts among countries and such countries may share common boundaries or lie in the same ecological zone. They may pool their assets together and agree to solve problems that go beyond national boundaries such as smuggling, illegal migration, attack from terrorists and armed robberies (Adedipe, 2002). International planning becomes imperative when there is a shared goal (example, tackling boko-haram within the West African region). Also, countries may agree to design development plan for activities spanning more than one country e.g transportation plan for trans-West African coastal highway. For instance, Trans – African pipeline expected to link Morocco and Nigeria. Other plan of this sort include ECOWAS commission strategic plan; ECOWAS community development plan.

National planning

This is the highest level of planning in Nigeria that addresses the nation’s social, economic and physical interests and demands. It is directly involved in guiding the allocation of resources (industries, social institutions, public funds and utilities e.t.c.) to states or regions in order to achieve rational population re-distribution, balanced development, national integration and stable political atmosphere. However, the success of any national planning depends on its ability to formulate goals

that reflect the aspirations of the people and achieve the articulated goals more successfully than unplanned activity (Adedipe 2002). The Nigeria Urban and Regional Planning Decree No 88 of 1992 in its section 1 and 2 provided for national planning capacities and its administrative requirement.

Regional planning

This is expected to be the second level of planning in Nigeria. Planning for separate regions within a nation is described as regional planning. A large sized country of the continental dimension is bound to have many regions with varying differences such as climatic and resources. Other variable that abounds in regions includes living patterns, desires and problems. Therefore, regional planning is concerned with the utilization and distribution of the resources to meet the needs and aspirations of the people within the region. It serves as the best means of meeting regional aspirations, exploiting regional resources and promoting the implementation of national plans if they are correctly fitted into them among several others (Adedipe, 2002). The tone of regional planning in Nigeria has been reduced due to the exit of administrative regions in the year 1967; this has made state planning more evident whereas tribal, resources, and developmental characteristics and demands may cross the border of a state leaving planning at such capacities nearly impossible. Meanwhile, insurgency in the North East and the need for revitalization of the Niger Delta region of the country has led to recent advent of regional planning to address issues relating to such regions.

State planning

This is the third level of planning in a Nigeria. This has thrived in the recent years because states are seemingly perceived as an administrative (political) region. However, within a state, differences exist in terms of natural resources endowment, level of development and complexity of problems. Therefore, state planning demands allocation of resources within the state, channeling of public investment funds, distributing and redistribution of industries, public utilities and social amenities to the various local government areas or identifiable homogenous regions within the state for balance development.

Metropolitan and local planning

It is the last level planning in Federated states. Likewise, it is a process of preparing and implementing consistent plan that will guide the development of Local Areas within the State. However, since Local Areas within the State varies (e.g. resources, cultures, traditions, development and problems), therefore local planning will focused on the utilization of local resources to meet the desires of the people. This level of planning will also ensures orderliness of various land uses in both urban and rural communities so as to curb incompatible land uses and arbitrary development (Adedipe, 2002). The establishment of city/metropolitan developments in different states has aided the metropolitan planning in the country as their urban peculiarity may not be adequately catered for in state plans.

PLANNING PRACTICE

There is no doubt that Planning as a discipline has different definitions from various schools of thought but the main motive is that it helps in solving the future problems. The problems are in different forms such as traffic congestion, slum shanty towns and inadequate housing among several others. In this regard, Town Planner as a professional has to equip himself/herself with various techniques to cope with these problems as well as forecast and plan for the future development (Aluko, 2004). However, the recognition of the needs to plan our environment with appropriate laws led to the emergence of Urban and Regional Planning Profession and subsequently to professional body such as NITP.

Planning practice can be seen as a social and political process with many actors representing different interests participating in a refined division of labour. Some of the actors are town planners, architects, builders, surveyors, engineers, economists and lawyers. Planning practice sometimes is used extremely loosely to describe virtually any pattern of decision making which is not reflection of either market forces or political demand (Sandercock and Forsyth, 1992). Planning practice is therefore an evolving process which makes use of concepts, laws and models already in existence (Aluko, 2004).

ACADEMIC AND PROFESSIONAL REQUIREMENTS OF A TOWN PLANNER

A town planner in Nigeria and the context of this paper is one that has acquired both academic and professional knowledge as well as certification respectively from accredited institutions and Town Planners Registration Council hence bounded by a common seal and its obligations. Town Planner Registration Council as charged by Decree no. 3 of 1988 now CAP 431 Law of Federal Republic of Nigeria is then saddled with the responsibility of furthering defining the terms of becoming a town planner from time to time. This paper will examine thoroughly both academic and professional requirements of a town planner. It must be of note, that the latter is

dependent on the former hence academic requirements is fundamental to gaining professional access.

The academic requirement of a town planner in Nigeria is coined around university education, polytechnic education and institute examinations. A First Degree university education in Urban and Regional Planning or Higher National Diploma automatically qualifies one as prospective candidate for professional examination once the tutelage period (post-graduation) of 2 years has been met and one has been registered as a full member of Nigeria Institute of Town Planners (NITP). However, to caption graduates from allied disciplines like architecture, estate management, surveying and civil engineering among others a three-part qualifying examination organized by the examination committee of both NITP and TOPREC on Planning Education is required.

"*Secondary school graduates who must have passed Mathematics, English, Geography and two other subjects are admitted having credits in at least five subjects including English and Mathematics, Geography and two other subjects are admitted to the stage 1 of the preliminary stage. With this arrangement it takes a minimum of nine years to get qualified as a graduate member of the Nigerian Institute of Town Planners. Graduates in allied fields are admitted into stage two of the final part. On the other hand, graduates with Masters Degree or Ph.D. are admitted into stage three of the final part (professional stage). After qualifying, they are then admitted into Graduate Membership cadre. Two years after, they move on to Corporate Membership of the Nigeria Institute of Town Planners (MNITP). Such a member now qualifies for the Town Planners Registration Council Examination to be certified fully as a Chartered Town Planner or Registered Town Planner (RTP)*" (Adeleye, 2008).

This arrangement though reflects the interest of the professional forebears in the advancement of planning education in the country but it has in recent times posed more of professional challenges than benefits. No doubt, town planning in the world over has emerged as the marriage of different disciplines possible because of the multifaceted and usually complicated nature of the problems it is set to address. This marriage is reflected in the admission of graduates of allied disciplines into the profession. However, Oyesiku (1998) has observed that recent graduates of urban planning in different schools are hybrids of these professional variants having gotten sound knowledge in its entire composite (e.g. geography, sociology and architecture among others). It is observable that opening of door for all variants of allied professionals through postgraduate diplomas and advanced studies in town planning proliferate the profession as this is not fetchable in these allied professions. For instance, it is observable that graduate from first degree architecture or other allied profession having done Masters in Urban and Regional Planning and the two years tutelage period will be qualified for Town Planners Registration Council Examination, thereby, becoming a town planner; this results in less understanding of the fundamentals of Urban planning which is the nitty-gritty of planning itself. It is unfortunate that this is not fetchable in other allied professions like architecture, estate management and quantity surveying among others. It is however, advisable that graduates of these professions should be made to seek admission into 200 level First Degree of Urban and Regional Planning in Nigerian Universities or Higher National Diploma of polytechnics before proceeding for advance studies.

CHALLENGES OF TOWN PLANNING IN NIGERIA

Town planning in Nigeria is though in its formative stage but has witnessed series of transformation and developments in the past 50 years. These includes but not limited to governments recognition and establishment of departments that that are urban planning based; Implementation and usage of various planning mechanisms in different government capacities; establishment of institute and council; and advancement of planning education among others. These are direct products of governmental policy, societal acceptance and trust as well as relentless service of planning professionals. It is in response that societal awareness of the profession is increasing while tertiary institution offering the course is growing (it is now offered in private universities).

Despite these, the Nigeria situation of the profession needs extensive evaluation especially at the sight of the dynamic diversity of the country and its associated socio-economic realities as well as responses, increasing number of town planners and seemingly limited opportunities for the same. These in the generic culminates into the weakness of the profession but this paper will at the end propose ways of transforming these perceived weakness into strength and opportunities. These challenges will be discussed under two broad sections.

Government's policy

The success of any professional engagement is dependent on the content of its government policy statement. The fullness of planning profession in the country has not been blown. This is evident in the neglect of planners in the development of National Development plans (which has been criticized as usually economic), while it must be noted that these plans cannot be divorced form physical planning because economic and other anticipated development takes place within the fabric of settlement (either urban or rural). Another critical

aspect of this is the departmentalization of public offices especially at the federal level, where ministry of physical planning and urban development has been scrapped (especially in this federal government led dispensation). This in itself will affect the development and monitoring of physical developments at national level. Communities superficially grows heterogeneously and independently even within states and federal bounds without cognizance to the spillover effects on neighbouring settlements and the national outlook possibly due to absence of coordinated plans (even if such plans exists). Nigeria as a country is without National Physical Development Plan while nearly all states are without physical development plans. However, in states where it is in existence, it obsolete and needs review. It is in response to these that urban blight, leap frog developments, migration of all sort and socio- economic imbalance are increasingly evident in the country thereby placing the profession on the bad light of the populace.

Institutional compliance and recognition

This is a very disturbing challenge of the profession in the country. Job usurping especially from allied professionals and establishments non-compliance with rule of engagement is a big deal to tackle for planning professionals. Planning jobs are usually given out to non-town planners but graduates of allied professionals. Vacancy announcement made in various institutions especially for the post of Director of Physical Planning is a testimony along this lane. Whereas, Nigeria Urban and Regional Planning Act CAP 431 Law of the Federal Republic in its part 1 subsection 6(3) clearly provided that an executive director should be a registered town planner with a minimum of fifteen years of professional practice. This situation is worsened as some planning based ministries and departments have non town planners as directors, special advisers and commissioner. Though, one must commend the efforts of the professional body (NITP) and TOPREC in ensuring that this attitude is corrected.

RECOMMENDATIONS

Based on the two broad identified problems affecting town planning in Nigeria, the following recommendations are proffered.

(1) Government should reinstate ministry of Physical Planning and Urban Development as this will aid effective planning in the country.
(2) National Physical Development Plan for the country should be formulated as this will channel physical development growth pattern for the country which can be filtered to different states.
(3) National Development Planning should be inclusive of town planners. This elevates national development plans to be more than just economic tool but a development mechanism as every indicators of development will be included.
(4) Community planning should be encouraged through establishment of planning offices in different communities once its population is more than 2000 people. This which will aid the realization of rural planning can be achieved through the involvement of traditional leaders and other leaders within such communities.
(5) Nigeria Institute of Town Planners alongside Town Planner Registration Council should increase its advocacy for engagement of strictly town planners for town planning jobs through writing of letters to various state governments, different ministries, departments and agencies, several higher institutions as well as making wide awareness through print media among others.

CONCLUSION

This paper has discussed extensively what constitutes planning. Looking at various definitions, it can be deduced that no single definition can adequately define what planning is because of its multifaceted nature. The approach to it depends on the interest and focus of the user of the word. Generally, planning takes the effort of simplifying the actions involved in the implementation of anticipations and aspirations of any task at hand with respect to time. Although it is imperative to simplify problems before executing solutions on them but the impetus of any successful plan is planning. It keeps the work on motion, elicits men to action and further plans to specific targets as desired. It is impossible to achieve a successful plan by trier and error.

The global perspective of town planning evolution in both developed and developing countries show that it (Town Planning) arose out of challenge to intervene in the social and economic problems in order to create cities of lasting beauty, health and convenience. This implies that recognition of the needs to plan environment with appropriate laws led to the emergence of Urban and Regional Planning Profession, subsequently, to formation of professional body and regulatory council. While this paper has comfortably delineated town planning from general planning, it is imperative to observe that definition of planning as an activity will continue to vary across space, time and situation. Then, at every instance, it is necessary to ask, what is planning?

Conflict of Interests

The author has not declared any conflicts of interests.

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Urban land use planning and its effects on the provision of public sanitation facilities in the Wa Municipality, Ghana

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This study has investigated the implications of land use planning on the provision and management of public sanitation facilities in the Wa Municipality, using three zones (Zone 1-Jangbeyiri and Suriyiri; Zone 2-Kpaguri; Zone 3-Mangu) of different land use and socioeconomic characteristics. A mixed method approach was utilized. Field surveys including 374 respondents, key informant interviews, and spatial planning methods were employed to gather the primary data. The results revealed that local plans and building regulations were not available at the time the indigenous settlements (Zone 1) were developed, resulting in haphazard development in the area. The high-income residential area (Zone 2) had household toilet facilities and access to door-to-door waste collection services due to the adherence to building regulations and good access routes. Zones 1 and 3 had sanitary spaces with public sanitary facilities (communal containers and public toilets) provided by either the Wa Municipal Assembly or Zoomlion Ghana Ltd. However, the sanitary facilities in the two areas were found to be inadequate and not well spaced. Access to public sanitation facilities is very difficult for service providers as well as the beneficiaries of the services. The Wa Municipal Assembly should inform the public through radio programs and community fora on the need and procedures of obtaining building permits before developing their lands. The Municipality should also create and adopt urban renewal strategies to provide sanitary services for unplanned areas like Jangbeyiri and Suuriyiri.

Key words: Land use, sanitation, sustainability, urban planning, waste management.

INTRODUCTION

Urbanisation and its associated challenges have become one of the major topics of global discourse. Land use planning, especially in the urban space, is imperative when it comes to solving the problems associated with rapid urbanisation in many cities in the world. Globally, there is a strong connection between urban land use planning (ULUP) and urban sanitation management as the two form crucial components of the 2015 Sustainable Development Goals (SDGs). While SDG 11 aims to "enhance inclusive and sustainable urbanisation and the

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capacity for participatory, integrated and sustainable human settlement planning and management in all countries," SDG 6 seeks to "ensure availability and sustainable management of water and sanitation for all." These two SDGs, therefore, underpin the link between land use planning and sanitation (UNCG-CSOP, 2017). According to the World Health Organization (WHO), sanitation deals with the provision of facilities and services for the safe management (treatment, reuse or safe disposal) of human excreta and sullage. However, in a broader context, sanitation encompasses both solid waste and animal waste (WHO, 2017). Public sanitation facilities are provided by either the Local Council or a non-governmental organisation (NGO) for the benefit of whoever wishes to use it (Heijnen et al., 2014). Land use planning is a systematic and repetitive process carried out to create favourable conditions for sustainable development of land resources which address the needs and demands of people (FAO-UNEP, 1999). While this definition emphasises systematic assessments, another definition by Gesellschaft für Technische Zusammenarbeit (GTZ) rather focuses on participation among all stakeholders in building a consensus on sustainable land use (GTZ, 2012). A combination of the two definitions thus, integrates the collaboration among all stakeholders in using procedures to ensure sustainable land use.

Theories of land use planning

ULUP dwells on three classical models namely, the Concentric Zone Model (CZM), the Sector Model and the Multiple Nuclei Model (MNM). The CZM, proposed by Burgess, describes the process of land development and urban growth by a series of concentric circles which expand drastically from the core Central Business District (CBD). The CBD has most of the economic activities because it is the focus of intra-city transport (Nakatudde, 2010; Yendaw, 2014). The Sector Model (Hoyt, 1939) argues that housing areas in a city develop in parts along the lines of communication, from the CBD outwards. High-quality areas run along roads and reflect the incidence of higher ground. Industrial sectors develop along canals and railways, away from high-quality housing. The MNM, proposed by Harris and Ullman (1945), views a city as growing and assumes that urban growth takes place around several distinct locations. These locations could include a market, a nearby village, a factory, a mine, or a railway terminal. Ultimately, all the locations would be combined into one urban area largely agglomerated by residential use and intra-city transportation. At the centre of the model is the CBD with light manufacturing and wholesaling located along transport routes (Nakatudde, 2010). These models have been criticised for being more applicable to cities in the United States of America than other nations' cities. They have also been viewed as static: they only described patterns of urban land use in a generic city but do not describe the processes by which land use changes. Despite the criticisms, these models are still considered relevant to land use planners and have been applied in recent studies (Yendaw, 2014; Asamoah, 2010; Amponsah, 2011). The study reviewed these models to ascertain how land use planning can incorporate provisions for public sanitation facilities in the Wa Municipality.

Land use planning and sanitation in Ghana and the Wa Municipality

Land use planning is a useful tool in the development of infrastructure as well as the provision and distribution of public facilities (UN-Habitat, 2012). Land use planning affects the distance of public facilities (including educational, health, sanitation and emergency facilities) from most houses in a community (Yendaw, 2014). It equally influences a better road network with the presence of designated areas for loading and offloading. This encourages the operation of public vehicles in the community thereby making houses, facilities, and other land use easily accessible in the planned area (TCPD, 2011). Land use planning impacts physical development and, thus, generally ensures a cleaner and safe environment and aims at improving the lives, living environment and health status of the residence of a given urban area (Boamah et al., 2012). Land use planning can ensure the efficient use of urban land by providing control over the spatial structure of residential development; reducing the cost of providing some local public goods and providing valued neighbourhood quality (Owei et al., 2010; Cheshire and Sheppard, 2002). Land use planning has evolved over the years to adjust to the dynamic Ghanaian society. This evolution reflects the changes in the implementation of instruments and methods (Matey, 2016; Sliuzas, 2004).

During the early 1960s, the master plan approach formed the basis of land use planning in the country. However, little emphasis was placed on the local economy and social development to generate wealth, expertise, and the needed resources for a better environment. Other shortcomings of the master plan strategy included the long preparation time, the need for a strong administration system to oversee it, and the lack of coordination among development agents at different levels of government and the private sector. These challenges led to the adaptation of the Three-Tier planning system (Matey, 2016). The three-tier framework consists of three plans: the Spatial Development Framework (SDF), the Structure Plan, and the Local Plan. According to the TCPD (2011), the SDF is the spatial strategy that defines social, economic, and environmental policies. It addresses the spatial development implications of issues like housing,

infrastructure services, transportation, and the environment. The SDF shows the expected development over the twenty-year period, including the location of key components of the strategy aimed at achieving the desired development. The SDF must also be in coherence with the National Development and Medium Term Development Plans (MTDP) and other relevant national and regional-level policies, plans and programs. A structure plan serves as a guide to the future development of a district, town or city, or the development or redevelopment of a part of these areas. It defines all land uses, including residential, commercial, industrial and mixed-use areas, and major open space. It further provides a framework within which all local plans for the city or town complies. Some of the basic land uses identified in the structure plan are open space, residential, and areas of public facilities.

A local plan lays out the use of land by function, purpose and sustainable use of land. Local plans indicate that the use of land must conform with the permitted use of the land in the designated zoning classification. The local plan provides maps that show the precise land uses for each plot in the area covered by the plan and the type of buildings that can be built on each of the designated plots. It also shows the dimensions of any parcel and the permitted maximum ratio of built area to plot area and details of designs for each type of road or footpath, including pedestrian footpaths, cycleways, drainage and reserve for infrastructure lines (TCPD, 2011). Currently, the laws enforcing land use plans of a city in Ghana include the Local Government Act (Act 462), 1993, the National Building Code (LI 1630), 1996, and Land Use and Spatial Planning Act (Act, 925), 2016. Act 462 makes building permits a mandatory requirement for physical development in Ghana. The LI 1630 spells out the building permit application requirements, building densities, permissible land uses, site and spatial standards, the responsibility of the District Planning Authority (DPA) and the validity period of building permits. Improving access to public sanitation facilities in urban areas in developing countries is very significant, but a problematic issue for urban planners (Abubakar, 2017). However, in the Wa Municipality the standard and practice of effecting healthy and hygienic conditions in the environment to promote public health are not effective, contributing to the prevailing insanitary condition in the municipality (Zormal, 2016).

The Wa Municipality lacks specific disposal points for waste; and this has resulted in indiscriminate dumping of waste in street corners, in between houses, in gutters, drains, and waterways. Which in turn poses a serious challenge of municipal waste management in the municipality (Dongballe, 2016)? Figure 1 conceptualises the effects of land use planning on the provision of public sanitation facilities in the Wa Municipality. The framework indicates that effective land use planning focuses on principles such as safety, aesthetics, convenience, and economy. Effective land use planning ensures redevelopment in old residential areas and new residential development. These developments are characterised by improved road network or transportation and reduced cost of providing public sanitation facilities. The intent is to improve the public sanitation service or facilities delivery and adequate provision of public sanitation facilities. Consequently, it leads to access to public sanitation facilities and sustained urban sanitation management. Again, the framework shows that effective land use planning reduces urban sprawl and creates room for conforming land uses or neighbourhood lines resulting in planned residential areas. Planned residential areas achieve sustained urban sanitation management as they are characterised by the availability of sanitary areas, reduced cost of providing public sanitation facilities, and access to public sanitation facilities.

Studies on land use planning and sanitation in the Wa Municipality are lacking, as earlier ones have focused on land use and housing (Boamah, 2013), and land use and crop production (Kuusaana and Eledi, 2015). This study, therefore, sought to point out the effects of land use planning on the provision of designated sanitary areas and accessibility to public sanitation facilities, in order to provide relevant information to the relevant stakeholders of sanitation management in the area. To achieve this aim, the paper (1) examined the conformity of physical developments to land use plans, (2) assessed the effects of land use planning on the provision of spaces for sanitary areas and facilities, and (3) investigated the effects of land use planning on the accessibility of public sanitation facilities in the municipality. This study adopted the Sector Model because it describes the urban structure in the form of sectors or zones with regards to urban land development.

This study conceptualised the Sector Model by classifying ULUP of the Wa Municipality into three main zones, according to (Osumanu et al., 2016). Zone 1 is made up of indigenous areas, surrounding the CBD, classified as a low-class residential area that has been developed without local plans (unplanned suburbs). Zone 2 consists of newly developed areas, located far from the CBD, classified as a high-class residential area that is developed with local plans (planned suburbs). Zone 3 is a mixed settlement classified as a middle-class residential area. The purpose of this study is, therefore, to find out whether urban land use plans have created a provision for the establishment of public sanitation facilities in these zones for the proper management of sanitation in the Wa Municipality.

This study has been carried out in Ghana and the Wa Municipality of Ghana in 2018.

MATERIALS AND METHODS

Study area

The Wa Municipality, located at latitude 10° 03' 60.00'' N and

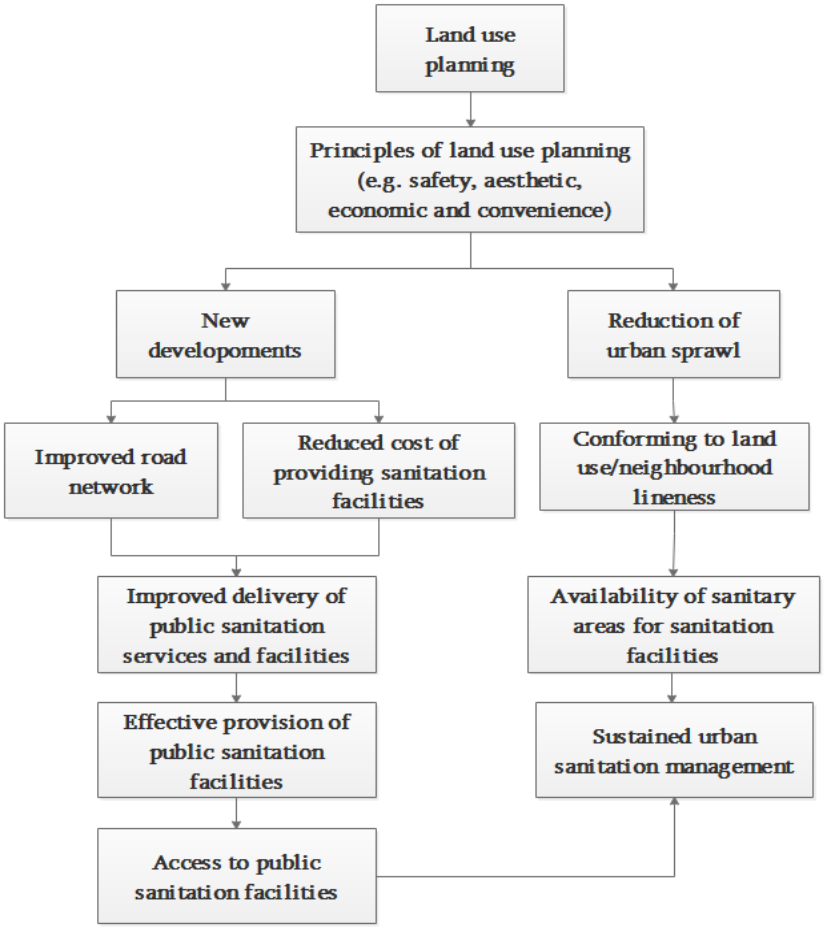

Figure 1. The conceptual framework of urban land use planning on the provision of public sanitation facilities in the Wa municipality.

longitude -2° 29' 59.99" W, is one of the eleven districts in the Upper West Region of Ghana, bordered by the Nadowli-Kaleo, Wa East and Wa West districts (Figure 2). It has a land area of about 579.86 km^2. The Wa Municipality lays in the Savannah high plains, with an average elevation between 160 and 300 m above sea level. The annual rainfall of the area is between 840 and 1400 mm, and is characteristically erratic and punctuated by spells of prolonged droughts and heavy downpours sometimes causing floods is experienced (GSS, 2014). The population of the Wa Municipality is 120,884. The majority (58.3%) of the dwelling units in the municipality is compound houses; separate houses and semi-detached houses constitute 23.0 and 10.2%, respectively. More than half (55.4%) of the dwelling units in the municipality are owned by members of the household; 26.6% are owned by private individuals; 10.7% is owned by a relative who is not a member of the household, and only 3.6% are publicly, or government-owned (GSS, 2014). Wirth regards to sanitation, 37% of the households in the Wa Municipality use public toilets, whereas 41.8% of households practice open defecation (OD). 44.6% of households in the municipality dispose of solid waste in the communal containers, 4.3% patronise the door-to-door collection of solid waste, while 17.6% dispose of solid waste indiscriminately (GSS, 2014).

This study focused on three zones based on the land use characteristics in the Wa Municipality. Zone 1 is an indigenous area developed without local plans consisting of the Suuriyiri and Jengbayiri suburbs. Zone 2 (the Kpaguri Residential) is a newly developed area that has been developed with local plans. Zone 3 (Mangu), however, has a mixture of both indigenous and new developments; the newly developing area of Zone 3 is developing based on local plans.

Data collection

This study encompassed many forms of data collection, including: questionnaire surveys, key informant interview, Global Positioning System (GPS), satellite imagery and direct observation methods in the gathering of primary data. A proportional allocation of 374 houses was estimated as the sample size for the study area based on equation provided by Yamane (1967). Three hundred and seventy-four (374) structured questionnaires were administered to household heads or their representatives of the sampled households. The questionnaire sought to gain information about respondents' demographic characteristics; building types, age and use; acquisition of permit prior to constructing their building; adherence to land use regulations; and the availability and accessibility to toilet and waste dumping facilities and services. In cases where the household head contacted was not the owner of the house, all possible avenues were exhausted to interview the owners of the selected houses. In addition to the household

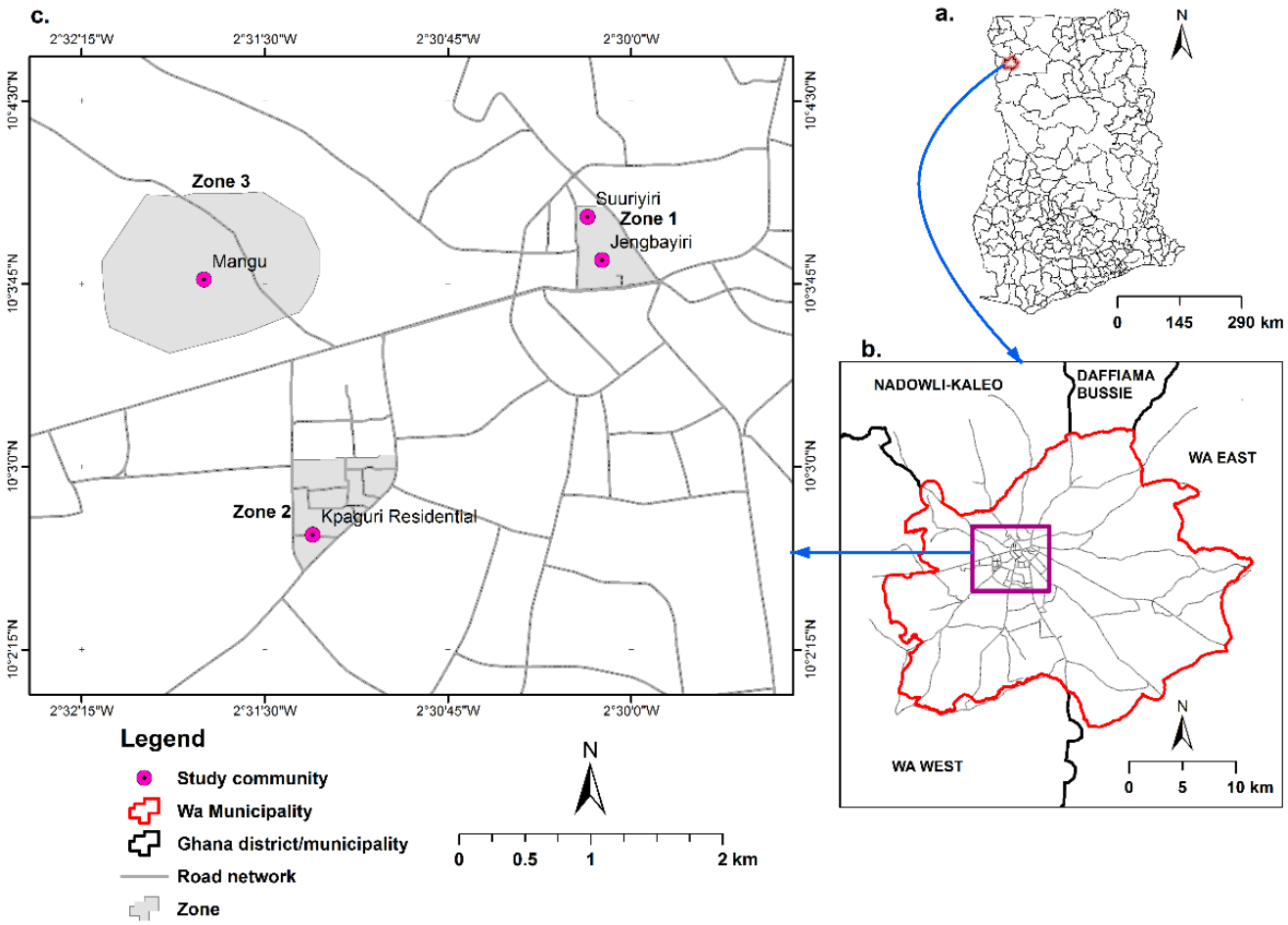

Figure 2. Geographic location of the study area in (a) districts and municipalities in Ghana, (b) the Wa municipality and (c) the study communities.

surveys, semi-structured interviews were conducted on three (3) heads of institutions: the Town and Country Planning Department (TCPD, 2018), the Wa Municipal Assembly (WMA) and Zoom Lion Ghana Limited. All administered questionnaires were cross-checked for completeness and accuracy in order to detect and eliminate errors.

The geographic coordinates of various public toilets and communal waste containers in the study suburbs were obtained with the help of a hand-held global positioning system (GPS) receiver. The points were overlaid with existing country shapefile, using the same projection. The points were plotted in a GIS (Geographic Information System) environment using a satellite image of the study area as a base map, to ensure the conformity of physical development to land use plans within the neighbourhood. Besides, direct field observations were conducted with the help of local plans to cross-check for the availability of sanitary areas in the selected suburbs.

Data analysis and presentation

The quantitative data was analysed using descriptive statistics that is, frequency distribution, percentage frequency distribution and cross tabulation. Additionally, a Chi-square test of independence was performed on the cross tabulation. The information gathered from the interviews of key informants were transcribed and summarised into statements and quotations, which was used to clarify some of the results obtained in the study. The geographic location points of public toilets and communal containers were plotted using ArcGIS (version 10.1), and the results were presented in maps to establish the spatial distribution of public sanitation facilities in the study suburbs.

RESULTS AND DISCUSSION

Demographic characteristics and Land use planning

Table 1 shows the demographic characteristics of the respondents. The majority of the respondents (73.3%) were males while 26.7% were females. Also, 79.9% were married. This is likely due to the fact that marriage is held in high esteem in Ghana, and is considered as a symbol of a matured individual (age-wise) being responsible (Ahortor, 2016; Bogya, 2014). Most of the respondents were males because, within the traditional settings in Ghana, males are considered to be the household heads;

Table 1. Demographic characteristics of respondents.

Characteristics	Category	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Total (%)	Chi-square (χ^2) test
Sex	Male	135 (90.0)	68 (60.7)	71 (63.4)	274 (73.3)	
	Female	15 (10.0)	44 (39.3)	41 (36.6)	100 (26.7)	
Age (y)	20-39	15 (10.0)	21 (18.8)	38 (33.9)	74 (19.8)	χ^2 = 57.96**; *df* = 6; *n* = 374
	40-59	74 (49.3)	70 (62.4)	64 (57.1)	208 (55.6)	
	60-79	39 (26.0)	19 (17.0)	10 (8.9)	68 (18.2)	
	80+	22 (14.7)	2 (1.8)	0 (0.0)	24 (6.4)	
Level of education	Primary	26 (17.3)	4 (3.6)	14 (12.5)	44 (11.8)	χ^2 = 203.20**; *df* = 8; *n* = 374
	JHS	19 (12.8)	8 (7.1)	47 (42.0)	74 (19.8)	
	SHS	26 (17.3)	10 (8.9)	9 (8.0)	45 (12.0)	
	Tertiary	14 (9.3)	86 (76.8)	18 (16.1)	118 (31.6)	
	None	65 (43.3)	4 (3.6)	24 (21.4)	93 (24.8)	
Occupation	Teacher	18 (12.0)	37 (33.0)	22(19.6)	77 (20.6)	χ^2 = 93.49**; *df* = 12; *n* = 374
	Trader	72 (48.0)	38 (33.9)	44 (39.3)	154 (41.2)	
	Civil servant	14 (9.3)	31 (27.7)	13 (11.6)	58 (15.5)	
	Farmer	27 (18.0)	2 (1.8)	20 (17.9)	49 (13.1)	
	Driver	10 (6.7)	0 (0.0)	13 (11.6)	23 (6.1)	
	Banker	0 (0.0)	4 (3.6)	0 (0.0)	4 (1.1)	
	Unemployed	9 (6.0)	0 (0.0)	0 (0.0)	9 (2.4)	
Marital status	Married	-	-	-	299 (79.9)	-
	Single	-	-	-	24 (6.4)	
	Widow(er)	-	-	-	29 (7.8)	
	Divorced	-	-	-	22 (5.9)	

**Indicates $p < 0.01$.

and the head makes household decisions (Klingshirn, 1973; Lloyd and Gage-Brandon, 1993). Females only assume leadership of the household in the absence of the husband. Even in such cases, she will require her husband's approval upon his return. Therefore, it could be said that decisions relating to land use planning are male-dominated. However, the quality and accessibility of the neighbourhood affect the lives of both males and females. Females play a vital role in terms of ensuring the cleanliness of the household and the neighbourhood at large (Lloyd and Gage-Brandon, 1993). Therefore, incorporating female views in land use planning issues, particularly regarding sanitation needs critical attention.

The age of the household heads differed significantly across the zones. Older household heads dominated Zone 1 as compared to the other zones because the area is an old or indigenous settlement. In contrast, the majority among the younger household heads, such as those within the age group of 20 to 39 years, were found living in Zones 2 and 3. Also, most (55.6%) of the respondents were in the age group 40 to 59 years indicating that the majority of the respondents were within the economically active class. This observation explains why people are putting up buildings in emerging or new developing areas, as further highlighted in the next section. This is an indication that the economically active age groups live outside of the indigenous settlements, possibly due to their ability to afford the cost of constructing new houses.

Education plays a vital role in all aspects of the functional socioeconomic system of a society. An individual's level of academic education determines how they will embrace and take part in crucial decision making (Klein, 1999). Of the 374 respondents, 31.6% had attained tertiary education while 24.8% had no formal education (Table 1). The level of education of the household heads varied significantly across the zones. 76.8% of the respondents in Zone 2 (Kpaguri Residential) were identified to have attained education at the tertiary level; but a sharp contrast was observed for Zone 1 (indigenous communities), where only 9.3% of the respondents had educational higher levels. Though the respondents have attained other levels of education, it is believed that tertiary education gives an individual the

Table 2. Building type, the use of the building, and obtaining building permits in the three zones of the Wa Municipality.

Parameter	Category	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Total (%)	Chi-square (χ^2) test
Type of building	Detached	18 (12.0)	54 (48.2)	23 (20.5)	95 (25.4)	χ^2 = 158.95**; *df* = 6; *n* = 374
	Semi-detached	7 (4.7)	44 (39.3)	8 (7.2)	59 (15.8)	
	Storey building	0 (0.0)	2 (1.8)	0 (0.0)	2 (0.5)	
	Compound	125 (83.3)	12 (10.7)	81 (72.3)	218 (58.3)	
Use of building	Residential	-	-	-	355 (94.9)	
	Commercial	-	-	-	8 (2.2)	
	Mixed use	-	-	-	11 (2.9)	
Obtained permit	Yes	0 (0.0)	100 (89.3)	12 (10.7)	112 (29.9)	χ^2 = 271.85**; *df* = 2; *n* = 374
	No	150 (100)	12 (10.7)	100 (89.3)	262 (70.1)	
Reason for not obtaining a building permit †	High cost	-	-	-	14 (6.4)	*n* = 220
	Unaware	-	-	-	189 (85.9)	
	Denied	-	-	-	17 (7.7)	

†Based on responses from only Zone 1 and Zone 3; **Indicates $p < 0.01$.

power to critically analyse and appreciate issues. Land use planning, with compliance to building regulations among others are determined by the individual level of understanding, and this is dependent on one's level of education. Previous studies have opined that low educational attainment in the Wa Municipality results in residence inability to understand building standards, which significantly leads to noncompliance of building regulations (Boamah, 2013; Abugtane, 2015). This noncompliance of building regulations has considerable impacts on the provision of sanitary facilities in the municipality.

A vast majority (97.6%) of the respondents were employed in various sectors of the economy whereas 2.4% of the respondents were unemployed. Traders (businessmen and women) constituted most of the employed group (41.2%) while bankers (1.1%) were the least. Furthermore, traders (48.0%) and teachers (33.0%) dominated Zones 1 and 2 respectively, while the respondents without employment (6.0%) lived in only Zone 1. The Chi-square test indicated a significant relationship between the occupation of the household heads and their areas of residence (zones). The results also suggest that some occupational distributions are located in some residential areas when compared with others. For example, most of the formal jobs are concentrated in the high-class residential areas such as Zone 2 and middle-class residential area, Zone 3, while the informal jobs are concentrated in the low-class residential areas such as Zone 1. This finding agrees with Hoyt's Sector Zone model which describes the urban structure to be in zones (residential areas) (Boamah et al., 2012). The low-class residents live very close or within the CBD where most of them work in informal jobs, shop, and cheaply commute to work, while the high-class residential areas live far from the CBD, and work in formal jobs.

Building age, type and usage in the Wa municipality

The respondents lived in both old and new housing structures, with ages from 1 year to 110 years (Figure 3). The majority of the houses across the zones were constructed in the year 1991 to 2005; the building age was averagely 25.5 years. Generally, the housing units in the indigenous settlements (Zone 1) were older (average = 33.3 years), but the houses in Zone 2 (average = 17.4 years) and Zone 3 (average = 16.4 years) had almost the same mean age. In addition, the maximum age of houses in Zone 2 is 25 years whereas that for Zone 3 was 27 years. Zone 3 is quite older because part of the area is an indigenous settlement. The fact that all the residential areas have a minimum age of 1 means that housing development is still taking place in all of them. However, the maximum age of 110 also suggested that some of the households were constructed before the introduction of physical development planning in the Wa Municipality. Most of the buildings sampled were used solely as residential facilities, with only about 5% serving as commercial or residential cum commercial facilities (Table 2). The results indicate that there are different kinds of residential units in the Wa Municipality, but compound housing facilities are the most common. In addition, the different zones had significantly different type of housing systems. As shown in Table 2, 58.3% of the respondents lived in compound houses, while 25.4, 15.8 and 0.5% of the respondents stay in detached, semi-detached and

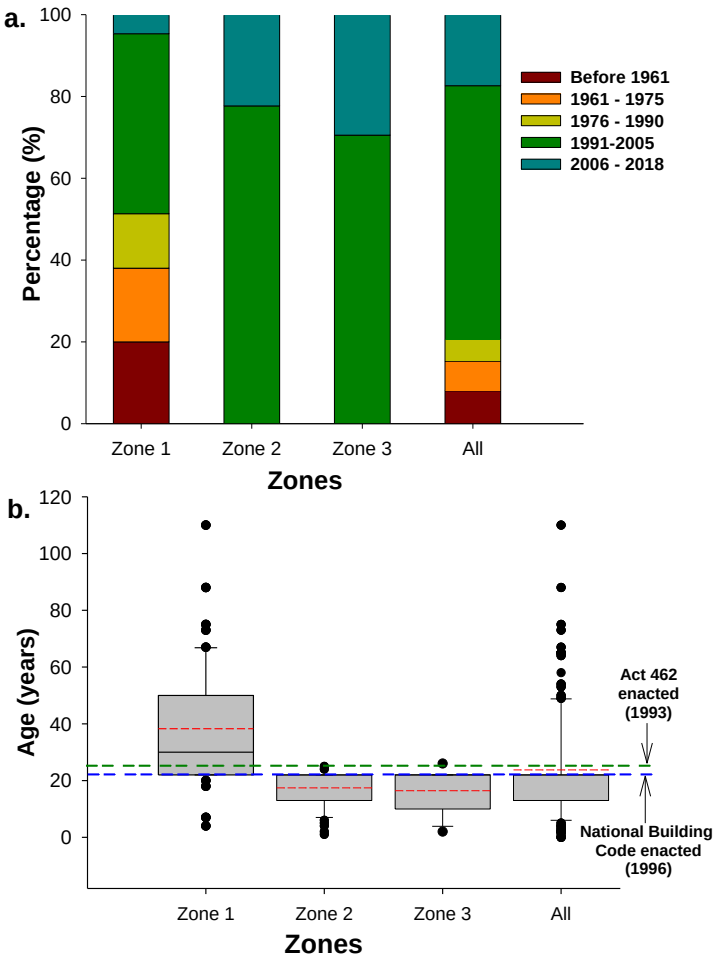

Figure 3. (a) Periods of construction and (b) age of buildings in the residential zones. In the box and whisker plot (b), the black dots denote outliers; the solid black line in the box and the red dashed lines represent the median and mean values respectively.

story buildings, respectively. The results agree with that of the 2010 population census data (GSS, 2014) which indicated that the majority (58.3%) of the dwelling units in the municipality are compound houses; separate houses and semi-detached houses constitute 23.0 and 10.2%, respectively. Considering the three zones, 83.3% of the houses were compound houses, 12% of the structures are detached, and 4.7% are semi-detached houses in Zone 1. The dominance of compound houses contributes greatly to the congestion of the Zone. This buttresses the Sector Zone Model that the low-class residential areas live in a congested area or environment, while the high-class residential areas live in spacious environments (Hoyt, 1939).

Conformity of buildings to land use plans

Land uses in the local plan of parts of the Wa Municipality, and all land uses on the plan indicate the kind of physical development that is allowed as shown in Figure 4. The local plan indicates areas for residence, open spaces as well as sanitary areas (marked with grey colour in Figure 4). The local plan is used as a tool for controlling physical development to achieve conformity of buildings to land use plans. Yendaw (2014), noted that communities in Ghana with ineffective land use planning schemes (land use planning regulations not achieving their stated objectives) have poor access to sanitation facilities such as refuse bays and collection points, poor access to residential areas and haphazard siting of buildings; but this does not apply to Kpaguri Residential (Zone 2) of the Wa Municipality. It can be seen that blocks of land within parcels of land have been allocated for sanitation purposes. Perhaps the view of Owei et al. (2010) will be the case of the Wa Municipality. They argued that unsuccessful enforcement of land use plans is one of the challenges of urban sprawl in developing countries. This

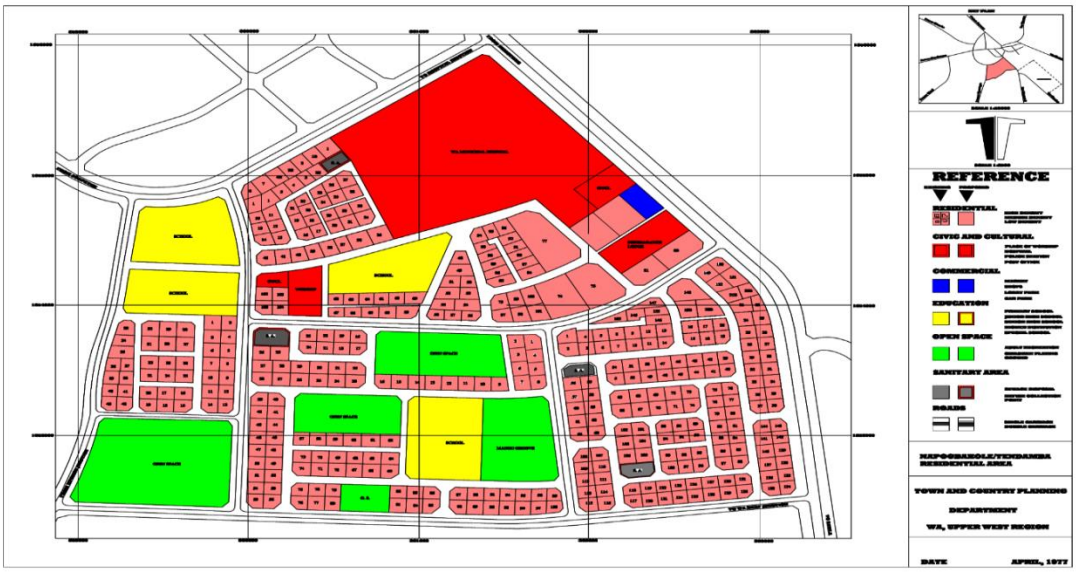

Figure. 4: Local plan of part of the Wa Municipality (TCPD-Wa, 2018)
(Sanitary places are marked with grey colour)

is due to the fact that the enforcement in these countries is often corrupt and intermittent. This brings up the discussion on household compliance with land use plans. The key issues discussed are the building type, obtaining of building permit and the extent of adhering to planning standards and regulation.

Act 462, enacted in 1993, and the National Building Code (LI 1630) prohibit any physical development without approval from the planning authority by the issuance of a building permit. However, from Table 2, most (70.1%) of the respondents built their houses without obtaining a building permit while only 29.9% had obtained building permits. This revelation supports the findings of Boamah et al. (2012), that most landlords constructed their facilities without securing building permits in the Wa Municipality. While no respondent (landlord) in Zone 1 and only 10.7% of the respondents in Zone 3 (Mangu) obtained a permit before putting up their buildings, 89.3% of the respondents in Zone 2 (Kpaguri Residential) obtained a permit before the construction. From Figure 3b, the majority of the houses in Zone 1 were built before the National Building Code was introduced, so it was not mandatory to secure permits before construction; hence, the observed outcome. The results also suggest that the residential areas in Zone 2 have higher compliance with the building regulations. The lack of acquiring building permits before constructing buildings is a major factor behind insanitary conditions in the Wa Municipality (Abugtane, 2015). Moreover, the type of residential areas significantly influenced the adherence to the building regulations. Generally, house owners in the newly developed areas, which are well-planned, complied with the building regulations such as obtaining permits before putting up buildings and provided sanitary facilities in these areas. On the issue of how the land use and spatial planning department assess compliance to building permits in the Wa Municipality, a key informant at the Town and Country Planning Department said: “The Town and Country Planning Department operates on statutory frameworks such as the Land use and Spatial Planning Act 2016 (Act 925) and National Building Regulation 1996 (L.I. 1630). The statutory frameworks mandate the department to ensure efficient use of land by way of planning. Building and development permits are what the department uses to ensure conformity of physical development to land use plans. However, there is no conformity to such development plans in the Wa Municipality because many land developers often fail to comply. Hence, some sanitary areas have been converted to other purposes.” Meanwhile, 85.9% of the respondents who did not obtain building permits indicated that they were not aware of building permit requirement when they were constructing their houses (Table 2). Those who were aware (6.4%) but still did not obtain the permit attributed their failure to the high cost of obtaining permits. The rest (7.7%) indicated that they were denied a building permit because they failed to provide the required information for obtaining a building permit. There is a sharp contrast between the explanations of the respondents and that of the TCPD regarding the non-compliance of obtaining permits prior to the construction of buildings. There seems to be less sensitising and ineffective enforcement of the land use plans by the municipal authorities and the Spatial Planning Unit. Meanwhile, factors such as the lack of an integrated central database system for permit processing, the lack of

Table 3. Compliance with building standards and the provision of sanitary facilities across the residential zones of the Wa Municipality.

Parameter	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Total (%)	Chi-square (χ^2) test
Level of compliance to building standards and regulations					
High	0 (0.0)	90 (80.4)	0 (0.0)	90 (24.1)	
Medium	0 (0.0)	2 (1.8)	8 (7.1)	10 (2.7)	χ^2 = 334.75**
Low	0 (0.0)	12 (10.7)	2 (1.8)	14 (3.7)	(*df* = 6, *n* = 374)
No compliance	150 (100.0)	8 (7.1)	102 (91.1)	260 (69.5)	
Toilet facility					
Private toilet	12 (8.0)	112 (100)	15 (13.4)	139 (37.2)	
Public toilet	138 (92.0)	0 (0.0)	80 (71.4)	218 (58.3)	χ^2 = 307.96** (*df* = 4, *n* = 374)
Open defecation	0 (0.0)	0 (0.0)	17 (15.2)	17 (4.5)	
Adequacy of public toilet facilities					
Yes	3 (2.1)	-	0 (0.0)	3 (1.2)	
No	141 (97.9)	-	106 (100)	247 (98.8)	
Waste dumping facility					
Household waste bin	6 (4.0)	110 (98.2)	9 (8.0)	125 (33.4)	
Communal container	144 (96.0)	0 (0.0)	69 (61.6)	213 (57.0)	χ^2 = 379.69** (*df* = 4, *n* = 374)
Dumping site	0 (0.0)	0 (0.0)	28 (25.0)	28 (7.5)	
Burning	0 (0.0)	2 (1.8)	6 (5.4)	8 (2.1)	
Waste facility providers					
Municipal Assembly	126 (84.0)	2 (1.8)	61(54.5)	189 (50.5)	
Zoomlion Ltd.	24 (16.0)	108 (98.2)	19 (17.0)	151 (40.4)	
Community members	0 (0.0)	0 (0.0)	16 (14.2)	18 (4.8)	χ^2 = 243.70** (*df* = 4, *n* = 356)
Adequacy of communal containers					
Yes	3 (2.0)	-	0 (0.0)	3 (1.2)	
No	147 (98.0)	-	92 (100.0)	239 (98.8)	

n is the number of valid cases; **Indicates $p < 0.01$.

coordination between the relevant institution, and too many processing steps vis-à-vis bureaucratic delays, have been cited as reasons why people do not obtain building permits in Ghana (Agyemang et al., 2014).

Adherence to planning standards and regulations

Regarding the general adherence of house owners to the planning standards and regulations, only 29.4% of the respondents were affirmative; the rest admitted to noncompliance. As shown in Table 3, the levels of compliance with the standards and regulations of buildings among the zones varied significantly. Buildings in Zone 1 were non-compliant; those in Zone 2, however, exhibited a high level of compliance (80.4%); and only about 9% of the buildings in Zone 3 had low-to-medium compliance. The high compliance in Zone 2 is because it is a high-class residential area which was well planned (Figure 5b). On the other hand, as evidenced in Figure 5a, the households in Zone 1 are congested and not arranged in a regular pattern that allows for the provision of some sanitary services. This observation is because households in Zone 1 do not have planning guidelines that will demand compliance, as discussed earlier. This result relates to the finding of Mabaso et al. (2015) that the lack of urban planning or failure to adhere to the provisions of such land use plans leads to unplanned, uncontrolled urbanisation, also known as urban sprawl. Additionally, (Boamah et al., 2012) argued that the noncompliance to building regulations in the Wa Municipality is caused by other factors including socio-cultural practices, political interference and, generally, the lack of knowledge regarding the importance of physical development planning. As a result, areas demarcated for the development of social infrastructure such as the

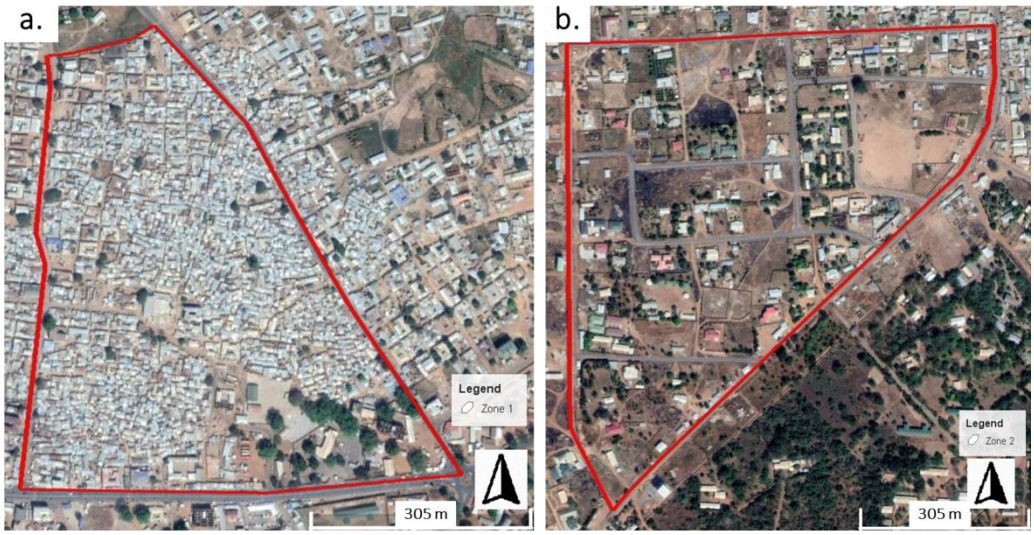

Figure 5. Aerial photographs from Google Earth depicting (a) haphazard developments in Zone 1 and (b) well-planned developments in Zone 2. The solid red line demarcates zone boundary.

construction of public toilets, siting of communal containers are often encroached and used for residential purposes (Abugtane, 2015). Consequently, the municipality is plunged into a 'sanitation mess' (Boamah, 2013; Osumanu et al., 2016). This sanitation problem is a clear indication that ULUP rationale has not been actualised in the Wa Municipality.

Provision of toilet facilities and spaces for toilet facilities

To ascertain compliance with the building standards and regulations in the study area, we further elicited information about the provision of sanitary facilities in the zones. Table 3 shows that the distribution of the types of toilet used among the various zones showed significant differences. Public toilets dominated Zones 1 and 3, whereas household toilets were typical of Zone 2. Figure 5 shows the distribution of public toilet facilities and Zones 1 and 3. As stated earlier, because Zone 2 is a newly developed, high-class residential area, every landlord is expected to incorporate a toilet facility in the house. Considering all the three zones, the public toilet facilities constituted the majority (58.3%) of sanitary facilities in the area followed by private facilities (37.2%); open defecation (OD) was practised in 4.5% of the households surveyed. The proportion of the households who practice open defecation in the study area is relatively smaller as compared to that reported by the GSS (41.8%) in the Wa Municipality. In Zone 1, public toilets dominated (92.0%); the remaining households (8%) had in-house toilets. All the households in Zone 2 had household toilets. Within the suburb of Zone 3, public toilet facilities served the majority of the population (71.4%), with 13.4% of the households having toilets facilities in their homes. A significant proportion (15.2%) of the households in Mangu has no sanitary facilities and, therefore, resorts to open defecation. This finding supports the argument of Oyinloye and Oluwadare (2015) that this lack of public toilet facilities results in the increase of open defecation in low-income residential areas and its associated health impacts. Specifically, Zormal (2016) also reported that the inadequacy of public toilets in the Wa Municipality had compelled some residents to resort to open defecation. However, a recent study indicated that the primary reasons for open defecation in the municipality is because it has been an age-long practice (57%) and financial constraints (18.6%) (Osumanu et al., 2019).

As presented in Figure 7, based on the responses, public toilet facilities are mostly provided by the WMA (97.4%), while Zoomlion Ghana Ltd. and community members/elders contributed to less than 3%. Moreover, 35.3 and 24.9% of the respondents said that the Municipal Assembly and community elders, respectively provided the spaces for the construction of the communal toilets facilities. Only 0.5% of the respondents said Zoomlion Ghana Ltd. provided spaces for the construction of the public toilets. This means that though the community members or elders do not provide public toilet facilities, they contribute significantly towards making land available for the building of such facilities. On the adequacy of the public toilet facilities, only 66.8% of the respondents provided answers. The majority (98.8%) of those that responded said the public toilets in their neighbourhoods were not enough, citing the unplanned nature of the suburbs as well as the negligence of the WMA in providing adequate facilities. Only 0.8% of the respondents were affirmative while the

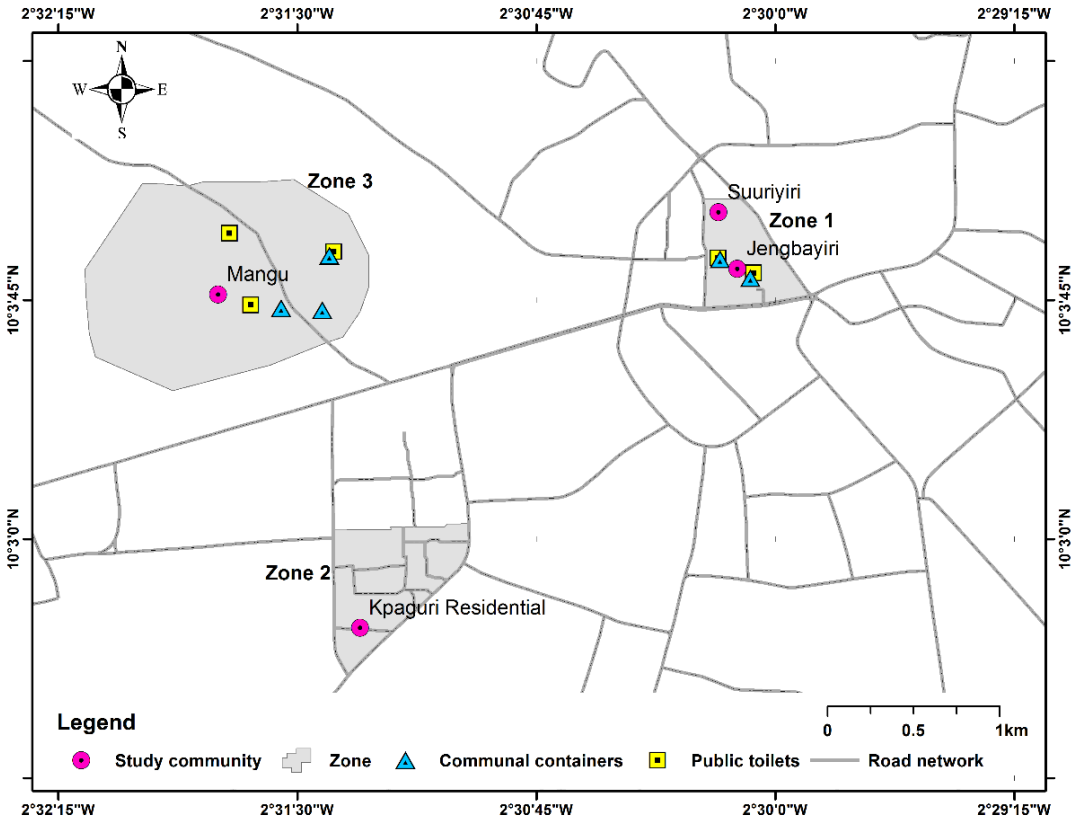

Figure 6. Spatial distribution of communal containers and public toilet facilities, and road network in the Wa Municipality.

rest provided no answer to the question. However, according to a staff of the Environmental Health Department of the WMA,

"Liquid waste management requires all households to own toilets in their houses and the Municipal Assembly to provide public toilets for strangers or people on transit. This is lacking because many households in the Municipality do not have toilets and the Assembly has not been able to provide enough for the public. Therefore, there is pressure on the few that are available, and many people also practice open defecation."

Thus, from both the WMA and the respondents, public toilets in the Wa Municipality are inadequate.

Provision of solid waste handling services and waste dumping facilities

From Table 3, the solid waste disposal facilities or methods used across the zones varied significantly. As shown in Figure 6, communal containers are placed at designated places in the Wa Municipality where households dump their waste. About 57% of the respondents indicated that their households dump their waste in communal containers; 33.4% had household waste bins which are collected by a door-to-door service provider; 2.1% of the respondents always burn their waste. Most (80%) of the respondents who reported dumping their waste in waste bins were found in Zone 2. However, almost all (96.0%) respondents within Zone 1 said they dumped their waste into communal containers. Though the communal container system was the most popular disposal option in Zone 3 (Mangu suburb), accounting for 61.9%, a quarter of the respondents indicated that they dispose of their waste at a dumping site. While Zones 1 and 2 use the communal containers and household bins, respectively, Zone 3 has a blend of the communal containers and waste dumping sites. The results confirm previous reports (GSS, 2014; Bowan, 2013) that the communal container system is the most prevalent waste collection option in the Wa Municipal. However, an earlier report suggested that spaces for communal containers have been encroached, compelling residents to travel a long distance before accessing communal containers in the Wa Municipality. Thus, some people are tempted to dump their waste at inappropriate locations (Osumanu et al., 2016). This may have deleterious sanitary ramification on the health of dwellers

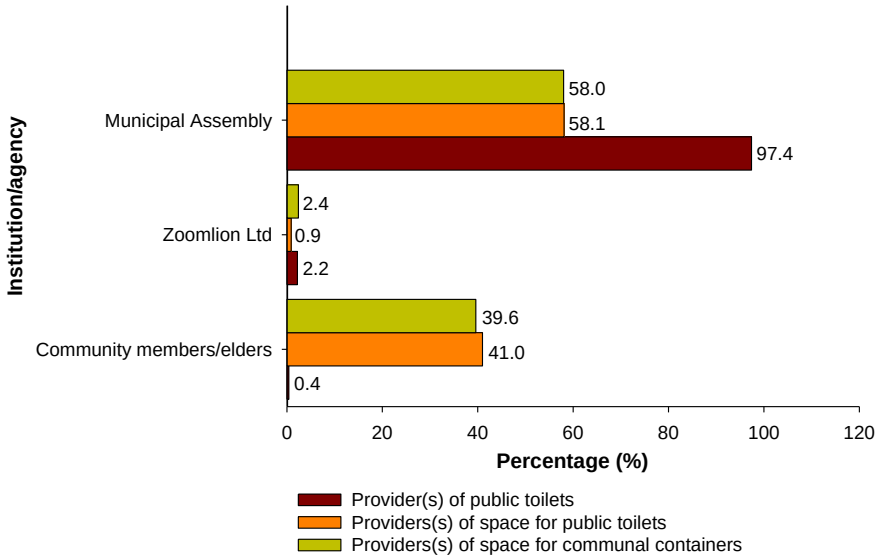

Figure 7. Providers of public toilets and space for public toilet facilities and communal containers in Zone 1 and Zone 3.

in the Wa Municipality. Therefore, there is a need for land use planners to make a provision for the siting of communal containers in building plans and enforce adherence to these plans. Furthermore, one of the informants intimated: “In the planning guidelines, local plans are to be prepared in blocks; each has a sanitary area. Sanitary areas are provided in the local plan for low-class and second-class residential areas, while that of the high-class residential areas, no provision is made for sanitary but rather every house must have toilet and waste facilities.” Since residents in Zones 1 and 3 fall in the low and middle-income brackets, respectively, affordability of the door-to-door waste collection service is a challenge; hence, the local authorities provide public sanitary areas and facilities. However, the local plans for the Kpaguri Residential (Zone 2), a high-class residential area, demarcated no sanitary areas (public container sites or dumping sites) because every house is expected to subscribe to a door-to-door waste collection service. The absence of sanitary areas and facilities in Kpaguri Residential implies that developments in the area have conformed to the local plans of the Wa Municipality. Moreover, the dominance of household waste bins in Zone 2 relates well with the sector model which argues that the wealthy class prefers to stay far away from the CBD, and are able of pay for other services such as transport and sanitation.

Access to sanitary facilities

On the general accessibility to sanitation facilities, most (68.2%) of respondents, all residents of Zones 1 and 3 indicated that they do not have full access to public sanitation facilities in their suburbs because of the unplanned nature. The remainder, mostly residents of Zone 2, said otherwise and pointed out that their suburbs are well-planned (Table 4). As discussed earlier, many households still have challenges in accessing sanitary facilities in the Wa Municipality primarily because the municipality has inadequate sanitary facilities, as earlier reported by other studies (Boamah, 2013; Dongballe, 2016; Zormal, 2016). Further, as presented in Table 5, we found that inadequate spacing of the available facilities, long distances from houses and conflicts in siting the facilities also pose challenges to the accessibility and sanitary facilities. A staff of the TCPD of the WMA noted: “In providing sanitary space in the local plans, the distance of every house to the sanitary place is considered to ensure easy access. Planned areas allow every house in all the residential areas to have good access to sanitary facilities. However, areas not planned face challenges in accessing sanitary facilities.” This implies that the TCPD are making efforts to facilitate residential areas access to sanitary facilities; however, this is only possible if the area is well-planned. As a result, the indigenous settlements, which were occupied before the development of the land use planning guidelines often, lack the opportunity to be provided with sanitary areas within their residences.

In addition to this, the proportion of homes accessible by vehicles and well-connected to roads, and the conditions of road networks were significantly different across the zones, as depicted by the Chi-square results in Table 4. The results show that in Zones 1 and 3, the lack of accessible roads and the poor conditions of the

Table 4. Conditions of roads linking suburbs and homes, and walking time to sanitary facilities.

Parameter	Zone 1 (%)	Zone 2 (%)	Zone 3 (%)	Total (%)	Chi-square (χ^2) test
Have full access to sanitary facilities?					
Yes	4 (2.7)	112 (100)	3 (2.7)	119 (31.8)	-
No	143 (95.3)	0 (0.0)	107 (95.5)	250 (66.8)	
Home accessible by vehicle?					
Agree	9 (6.0)	110 (98.2)	8 (7.1)	127 (33.2)	
Disagree	141 (94.0)	0 (0.0)	97 (86.6)	238 (63.6)	χ^2 = 307.40** (*df* = 4, *n* = 374)
Neutral	0 (0.0)	2 (1.8)	7 (6.3)	9 (2.4)	
Houses well-connected with road?					
Agree	0 (0.0)	108 (96.4)	0 (7.1)	127 (34.0)	
Disagree	149 (99.3)	0 (0.0)	109 (86.6)	238 (75.7)	χ^2 = 365.70** (*df* = 4, *n* = 374)
Neutral	1 (0.7)	4 (3.6)	3 (6.3)	9 (1.3)	
Conditions of the road network					
Good	1 (0.7)	90 (80.4)	0 (0.0)	91 (24.3)	
Fair	10 (6.6)	22 (19.6)	3 (2.7)	35 (9.4)	χ^2 = 331.64** (*df* = 4, *n* = 374)
Poor	139 (92.7)	0 (0.0)	109 (97.3)	248 (97.3)	
Main challenges posed by poor road network†					
Unable to access house by vehicles				223 (99.6)	-
Unable to access public sanitation facilities				220 (98.2)	
Have full access to sanitary facilities?					
Yes	4 (2.7)	112 (100)	3 (2.7)	119 (31.8)	-
No	143 (95.3)	0 (0.0)	107 (95.5)	250 (66.8)	
Walking time from house to sanitary facilities (min) †					
1 – 10	103 (73.0)	-	70 (0.7)	173 (70.9)	
11 – 20	38 (27.0)	-	23 (6.6)	61 (25.0)	-
21 – 30	0 (0.0)	-	10 (9.7)	10 (4.1)	

n is the number of valid cases; †Based on only responses from Zone 1 and Zone 3.

Table 5. Distance, spacing, and land use conflicts in siting sanitary facilities.

Parameter	*n*	Agree (%)	Disagree (%)	Neutral (%)
Facilities adequately spaced	258	9 (3.5)	235 (91.1)	14 (5.4)
Distance allows easy access	257	34 (13.2)	180 (70.0)	43 (16.7)
Conflict in siting facilities	256	57 (98.0)	140 (70.0)	59 (100.0)

Results based on responses from only Zone 1 and Zone 3; *n* is the number of valid cases.

existing roads contributes to the difficulty of accessing sanitation facilities. Most of the houses in these zones are not well-connected to a road or have roads in a deplorable state. The lack of access routes hampers the delivery of door-to-door waste collection services by Zoomlion Ghana Limited. A staff of the company confirmed this assertion, saying “Our waste trucks have easy access to residential areas with roads network but have challenges in areas without roads and walkways. It is, therefore, not easy accessing communal containers in Suuriyiri and Jengbeyiri.” The poor road access has also culminated in the popularity of the communal containers and waste dumping sites in the two zones. The absence of roads network implies that residents have to walk for a

long distance to access sanitation facilities elsewhere, or are living under poor sanitation conditions. The residents in these zones walk between 1 and 30 min to access sanitary facilities, with a significant proportion (about 30%) walking more than 10 min. This finding empirically illustrates the description by the Sector Model that low-class residential areas are highly inaccessible, have no open spaces (congestion) and are characterised by bad environmental issues like poor sanitation and air pollution (Hoyt, 1939).

Regarding the conflicts in siting sanitation facilities, the Environmental Health Officer at the WMA explained as follows: “The Municipal Assembly provides sanitary areas, as contained by the general layout of the municipality by the Town and Country Planning Department. The assembly has to provide the sanitary facilities. However, when the assembly fails to negotiate well with landlords to procure and protect such places for sanitary areas, they are encroached by the landowners, and large sums of monies are paid to compensate the landlords in order to acquire places for sanitation practices. Moreover, the unplanned areas are deprived of sanitary facilities once it is difficult to access land.” Therefore, though the local plans provide spaces for both residential and sanitation facilities, the WMA needs to negotiate with the landlords in order to procure and protect the public places (sanitary areas). In addition to this, the landowners can claim their lands if the negotiation fails or delays, thus making it difficult for the Municipality to access places for sanitation. Hence, the dynamics between the WMA and the landowners also contribute to the challenges associated with limited access to sanitary facilities in the Wa Municipality.

Conclusion

This study investigated the impact of ULUP on the provision of sanitation facilities in the Wa Municipality, using three zones of different land use and socio-economic characteristics. We found that less than one-third of the landlords had permits before constructing their buildings, leading to noncompliance to building regulations and resulting in insanitary conditions. The noncompliance was typical of the indigenous settlements because the building regulations and local plans were not available at the onset of the developments in such areas. Moreover, a significant proportion of the respondents who admitted to non-compliance were unaware of the need to secure building permits prior to any physical development. Also, adherence to building regulations led to the provision of household toilet facilities whiles good access routes to households facilitated the delivery of door-to-door waste collection services. These observations were typical of the high-income zones. Communal container systems and public toilets dominate the low to middle income communities; and apart from the municipal authority, community members and elders contributed significantly to providing lands for such sanitary facilities. Nonetheless, current challenges include conflict of land use in siting public sanitary facilities, insufficient toilet facilities, long distances from houses to sanitary facilities and poor access routes for waste collection vehicles. From this study, it is recommended that the public is sensitised and given more education on the need and procedures of obtaining building permits before developing their lands, through radio programs and community fora. The WMA should create and adopt urban renewal strategies to provide sanitary services for unplanned areas like Jangbeyiri and Suuriyiri. Moreover, municipal authorities must put in measures such as Public Private Partnership (PPP) to ensure that lands marked and secured for sanitary purposes are protected from encroachers.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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Trends in land use/land cover changes in the Densu River basin and its impact on the Weija reservoirs and the Densu Delta (Sakumo I lagoon) in Ghana

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The Densu River basin is one of the most import water resources in Ghana. It is a source of drinking water to more than half of the five (5) million populations of Accra and seven other communities within the basin. Rapid population growth and increasing development pressure within the basin is changing the basin land cover into settlement. This study examined the trend in land use and land cover changes that occurred within the basin from 1986 to 2018. The results show that between the years 1986 and 2018, the area within the basin covered by settlement and bare land increased from about 3% to about 25%. Within the same period, the forest area reduced from nearly 49% to about 17%. Shrub and grassland increased from 27% to about 49%, farmland decreased from nearly 20% to about 8% and the water bodies changed only marginally, from 1.02 to 1.15%. In general, the most significant changes in land use and land cover occurred between 1986 and 2002. After 2002 the land use and land cover changes either slowed down or changed course. This can be attributed to the establishment of the Densu Basin Board in 2003. Through the board a riparian Buffer Zone Policy was developed with the aim of protecting and maintaining the vegetation cover within the basin so as to improve water quality.

Key words: River Basin, land use and land cover changes, water resources management.

INTRODUCTION

Land use refers to human actions on the land surface that modifies the land cover and it defines how lands are used while land cover is the characteristic physical covering on the land surface that describes an area (Food and Agriculture Organization, 1997). Studies have suggested that 83% of the earth's land surface has been affected by human settlements and activities, leaving only 17% in the wilderness (CIESIN, 2002). In most cases, an anthropogenic influence on biophysical factors results in land use and land cover changes (Addae and Oppelt, 2019). The alteration of the world's land surface has reached an unprecedented pace and magnitude and this has resulted in changes in land use (human purpose or intent applied to these attributes) and land cover

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(biophysical attributes of the earth's surface) (Lambin et al., 2001).

The driving force behind land use and land cover changes is several. Ayivor and Gordon (2012), stated that land use and land cover changes are mostly driven by the rural economy of an area and hence it is place specific. Geist and Lambin (2002), concluded that land use and land cover changes are driven by forces that have varying geographical and historical contexts and their influences are mostly due to their proximity to the area. Several researchers have also concluded that land use and land cover changes, especially urbanisation, is mostly driven by population growth and rural-urban migration as a result of human needs for economic prosperity and unequal distribution of social amenities (Addae and Oppelt, 2019; Kuma and Ashley, 2008; Geist and Lambin, 2002). The problem of rapid urbanization as a result of high population growth in Ghana is putting a great deal of pressure on land use and land cover (Asamoah et al., 2018).

Land use and land cover (LULC) changes resulting in environmental degradation and deforestation threatens the sustainability of water resources (Africa Commission Report, 2000). Changes in LULC are very important as they influence the flow of water on the land surface and different LULC changes generates different hydrological responses. Urbanization generates negative hydrological responses because it mostly results in flooding, high sediment transportation resulting in siltation and water pollution (Aduah et al., 2015). The conversion of forest land to other land uses such as agriculture or grassland has resulted in an increase in infiltration and a decrease in run off and stream discharge at Shalamulun River watershed in China (Yang et al., 2012).

A study by Attua et al. (2014) found a significant correlation between increases in an urban/bare land to turbidity and dissolved oxygen (DO) in the Densu River and also concluded that a changes in agricultural lands were significantly correlated with the pH, nitrate and phosphate concentration in the water. Kuma and Ashley (2008) concluded in their studies that between 1980 and 2007, precipitation and potential evapotranspiration within the Weija reservoir area reduced annually at a rate of 0.93 and 0.14%, respectively. The combined effect of the two is that natural runoff should possibly be decreasing. However, runoff into the Weija reservoir increased as a result of vegetation loss within the same period which generally increased runoff rate into the reservoir. The increasing urbanisation activities within the Densu River basin reduced the vegetative cover along the river, the reservoir and the delta making soils more vulnerable to erosion into the river, the reservoir and the delta, with serious implications on channel morphology and sedimentation (Kusimi, 2009).

Most of the communities within the basin depend on the Densu River for their survival. The Densu River has many uses such as for fishing especially along the reservoir, for irrigation farming specially around Nsawam and as a source of drinking water. The Densu River has eight water supply schemes that provide portable water to the communities within the basin and some communities outside the basin. Five of the water supply schemes depend directly on the Densu River while the remaining three are supplied with groundwater.

The current capacity of the Weija Dam drinking water treatment plant is 54.2 MGD. This treatment plant supplies water to more than half of the five million population in Accra-the capital city of Ghana (mostly in the western part of Accra, that is, Korle-Bu, Dansoman, Accra Central, Darkuman, Sowutuom, Achimota, Mallam, Bortianor) and Kasoa in the Central Region. The river is therefore very crucial in terms of its drinking water supply, irrigation farming and fishing. Any negative effect on the Densu River is likely to cause a major problem to many people who depend on the river for their daily survival.

This study therefore investigated the trend of land use and land cover change in the Densu River Basin from 1986 to 2018 and its impact on the water system. The specific objective is to:

(1) Develop historic land-use/cover maps for multiple years using Landsat images of 30 m × 30 m spatial resolution;
(2) Conducting change detection and analysing trends in land use/cover changes from 1986 to 2018 for the Densu basin, the Weija reservoir and the Densu Delta (Sakumo I lagoon) site;
3. Assessing impacts of land use/cover change on the Weija reservoir and the Densu Delta (Sakumo I lagoon) site.

METHODOLOGY

The study was conducted for the Densu River basin. The basin is part of the Coastal River System group in Ghana with an estimated total area of about 2,600 km^2. It is located between latitude 5°30'N - 6°17'N and longitude 0°10'W - 0°37'W (Figure 1). The river covers a distance of about 116 km from the Atiwa Mountains where it takes its source to the Weija Dam and then it enters the sea through the Densu Delta Ramsar site also known as Sakumo I Lagoon at Bortianor in the Ga Municipality. The basin spans three administrative regions of Ghana, namely, the Central, Greater Accra and Eastern regions. It covers 10 administrative districts in Ghana, most of which are in the Eastern Region. In terms of land area, 72% of the basin is within the Eastern region, 23% is within the Greater Accra and 5% is within the Central Region. Data from the 2000 Ghana population and housing census indicate that the average population density within the basin is 387 pop/km^2, which is five (5) times higher than the national average population density of 77 pop/km^2 (WCR, 2007). This high population density within the catchment has resulted in the over exploitation of the Densu River. In fact, the Densu River is one of the most exploited rivers in Ghana (WRC, 2007).

The original ecology of the Densu Basin was moist semi-deciduous forest with thick undergrowth featuring rich flora and fauna. The basin has two protected forest reserves within the East Akim district namely the Atewa and Apedwa forests. There are also

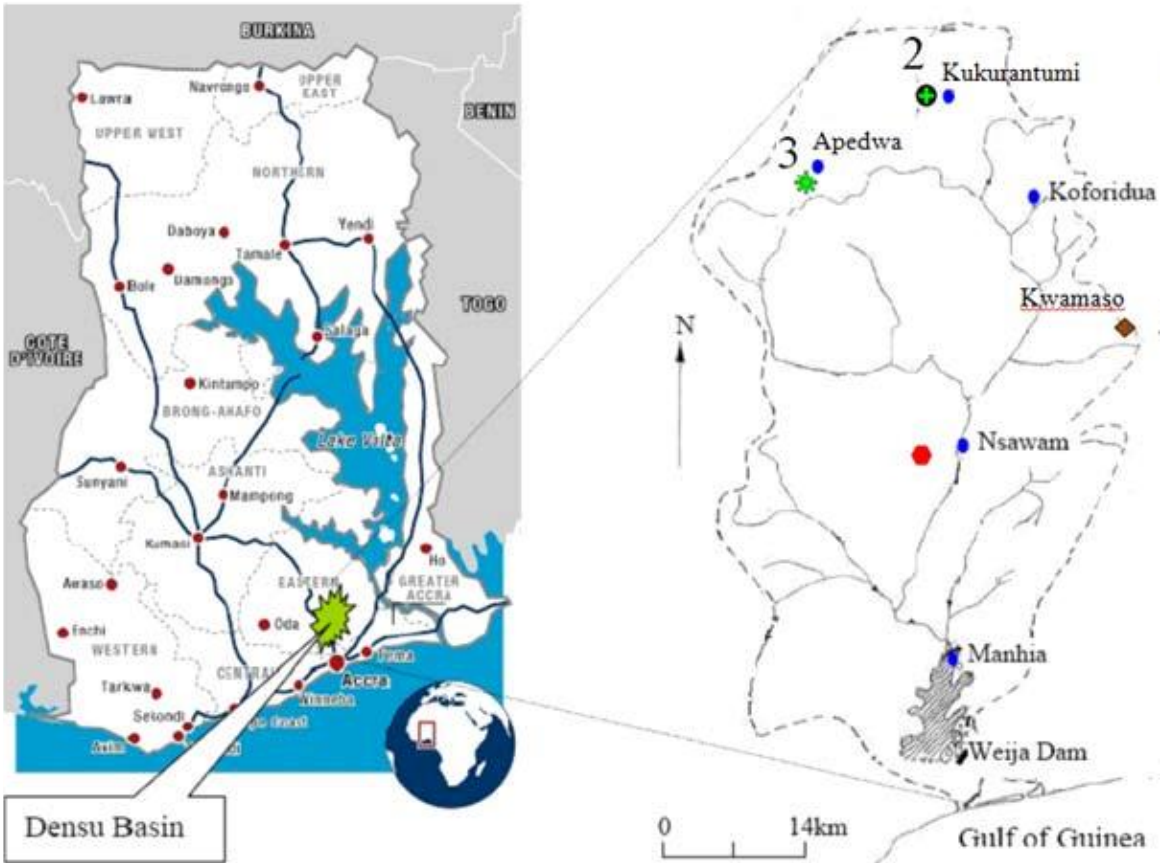

Figure 1. Map showing the location of the Densu River Basin in Ghana.
Source: Adapted from: http://www.volu.org/map.html.

Table 1. A Summary of the Landsat images and their date of acquisition.

Satellite	Date of acquisition
Landsat 5	22nd December, 1986
Landsat 4	10th January, 1991
Landsat 7	26th December, 2002
Landsat 7	6th January, 2013
Landsat 7	4th January, 2018

two other small reserves located in the Fanteakwa and Yilo Krobo districts.

The Densu Delta site also known as the Sakumo I Lagoon is where the Densu River enters the sea. The site constitutes one of Ghana's internationally declared protected wetland areas (Ramsar site) because of its sanctuary for migrating seashore bird species which utilise the delta site for roosting and as nesting grounds.

Protection activities in the area are undertaken by the Wildlife Division of the Forestry Commission, in close consultation with Panbros Salt Company, which owns part of the Ramsar site. A large portion of the Sakumo I Lagoon has been lost due to urban development. Most of the protected vegetation along the lagoon have been cleared for urban development resulting in the flooding of some parts of the area around the lagoon during parts of the raining season (May-July). The flooding becomes worse when the spillway at the Weija dam is opened because of the encroachment of the waterway from the dam and the area of the Densu delta which normally serves as a receptor to the flood water from the dam.

A Landsat Thematic Mapper (TM) image for the years 1986, 1991, 2002, 2013 and 2018 were acquired for the land use and land cover classification maps. The idea was to determine the land use and land cover changes for a minimum period of 30 years. The images were freely downloaded from the United States Geological Survey Earth Explorer webpage (https://earthexplorer.usgs.gov). A summary of the Landsat images and their date of acquisition is shown in Table 1.

The sensors on board Landsat 4 and 5 have a spatial resolution of 30 m×30 m for bands 1 to 5 and band 7 while the thermal band 6 has a spatial resolution of 120 m×120 m. Landsat 7 carries the Enhanced Thematic Mapper Plus (ETM+) with a 30 m×30 m spatial resolution for band 1 to 5 and Band 7, and a 60 m×60 m spatial

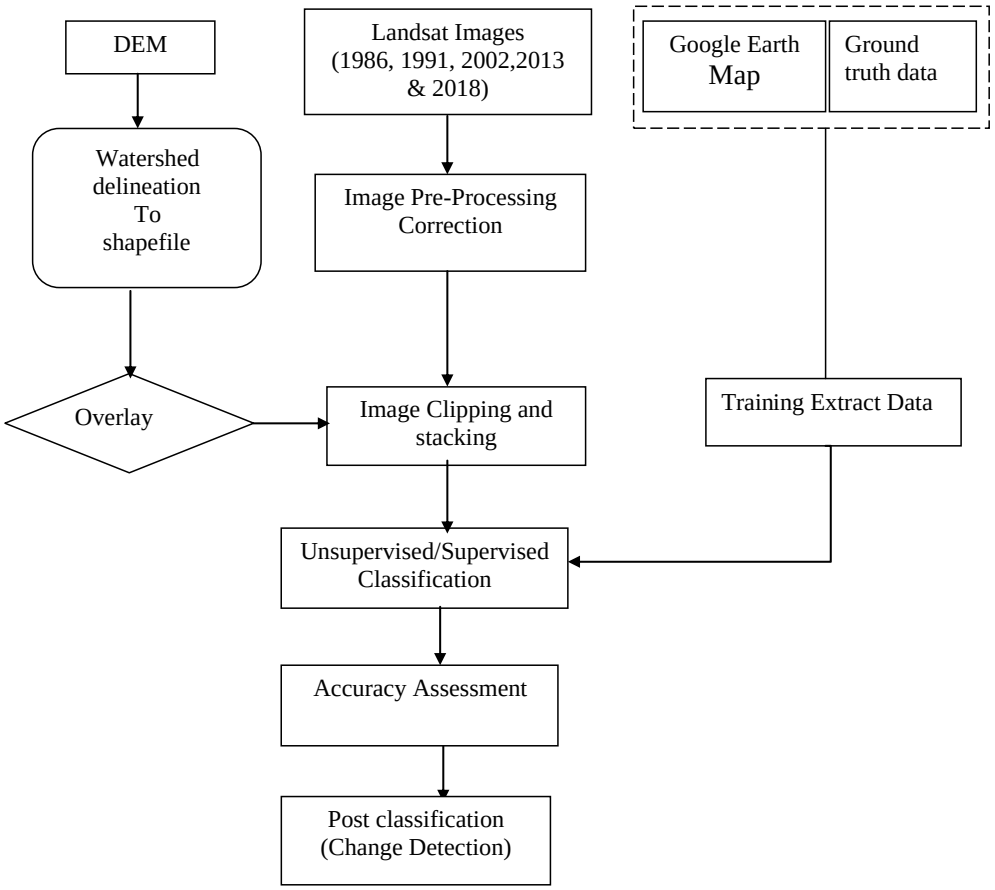

Figure 2. Flowchart for Land Use/Cover Classification and Accuracy Assessment.

Table 2. Land use and land cover types and description.

Land use/cover types	Description
Settlement	Residential areas and associated driveway
Bare land	Lands where there is no vegetation
Forest	Large area of mostly trees
Shrubs	Woody plants which are smaller than trees
Grassland	Grasslands are areas where the vegetation is dominated by grass
Farmland	Fields where food crops, cash crops and vegetables are grown
Water Bodies	Fields where food crops, cash crops and vegetables are grown

resolution for thermal band a 6 and 15 m×15 m spatial resolution for Panchromatic Band 8.

The flowchart in Figure 2 indicates the processes of obtaining the Land Use/Cover maps within the Densu River Basin using QGIS and ENVI. The selected downloaded Landsat images used for the land use/cover were with less or no cloud cover as cloud cover can lead to mis-classification of land use/cover. The images were pre-processed for atmospheric correction using QGIS. After the pre-processing of the images, the Area of Interest (AOI) which is the Densu River basin area was obtained from the images using the Densu River Basin Shapefile in QGIS. The extracted images were then stacked depending on the Landsat satellite used in acquiring the image. For Landsat 4, 5 and 7 images of Band 1 to 5 and then Band 7 were stacked together. The stacked image was then processed in ENVI for the land use/cover classification. Both supervised and unsupervised classifications were performed in ENVI. The unsupervised classification was performed first and the aim was to identify areas with similar classes to aid supervised classification.

The supervised classification was undertaken using ground truth data that were obtained by driving across the basin and taking coordinates of different LULC classes, with the aid of a handheld Global Positioning System (GPS). The history of the extent and trend of land use and land cover changes were also obtained by talking to chiefs and opinion leaders in towns and villages within the basin. This helped in determining the previous LULC at different locations in the basin. The land use/cover classes for which data were obtained are summarized in Table 2.

Table 3. Created Land use/cover classes.

Class number	Land use/cover class
1	Settlement and bare land
2	Forest
3	Shrub and grassland
4	Farmland
5	Water Bodies

The supervised classification was done with ENVI using the ground truthing data as the training data for the different classes. The five created LULC classes are shown in Table 3.

This was done by defining training areas for the various classes of Settlement and Bare land, Forest, Shrub and Grassland, Farmland and Water Bodies using the ground truth data obtained from the basin. The maximum likelihood classification algorithm was selected. This is because the maximum likelihood classification algorithm is the least affected by the size of training data sets and when a small-sized training data set is used, it still performs well (Li et al., 2014).

RESULTS AND DISCUSSION

Densu River basin

The derived land use and land cover maps for the Densu basin for the years 1986, 1991, 2002, 2013 and 2018 are shown in Figure 3a, b and c.

The distribution of the land use and land cover classes in terms of percentage in area and the total area are shown in Tables 4 and 5.

The trend in land use and land cover changes is also shown in Figure 4. The land use/cover class that increased most within the period is settlement and bare land whilst the land use/cover class that reduced most within the period is forest.

Between the year 1986 to 2018, the area within the basin covered by settlement and bare land increased from about 3% to about 25%. Within the same period, the forest area reduced from nearly 49% to about 17%. Shrub and grassland increased from 27% to about 49%, farmland decreased from nearly 20% to about 8% and the water bodies changed only marginally, from 1.02 to 1.15%.

The area of settlement and bare land consistently increased throughout the period from 1986 to 2018. This is mostly due to the increasing urbanisation in Accra, Kasoa and the other major towns within the basin such as Koforidua, Nsawam, Suhum and Adeiso. Table 6 shows the trend in increasing settlement and bare land from 1986 to 2018. The highest average yearly increase in settlement and bare land occurred between 2013 and 2018 while the lowest rate occurred between 1986 and 1991.

There was a general decreasing trend in the forest area between 1986 and 2013 (Table 7). However, the rate at which the forest area was reducing slowed down significantly to an annual rate of 0.07% between 2002 and 2013 from a rate of 1.90% between the years 1991 and 2002. The forest area then increased slightly by an average yearly rate of about 0.27% between the years 2013 and 2018.

The shrub and grassland area increased, on average, from 1986 to 2018. The most significant increase occurred between 1986 and 1991 at an annual rate of 3.38% (Table 8). This was followed by a marginal reduction between 1991 and 2002 at a rate of 0.20%. The trend changed to an increase between 2002 and 2013 at an annual rate of 0.39%, with a further increase between 2013 and 2018 at an annual rate of 0.43%.

The area for farmland generally reduced from 1986 to 2018 (Table 9). Between 1986 and 1991, the farmland area reduced yearly at a rate of 1.28%. On the contrary, there was an increase between 1991 and 2002, at an annual rate of 1.32%. It then decreased again between 2002 and 2013 at a rate of 0.87% and further decreased by 2.02% per year between 2013 and 2018. This therefore shows that farming activities decreased within the basin. Table 9 shows a summary of the trend of farmland within the Densu River basin from 1986 to 2018.

The area occupied by water bodies did not change significantly between 1986 and 2018 (Table 10). The year on year changes in area occupied by the water bodies were not significant. The average rate of change is 0.01%. A summary of the rate of change in the area occupied by water bodies between 1986 and 2018 is shown in Table 10.

In general, the most significant changes in land use and land cover occurred between 1986 and 2002. After 2002 the land use and land cover changes either slowed down or changed course. The settlement and bare land and shrub and grassland changes that occurred between 1986 and 2002 is about three times that which occurred between 2002 and 2018. Forest area reduced by about 66% between 1986 and 2002 but increased slightly by about 4% between 2002 and 2018. Farmland increased by about 40% between 1986 and 2002 but reduced by about 70% between 2002 and 2018.

Table 11 shows the changes in land use and land cover that occurred before 2002 and the changes that occurred after 2002.

The difference in trend can be attributed to the

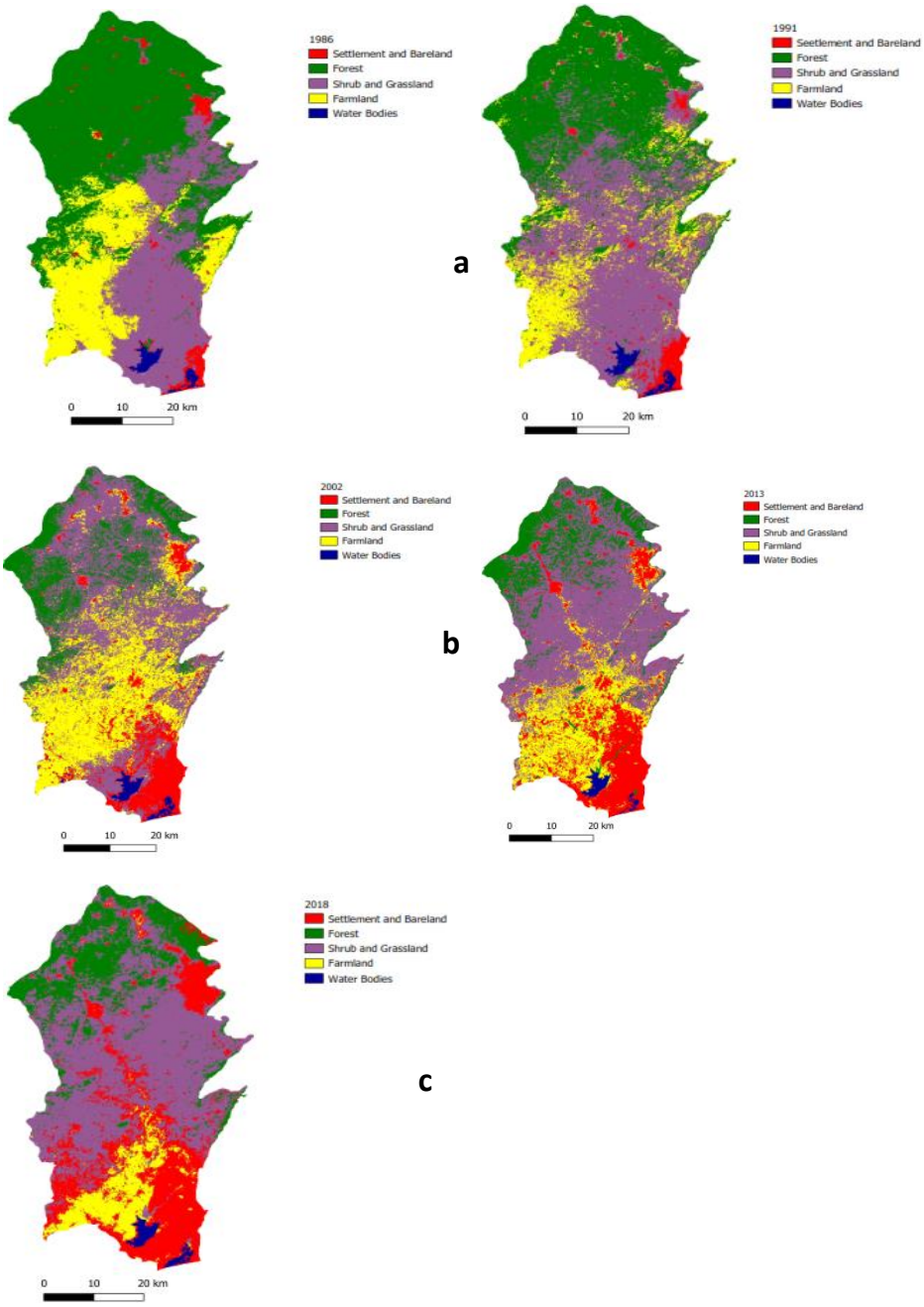

Figure 3. (a) Land use and Landcover maps for 1986 and 1991. (b) Land use and Landcover maps for 2002 and 2013. (c) Land use and Land cover map for 2018.

Table 4. Percentage of area covered by land use and land cover categories in 1986, 1991, 2002, 2013 and 2018.

Land use/cover types	% of area 1986	% of area 1991	% of area 2002	% of area 2013	% of area 2018
Settlement and bare land	2.98	3.39	11.79	18.09	24.55
Forest	48.77	37.69	16.83	16.09	17.46
Shrub and grassland	27.32	44.21	42.07	46.38	48.54
Farmland	19.91	13.49	27.97	18.45	8.33
Water bodies	1.02	1.20	1.35	0.99	1.15

Table 5. Area covered by land use/cover categories in 1986, 1991, 2002, 2013 and 2018.

Land use/cover types	Area (km^2) 1986	Area (km^2) 1991	Area (km^2) 2002	Area (km^2) 2013	Area (km^2) 2018
Settlement and bare land	78.88	90.04	312.60	479.39	650.66
Forest	1292.84	999.14	446.05	462.61	462.66
Shrub and grassland	724.32	1171.95	1114.94	1229.36	1286.52
Farmland	527.67	357.72	741.32	489.08	220.67
Water bodies	27.17	32.01	35.97	26.45	30.37

Table 6. Rate of change of 'Settlement and Bare land' land-use/-cover type in the Densu Basin (1986 to 2018).

Change (years)	Settlement and bare land		Average % Change in area/year
	No. of years	% of Change in area	
1986-1991	5	0.42	0.08
1991-2002	11	8.40	0.76
2002-2013	11	6.29	0.57
2013-2018	5	6.46	1.29

Table 7. Rate of change of 'Forest' land use/cover type in the Densu Basin (1986 to 2018).

Change (years)	Forest		Average % change in area/year
	No. of years	% of change in area	
1986-1991	5	-11.04	-2.22
1991-2002	11	-20.87	-1.90
2002-2013	11	-0.73	-0.07
2013-2018	5	1.37	0.27

Table 8. Rate of change of 'Shrub and Grassland' land use/cover type in the Densu Basin (1986 to 2018).

Change (years)	Shrub and grassland		Average % change in area/year
	No. of years	% of Change in area	
1986-1991	5	16.89	3.38
1991-2002	11	-2.15	-0.20
2002-2013	11	4.31	0.39
2013-2018	5	2.16	0.43

Table 9. Rate of change of 'Farmland' land use/cover type in the Densu Basin (1986 to 2018).

Change (years)	Farmland		Average % Change in area/year
	No. of years	% of change in area	
1986-1991	5	-6.41	1.28
1991-2002	11	-14.47	1.32
2002-2013	11	9.52	-0.87
2013-2018	5	-10.12	-2.02

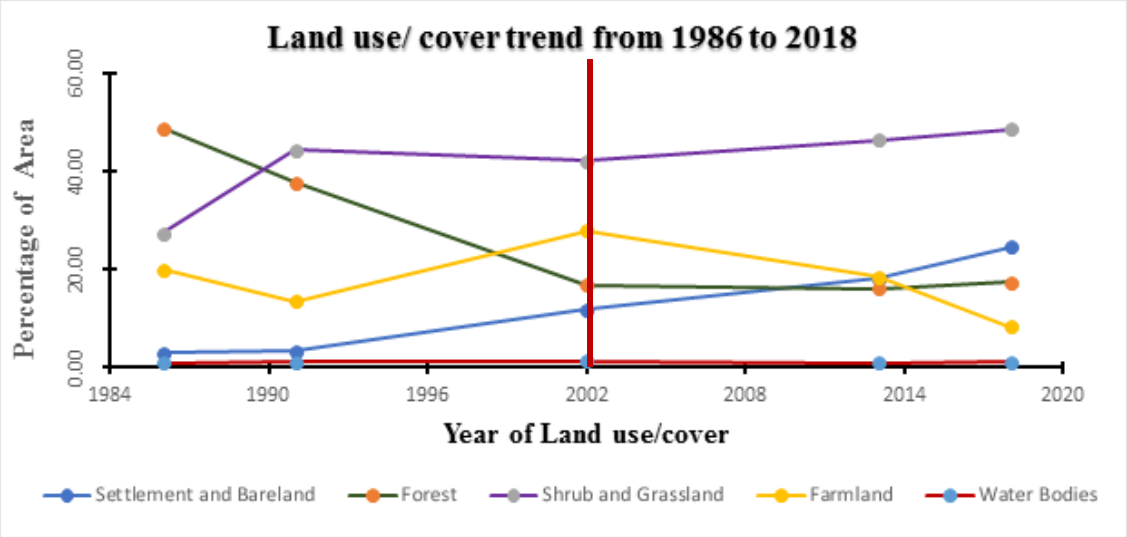

Figure 4. Trend of land use/cover in the Densu Basin, from 1986 to 2018.

Table 10. Rate of change of 'Water Bodies' land use/ cover type in the Densu Basin (1986 to 2018).

Change (years)	Water bodies		Average % change in area/year
	No. of years	% of change in area	
1986-1991	5	0.18	0.04
1991-2002	11	0.15	0.01
2002-2013	11	-0.36	-0.03
2013-2018	5	0.16	0.03

Table 11. Rate of change of land-use/-cover type before 2002 and after 2002 in the Densu Basin (1986 to 2018).

Land use/cover type	% of change in area before 2002	% of change in area after 2002
Settlement and bare land	296.28	108.15
Forest	-65.50	3.72
Shrub and grassland	53.93	15.39
Farmland	40.49	-70'23
Water bodies	32.40	-15.58

establishment of the Densu Basin Board (DBB). The DBB was established in 2003 but officially inaugurated in March 2004. It included all interested parties and the key stakeholders (including interest groups and traditional authorities) within the basin with the aim of sustainably managing the water resources within the basin. Through the Board a riparian Buffer Zone Policy was developed with the aim of protecting and maintaining the vegetation cover within the basin so as to improve water quality. The Densu Integrated Water Resources Management (IWRM) Plan was also put together in 2007 with an action plan for implementation.

Table 12 shows the trend in land use and land cover losses within the Densu River basin from 1986 to 2018. Forest lost the largest area. Between 1986 and 2018, about 1,613 km^2 of forest cover changed to other land use/cover types. This means that, within the period of 32 years, more than half of the area covered by forest within the basin changed to other types of LULC. The depletion of the forest will have a significant effect on the Densu River as most forests tend to serve as a cover for rivers and shield them from a high rate of evapotranspiration.

Table 12. Land Use and land cover loss in the Densu River Basin (1986 - 2018).

Land use and land cover change		Area (km^2)	Net lost area (km^2)
From	**To**		
Settlement and bare land	Forest	0.40	13.93
Settlement and bare land	Shrub and grassland	5.49	
Settlement and bare land	Farmland	3.41	
Settlement and bare land	Water bodies	4.63	
Forest	Settlement and bare land	859.89	1613.36
Forest	Shrub and grassland	750.82	
Forest	Farmland	1.68	
Forest	Water bodies	0.97	
Shrub and grassland	Settlement and bare land	339.39	478.91
Shrub and grassland	Forest	2.91	
Shrub and grassland	Farmland	135.88	
Shrub and grassland	Water bodies	0.72	
Farmland	Settlement and bare land	157.72	447.89
Farmland	Forest	5.22	
Farmland	Shrub and grassland	284.96	
Farmland	Water bodies	0.00	
Water bodies	Settlement and bare land	2.77	2.93
Water bodies	Forest	0.00	
Water bodies	Shrub and grassland	0.00	
Water bodies	Farmland	0.16	

Table 13. Land use/cover gained in the Densu River Basin (1986 - 2018).

Land use and land cover change		Net gain area (km^2)
From	**To**	
Forest	Settlement and bare land	859.49
Shrub and grassland	Settlement and bare land	333.90
Farmland	Settlement and bare land	154.31
Settlement and bare land	Water bodies	1.86
Forest	Shrub and grassland	747.91
Farmland	Shrub and grassland	149.07
Shrub and grassland	Water bodies	0.72
Farmland	Forest	3.54
Water bodies	Farmland	0.16
Forest	Water bodies	0.97

Shrub and Grassland and Farmland also lost a significant area between 1986 and 2018. Shrubs and Grassland lost a total area of about 479 km^2 while farmland lost about 448 km^2 (Table 12). This implies that farming activities have reduced significantly in the basin. Shrubs and Grassland also tend to shield the water bodies. Their loss therefore exposes the water bodies to high evapotranspiration levels.

Table 13 shows a summary of the LULC gained between 1986 and 2018 within the Densu River basin.

The biggest gainer was settlement and bare land. Within the period, settlement and bare land gained an area of 859.49 km^2 from forest, 333.90 km^2 from shrub and grassland and 154.31 km^2 from farmland. However, settlement and bare land lost an area of 1.86 km^2 to water bodies.

Table 14. Percentage (%) of area covered by land use and land cover categories in 1986, 1991, 2002, 2013 and 2018 for the Weija reservoir catchment.

Land use/cover type	% of area 1986	% of area 1991	% of area 2002	% of area 2013	% of area 2018
Settlement and bare land	14.15	24.03	56.09	67.24	65.82
Forest	0.88	1.34	0.00	2.19	0.04
Shrub and grassland	69.31	58.31	28.29	0.10	2.39
Farmland	4.15	2.96	1.96	19.44	18.81
Water bodies	11.50	13.37	13.67	11.03	12.93

Forest land use and land cover was the biggest loser within the period. Forest lost 859.49 km^2 to settlement and bare land, 747.91 km^2 to shrubs and grassland, and 0.97 km^2 to water bodies. Forest gained only 3.54 km^2 from farmland within the period.

Shrub and grassland lost 333.90 km^2 to settlement and 0.72 km^2 to water bodies. It however gained 747.91 km^2 from forest and 149.07 km^2 from farmland. Farmland lost 154.31 km^2 to settlement, 149.07 to shrub and grassland and 3.54 to forest. It however gained 0.16 km^2 from water bodies. Water bodies gained 1.86 km^2 from settlement and bare land, 0.72 km^2 from shrub and grassland and 0.97 km^2 from forest but lost 0.16 km^2 to farmland. The biggest loser in terms of the land use and land cover area is the forest and the biggest gainer is the settlement and bare land.

The Weija reservoir

The construction of the dam for Weija reservoir started in 1974 and it was completed in 1978 (Anon, 1997). The source of water to the reservoir is the Densu River. The dam covers a total area of 20.5 km^2 with an effective storage capacity of 133 million m^3. The maximum design height is 15.25 m and the normal water level is 14.33 m (WRC, 2007; Kuma and Ashley, 2008). The projected daily inflow into the reservoir is 315,000 m^3 and the projected daily upstream water consumption is 40,500 m^3 (Anon, 1997).

Land use/cover trend in the immediate surroundings of the reservoir is needed to analyze the impact of urbanization on the reservoir. The derived land use/cover maps for 1986, 1991, 2002, 2013 and 2018 for the Weija reservoir and its immediate area are as shown in Figure 5.

The distribution of the land use and land cover classes in terms of percentage of area for the catchment of the Weija reservoir are shown in Table 14

It can be observed that much of the area around the reservoir and the delta has been converted to settlement and bare land. The trend in the land use change within the environment of the Weija reservoir is as shown in Figure 6.

The biggest gainers are settlement and bare land and the biggest loser is the shrub and grassland. It can be observed that the shrub and grassland used to surround and protect the reservoir have been converted into settlement. The area for farmland and the water bodies did not substantially change. In terms of percentage, settlement and bare land increased from about 14% in 1986 to about 66% in 2018 while shrub and grassland reduced from about 69% in 1986 to 2% in 2018. Farmland also gained marginally from 4% in 1986 to 18% in 2018. The area covered by water remained almost constant.

The Densu Delta (Sakumo I lagoon)

The Densu Delta known as Sakumo I lagoon is an internationally declared protected wetland area (Ramsar site). The site is already a source of conflict between Ghana Water Company Limited (GWCL) who are managers of the dam and the owners of the salt industry at the delta and the fishing communities (WRC, 2007). The flow of water into the delta area is controlled by GWCL at the dam site. Fishermen's catch and salt production is also determined by the level of water at the delta site. Peak salt production occurs when the delta is a dry site and fishermen's catch also is reduced drastically when the water level at the delta is high (WRC, 2007).

Any time GWCL opens the spillway at the Weija Dam site, a lot of homes get flooded at the delta. The derived land use and land cover maps for 1986, 1991, 2002, 2013 and 2018 within the area of the Densu Delta are as shown in Figure 7.

The distribution of the land use and land cover classes in terms of percentage in area for the Densu Delta area is shown in Table 15.

The lands around the Densu Delta area are also changing to settlement and bare land. The changing trend is shown in Figure 8.

The area for settlement around the Densu Delta increased from about 34 to 76% between 1986 and 2018. This mostly came about as a result of the loss in area for shrub and grassland. In the same period, the area for shrub and grassland reduced from about 49% in 1986 to

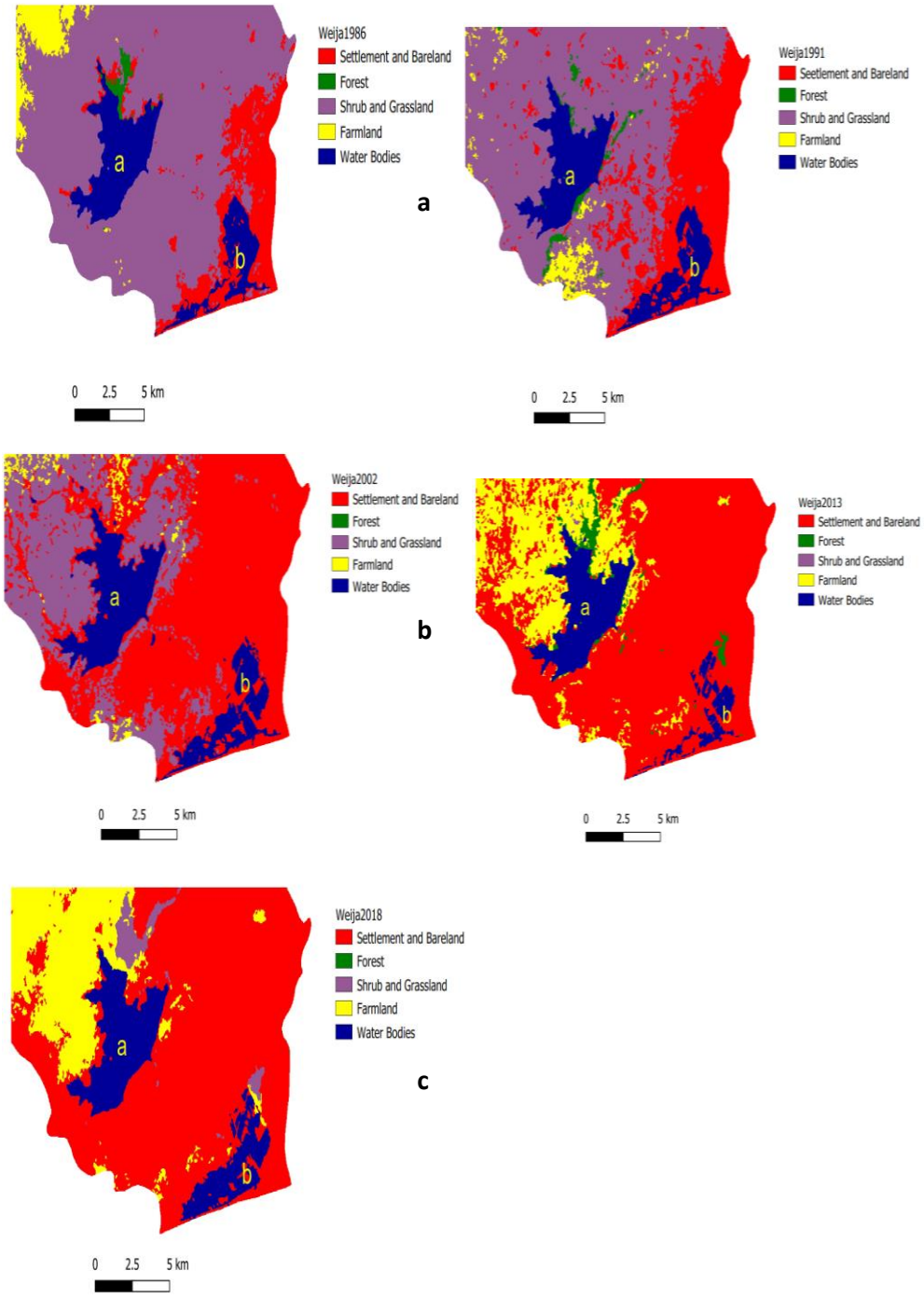

Figure 5. (a) Weija reservoir area land use/cover maps for 1986 and 1991 (a represents the Weija reservoir and b represents the Densu delta). (b) Weija reservoir area land use/cover maps for 2002 and 2013 (a represents the Weija reservoir and b represents the Densu delta). (5) Weija reservoir area land use/cover maps for 2018 (a represents the Weija reservoir and (b represents the Densu delta).

2% in 2018. This means that the shrub and grassland used to serve as a reservoir for the spilled water for the Weija Dam is being converted into residential area. This has become a problem because anytime the spillway at the Weija Dam is opened, a lot of residential area around the Densu Delta gets flooded. Within the same period, farmland increased slightly from 0 to 2.13%. The area for water bodies however remained almost constant.

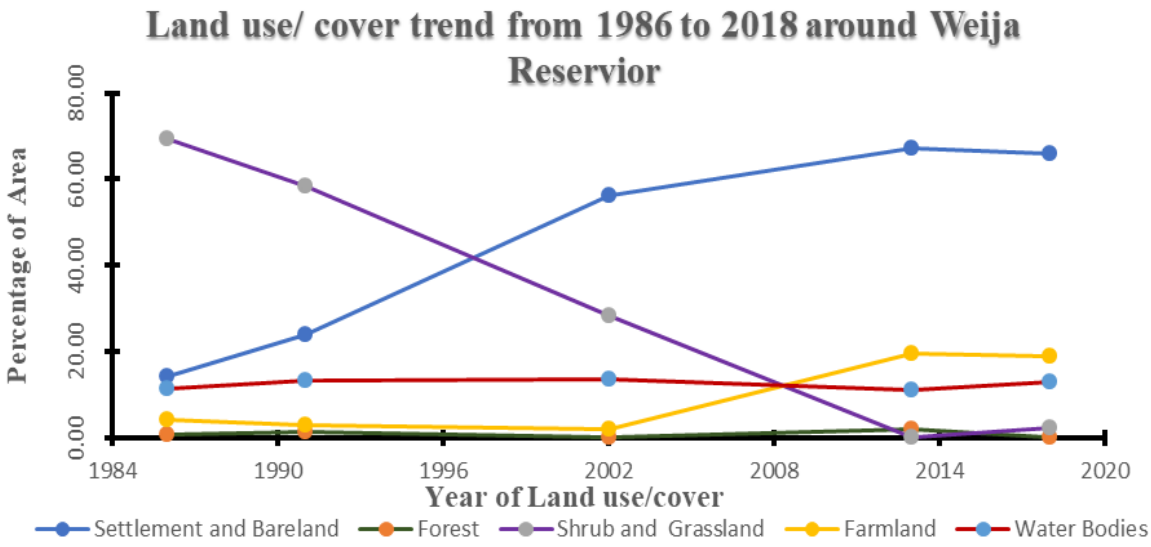

Figure 6. Weija reservoir area land use/cover trend for 1986, 1991, 2002, 2013 and 2018.

Table 15. Percentage (%) of area covered by land use and land cover categories in 1986, 1991, 2002, 2013 and 2018 for the Densu Delta area.

Land use/cover type	% of area 1986	% of area 1991	% of area 2002	% of area 2013	% of area 2018
Settlement and bare land	33.60	46.97	69.89	85.41	75.54
Forest	0.00	0.00	0.00	1.40	0.08
Shrub and grassland	48.93	29.03	8.14	0.00	1.52
Farmland	0.00	0.07	0.00	1.95	2.13
Water bodies	17.47	23.93	21.97	11.23	20.73

Conclusion

The study concluded that land use and land cover have significantly changed from 1986 to 2018 within the Densu River basin. It was observed that the area for settlement and bare land was the highest gainer while the area for forest was the highest loser. Within the period, more than half of the forest area was lost while the settlement and bare land increased more than seven fold. Most of the areas from forest, shrub and grassland, farmland and water bodies changed into settlement and bare land. A significant area of forest also changed into shrub and grassland. The area covered by settlement and bare land and shrub and grassland increased between 1986 and 2018 while the areas covered by forest and farmlands decreased within the same period. The area covered by water bodies did not significantly changed within the period.

The increasing trend of settlement and bare land within the Densu River basin and especially around the river is a worrying situation for the water quality of the river. The 35 m buffer along the river for its protection has been encroached upon.

The land use and land cover have also significantly changed around the Weija reservoir between 1986 and 2018. Most of the shrubs and grassland used to protect the lake have been converted to settlement and bare land and this is likely to affect the sustainability of the reservoir. Between 1986 and 2018, settlement and bare land area around the Weija reservoir more than quadrupled whiles the area for shrub and grassland almost became extinct. As a result of the increasing urbanization around the reservoir, the Water Resources Commission in 2010 inaugurated the Weija Lake protection association with the sole aim of protecting the lake against the high level of pollution.

The Densu Delta is an internationally declared protected wetland area (Ramsar site) as it is recognized for its role as a sanctuary for migrating seashore bird species. The area was therefore supposed to be conserved. However, the shrub and grassland around the delta have been converted mainly to residential area. This will greatly affect the ecosystem of the Densu Delta and hence affect the sustainability of the delta. Between

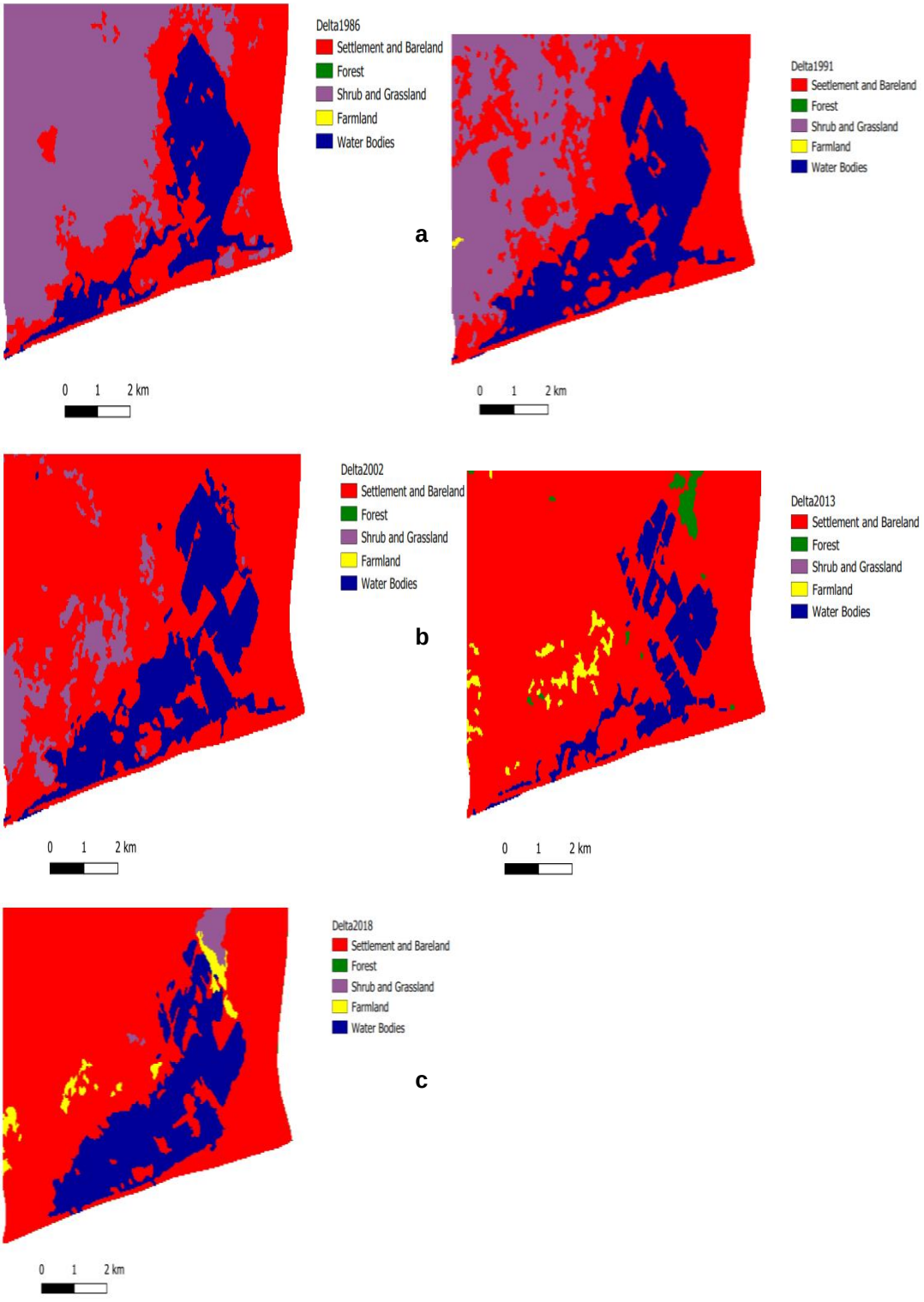

Figure 7. (a) Land use/cover maps of the Densu Delta area for 1986 and 1991. (b) Land use/cover maps of the Densu Delta area for 2002 and 2013. (c) Land use/cover maps of the Densu Delta area for 2018.

1986 and 2018, settlement and bare land area around the Densu Delta are more than double while the area for shrub and grassland almost became extinct.

The establishment of the Densu Basin Board in 2003 and the implementation of the Densu Integrated Water Resources Management (IWRM) helped in slowing

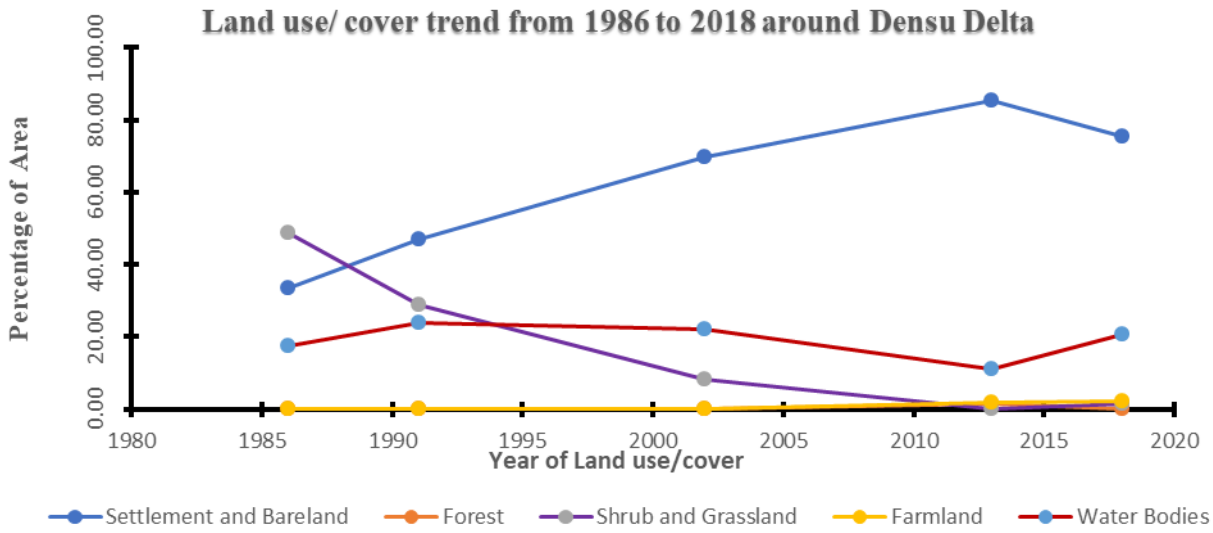

Figure 8. Densu Delta area land use and land cover trend for 1986, 1991, 2002, 2013 and 2018.

down the changes in land use and land cover within the basin.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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