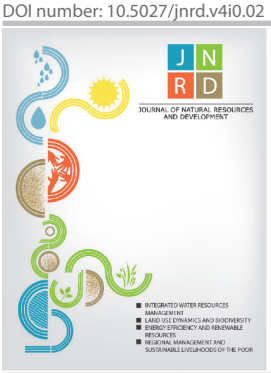
DOI number: 10.5027/jnrd.v4i0.02



JOURNAL OF NATURAL RESOURCES AND DEVELOPMENT

Assessment of encroachment of urban streams in Ghana: a case study of Wa Municipality.

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Article history

Received 24.06.2013
Accepted 28.08.2013
Published 24.02.2014

Keywords

Stream
Buffer zone
Urban area
Encroachment
Population growth

Abstract

This paper assessed encroachment of streams due to physical development in Wa Urban Area of the Upper West Region of Ghana. The assessment was informed by the recognition that the roles played by streams in flood control are undermined by physical developments. This affects sustainable urban development and renders the urban area vulnerable to floods. The assessment was based on the 300m buffer zone standard set by the Ghana Water Resources Commission as a protective zone for such streams in the country. It is mandatory to offset all physical development from this zone but that is not the situation on the ground. For the purpose of this study each buffer zone was divided into sub-buffer zones of 100m in order to appreciate how far development has moved into the prohibited buffer zone. The streams and physical structures were mapped with a Trimble GPS receiver while land owners and tenants were purposively selected and interviewed. The buffer zone and sub-buffer zones were defined using GIS and overlaid with map of the physical structures. The categories of structures found in the buffer zones were residential (93.4 %), commercial (5.1%), public (1.3%) and agriculture (0.2%). The results of the study indicates that more than 50 % of physical structures mapped are located in the inner buffer and the land acquisition process for development of these structures amongst others in Wa is mostly initiated by developers.

Introduction

Streams in urban environments are important features that add aesthetic and recreational appeal to the urban environment. They also play a critical role in flood control by serving as reservoirs for excess surface water during heavy downpour. The state of urban streams remains an important indicator of sustainable urban development (Furumai *et al*. 2009, Hai & Yamaguchi 2006) as it is regarded that deliberate occupation of these streams is a sign of unmanaged urbanisation (Drakakis - Smith 2000, WMO 2008 and Karley 2009). In developing countries, streams suffer deliberate encroachment (Darteh *et al*. 2010 and Ahmed & Dinye 2012) despite the fact that they have become an integral part of urban infrastructural network. Though many factors account for the encroachment, demographic-based urbanisation is a major driving force (Gould 1998, Songsore 2003). This makes residential and commercial land uses in urban areas so lucrative that other important land uses are constrained (Darteh et al. 2010). In such situations urbanisation triggers physical

development without regard for buffer zones of streams especially where suitable land for physical development is scarce (UN 2009). The occupation of buffer zones of streams is a major cause of human induced floods in the urban areas in Africa (UN 2011). This poses a serious challenge to the attainment of the Millennium Development Goal 7 which is aimed at ensuring environmental sustainability by 2015.

Expansion of existing physical infrastructure to accommodate the growing urban population is threatening the existence of urban streams and the important roles they play. They have become endangered resources in urban areas as the global urban population is estimated at 4.98 billion by 2030 (Cohen 2004, International Federation of Surveyors (FIG) 2010). In Ghana, the Water Resources Commission has set out a 300 m buffer zone on each side of a stream which legally prohibits physical development in this zone (Water resources commission 2008). The Town and Country Planning Department (TCPD) and the building Inspectorate Unit of the District, Municipal or Metropolitan Assemblies are on the ground to enforce it. However, uncontrolled physical development in relation to buffer zones of urban streams is characteristics of Wa Urban area, a fast growing city in terms of population and infrastructure.

The issue of uncontrolled urbanisation in the Wa Urban Area was studied by Ahmed and Dinye (2011) and Boamah et al. (2012) with a focus on the challenges of enforcing development controls. This was done without a spatial appreciation of the magnitude of the problem of uncontrolled physical development especially in high-risk areas such as the immediate surroundings of streams which is relevant for understanding and solving the problem.

This study assessed the state of the streams in Wa urban area in relation to physical development. The locations of the streams and physical structures mapped with a Trimble Global Position System (GPS) receiver and analysed using GIS while land owners and tenants were purposively selected and interviewed for the assessment.

Study area

The Study was conducted in the Wa Urban area which constitutes the business hub of the Wa Municipality. The Municipality shares administrative boundaries with the Nadowli District to the North, the Wa East District to the East and South, and the Wa West District to the West and South (Figure 1). It lies within latitudes 2°40'N and 2°15'N, and longitudes 9°55' and 10°20'W and is located in the Savannah zone, which is gently undulating with an average height between 160 m and 300 m above mean sea level. The topography is no barrier to physical development. The Wa municipal is within the Noumbiel sub-basin of the Volta Basin. The low lying areas have given rise to two main drainage systems, Bilibor and its tributaries to the North and the Sing-Bakpong and its tributaries to the South. The streams under consideration in this article are tributaries of the Bilibor. The streams are seasonal and dry up during the long dry season while they experience floods annually in the rainy season depending on the rainfall amounts (Wa Municipal Assembly 2011).

The vegetation is Guinea Savannah grassland type. Common trees found are shea trees, *Parkia biglobosa* (Dawadawa), *Ceiba pentandra* (Kapok) and *Adansonia digitata* (Baobab). *Anacardium occidentale* (Cashew) and *Mangifera indica* (mango) are exotic species growing well in the area. Generally, the Municipality has two marked seasons namely, the wet and dry seasons. The mean annual rainfall varies between 840 mm and 1400 mm. Most of the rainfall occur between June and September and is generally low and unreliable both in its timing and duration. The long dry season, dwindling and the erratic rainfall pattern encourages physical development in natural water ways.

Wa is the biggest and most urbanized settlement in the region. Observations of the Wa Township show that there are manifestations of haphazard development, isolated congestion of settlements and associated issues of environmental degradation and pollution of water ways. Housing development is increasing at a fast rate (Ahmed and Dinye 2011) particularly along the Wa-Kumasi highway where the University for Development Studies (UDS) permanent Campus is located, the Wa-Kpongu road where the Wa Polytechnic is situated, and the Wa-Dorimon road where the temporal UDS Campus is located. The two institutions are major development growth poles in the urban area and have contributed significantly to the increasing population and physical development in the study area.

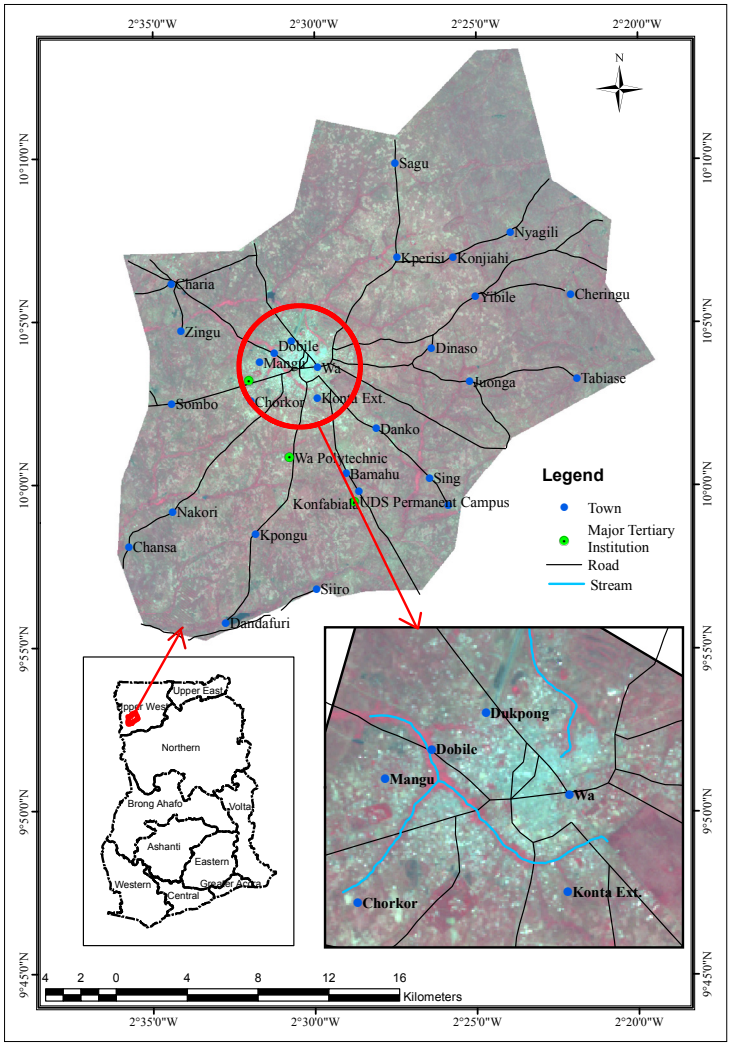

Figure 1. Map of Wa Municipality (Landsat 08th February 2011, band432)

Methods and materials

Mapping Physical Development

Sections of the streams were purposively selected based on proximity to the Central Business District (CBD). The streams that were close to the CBD were selected for the study because this is where the demand for land for physical development is high and competitive. The geographic coordinates of all buildings within and close to the selected streams were mapped with the Trimble GPS receiver in March 2012. The centre of each stream was picked as a line which also serves as basis for the definition of the buffer zone. The mapping was done starting from the centre of the water way and moving outward. This was to ensure that all the structures within the core area (first 100 m sub-buffer zone) of the streams were mapped. The concentration of the mapping of the structures was on the core of the water ways because it is the high-risk area of the buffer zone. It is assumed that the decision to build in the core area of the buffer zone meant that the outer area is already occupied because of the high risks associated with the core area. A total number of one thousand two hundred and seventy-four (1,274) structures were captured as points and two dams as polygons.

Sampling

The study area was stratified into three sections based on the sections of streams mapped earlier: Dobile-Mangu-Chorkor, Kumbiehi, and Kambali-Kunta. Purposive sampling was used to select landlords and tenants for interview because of the legal implications associated with building in the buffer zone. The targeted respondents were landlords and tenants who were willing to respond to the land issues without fear. This was to ensure that respondents were sincere as much as possible in providing the information sought. Hence, 68 people were interviewed, 38 tenants and 30 landlords (Table 1).

Table 1. Distribution of Samples according to the Various Strata

Zones	Questionnaires administered	
	Landlords	Tenants
Dobile-Mangu-Chorkor	14	18
Kumbiehi	8	10
Kambali-Kunta	8	10
Total	**30**	**38**

SOURCE: Field Survey, 2012.

Interviews

The land lords and the tenants were interviewed based on a questionnaire. The interviews were centred on the initiators of the acquisition process, the motivation for the acquisition and the challenges of developing or living in the buffer zones of the streams. The Town and Country Planning Office and the National Disaster Management Organization (NADMO) of the Wa Municipal Assembly were engaged in separate discussions centred on flood related disasters in the urban area, issuance of permits, availability of development layouts and the level of compliance by physical developers, and enforcement of building regulations.

Data Processing and Analysis

The GPS data were downloaded using GPS Pathfinder 4.00 software as shapefiles. The shape files were assigned WGS1984 coordinate system and projected to Universe Transverse Mercator (UTM) Zone 30N coordinates system in order to carry out the buffer analysis but the output maps were displayed in global units so that the locations are easily understood within the global context. The steams were overlaid on a February 8, 2011 Landsat Image (which was already in UTM Zone 30N coordinates system) to confirm that the lines depicting the water ways actually define the centre of the streams before the buffer analysis. The image captured these streams very well. For the purpose of this study, the overlay did not show any significant deviations between the lines and the streams as captured in the image.

Spatial data (points, lines and areas) were plotted to generate maps which clearly depicted the spatial relationship between these features within the study area. The 300m buffer zone of each stream was generated using GIS with the centre of the stream as reference. The buffer was divided into three sub-buffer zones of 100m each. The physical structures were then overlaid on the buffer zones and classified into public, residential, commercial and others. The responses from the landlords and tenants were processed and analysed to generate charts and tables that facilitate appreciation of state of the streams under study.

Results

Spatial distribution of physical development

The spatial distribution showed that physical development has spread into the core area (100m from the centre of the stream) of the buffer zones in the selected streams (Table 2, Figures 2, 3 and 4). There are also patches of clustering of physical development in all the selected streams. Out of the one thousand two hundred and seventy-four (1274) structures mapped in the buffer zone, 50.3% were in the core area, 49.70% in the rest of the 200 m outer zone of the 300m buffer (Table 2). The buffer zones were flooded with just 60 mm rainfall (Wa Meteorological Office) on 8th May 2012 (Figure 2).

Table 2. Buffer zones and houses

Sub-buffer zone	Number	%
First 100m	642	50.3
Second 100m	555	43.7
Third 100m	77	6.0
Total	**1274**	**100.0**

The categories of physical structures sited in the buffer zone were residential, commercial, public and agriculture. The residential structures were compound, detached and semi-detached homes

which were privately owned (Table 3 and Figure 5). The public structures were churches, mosques, schools and markets. The commercial buildings were stores, hostels, guest houses, washing bays and a filling station whilst agricultural consisted of basically fenced gardens. The fence consisted of mud which can impede free flow of water. The residential structures constituted 93.4% of all the structures mapped in the buffer zones (Tables 3 and 4). Commercial and public constituted 5.1% and 1.3% respectively. The rest were fenced gardens.

Table 3. Classification of buildings within the buffer zone

Type	Number	%
Residential	1190	93.4
Commercial	65	5.1
Public	16	1.3
Fenced Gardens	3	0.2
Total	**1274**	**100**

Table 4. Statistics of buildings within buffer zone for suburbs

Sub-buffer zone	Residential	Commercial	Public	Fenced Gardens
	Mangu-Chakor			
First 100m	154	11	0	0
Second 100m	184	4	3	1
Third 100m	27	0	0	0
Total	**365**	**15**	**3**	**1**
	Kambali			
First 100m	211	21	4	1
Second 100m	162	13	4	0
Third 100m	36	1	0	0
Total	**409**	**35**	**8**	**1**
	Kumbiehi			
First 100m	233	6	1	0
Second 100m	171	8	4	1
Third 100m	12	1	0	0
Total	**416**	**15**	**5**	**1**

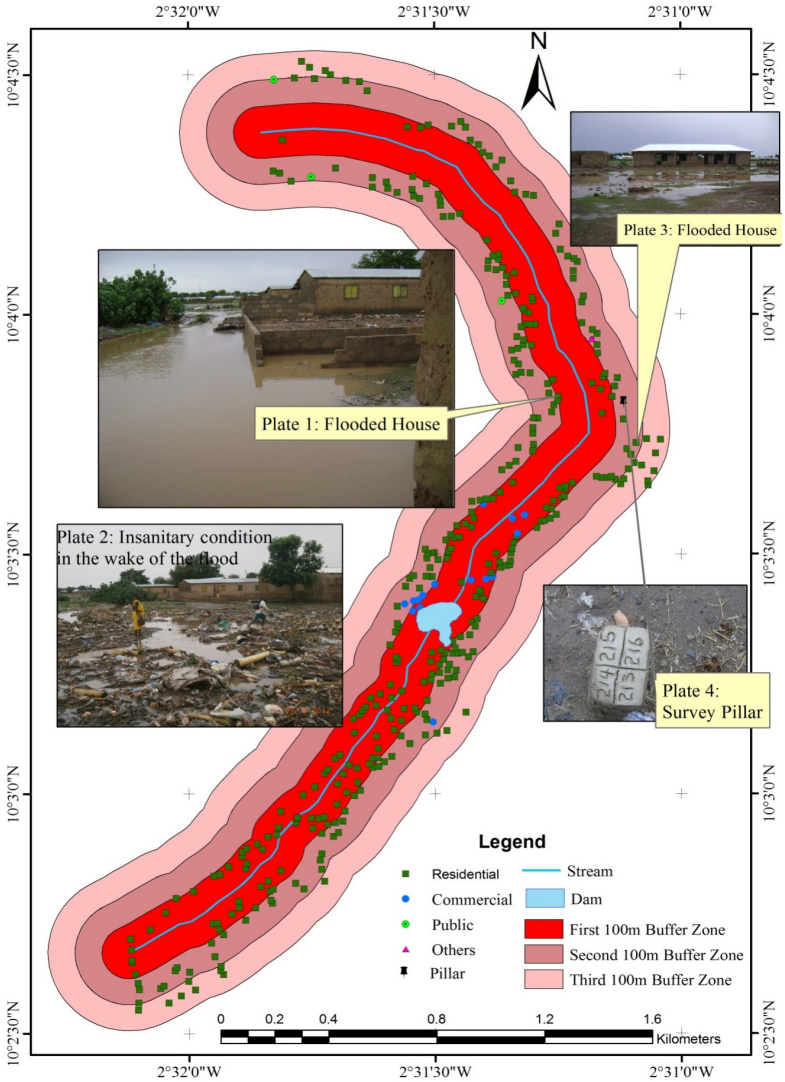

Figure 2. Map showing buffer zones in Dobile – Mangu – Chorkor (Pictures were taken on 9th May 2012)

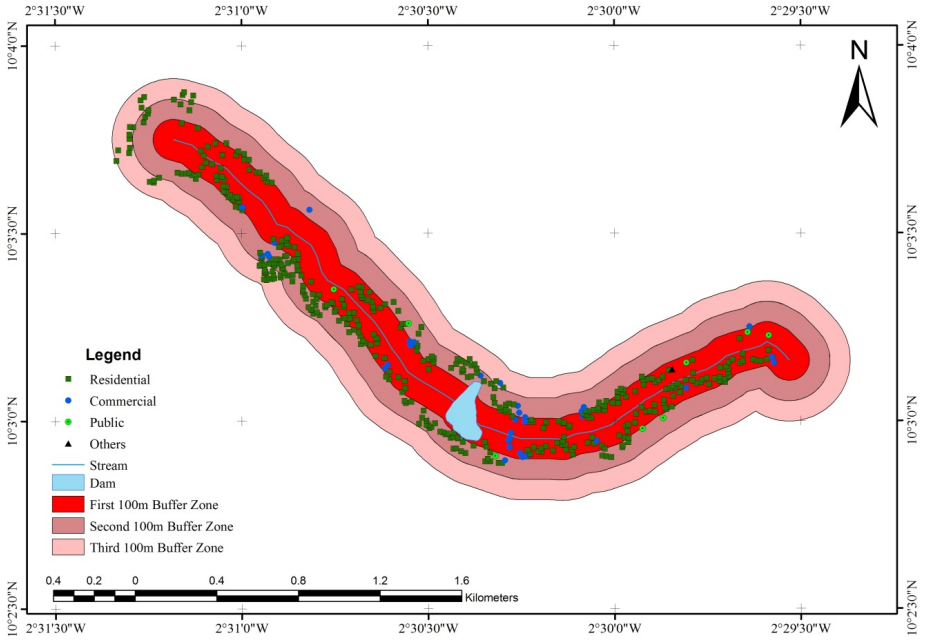

Figure 3. Map showing buffer zones in Kambale – Kunta

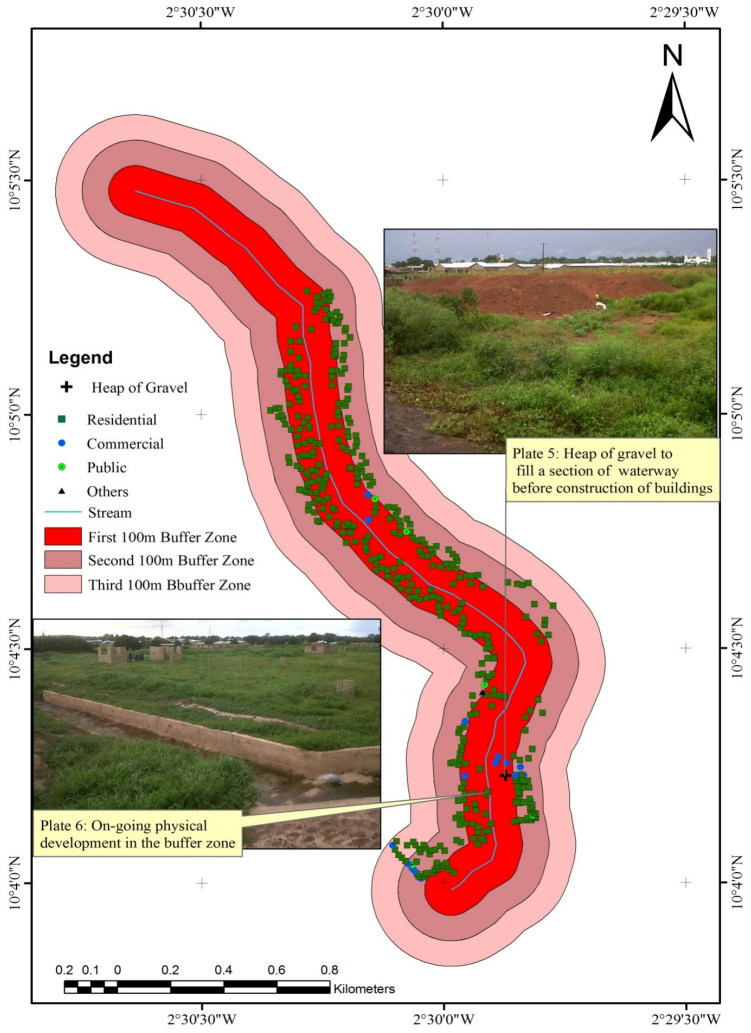

Figure 4. Map showing buffer zones in Kumbiehe (Pictures were taken on 28th August 2012)

Educational Status of Respondents

The educational status of the respondents shows that majority of the tenants attained tertiary education while majority of the landlords did not have any formal education. Out of 38 tenants interviewed, 60.5% had tertiary education while 18.4% attained secondary. The rest had either basic education or no formal education (Figure 2). The fact that majority of the tenants are literate and are in a better position to understand the implications of living in a waterway yet accept to live in such places explains the acute accommodation problem in the urban area. In the case of the landlords, out of 30 respondents interviewed, 46.7% had no formal education while 23.3% and 13.3% had tertiary and secondary education respectively. The rest had basic education. Thus the distribution of the educational level of the landlords indicates that a significant number (26.6%) are in a better position to know the consequences of developing infrastructure in waterways. This shows that there are other factors that influence the tenants and the landlords to live in the waterways.

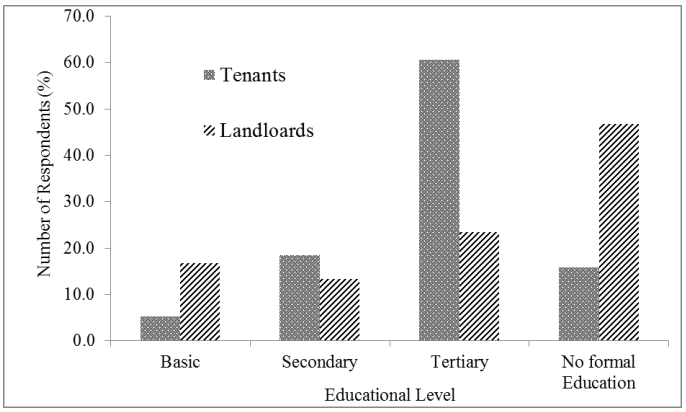

Figure 5. Educational Status of Landlords and Tenants

Initiators of Land acquisition process

Physical development in waterways are prone to challenges such as floods and insanitary conditions (Figure 2 and Table 7), it is therefore important to know how the land acquisition process starts. The findings (Table 5) revealed that, 86.7% of the land acquisition processes were initiated by landlords, (the landlords request the land from the land owners) while 13.3% were initiated by the landowners, (the land owner advertises the land to prospective developers). Figure 2 supports this revelation as it shows that parts of the buffer zone have been demarcated into plots (see Survey Pillar in Plate 4 of Figure 2). This means that either land outside the buffer zone is scarce or it is cheap to acquire land in natural waterways. Hence, these lands were acquired for various purposes without considering the dangers associated.

Table 5. Initiator of Land Acquisition

Initiator of Land Acquisition	Response	%
Landlord	26	86.7
Land Owner	4	13.3
Total	**30**	**100.0**

Motivation for physical development buffer zone of urban streams

Despite the unsuitable nature of the buffer zone for physical development particularly for residential purposes, people are motivated to either build or rent houses/rooms there. What is then the motivation? The motivations for physical development in the study area were: availability of land near streams, affordable land, wetland for gardening, and proximity to Central Business District (CBD), access to water and affordable accommodation. However, the main motivations for physical development were availability of land near streams and affordable land. Majority of the landlords indicated that development in the buffer zone was not deliberate but it was due to their inability to access land outside the buffer zone. This is also evident from the fact that public places such as the market being sited in the buffer zone by the Wa Municipal Assembly, a government institution, which is supposed to enforce the regulation against building in the 300 m buffer zone for natural waterways. Besides, developers have easy access to these lands at low cost and enjoy the opportunity of high water table for the construction of wells. These results indicate that social services and facilities were not evenly distributed. Hence, compelling people to move closer to CBD where they can benefit or enjoy such facilities.

Close observation by the research team reveals that population explosion could be one of the influencing factors for the rapid development of physical structures on water ways. This is supported by the data gathered from the TCPD (2009) of Wa Municipal Assembly. The continuous erection of illegal buildings and other structures on water ways include; weak enforcement of existing building, planning and environmental laws, unnecessary delays in the issuance of building permit, uncontrolled allocation and demarcation of land (TCPD, 2009).

Table 6. Reasons for acquiring land in waterways

Reasons for acquiring land/Renting a house	Landlords		Tenants	
	Number	%	Number	%
Availability of land near water ways	7	23.3	-	
Low cost of land	7	23.3	-	
A availability of wetlands for dry season Gardening	5	16.7	-	
Proximity to CBD	6	20.0	12	31.6
Access to Water	5	16.7	10	26.3
Cheap accommodation	-	-	16	42.1
Total	**30**	**100.0**	**38**	**100.0**

Challenges in the rainy season

According to the survey, 20% of landlords and 42% of tenants believed that flooding is the consequence of physical development. Also, mosquito infestation is predominant according to responses of both landlords and tenants. From the survey and the field visits it can be concluded that the main consequence of physical development on waterways in the study area is flooding. Erosion and deposition

of waste materials in the environment by flood waters are the least in terms of responses as indicated in Table 7. These responses show that the study area is a flood risk area in the event of heavy rainfall. Therefore, Government, NADMO and other stakeholders should put in place measures to protect these people who are at the risk of losing their properties, causing environmental degradation, outbreak of diseases, loss of lives and pollution of water bodies.

Table 7. Challenges during the Rainy Season

Challenges Faced	Landlords		Tenants	
	Responses	%	Responses	%
Flooding	18	60.0	25	65.8
Mosquito	10	33.3	9	23.7
Erosion	2	6.7	2	5.3
Littering	-	-	2	5.2
Total	30	100.0	38	100.0

Discussion

The distribution of physical structures in the buffer zones clearly shows that the core zones of the buffer zones of the selected streams have been encroached by physical development. This contradicts the norm that streams should be free of physical development to allow for effective flood control since the most effective measure to control floods is to empty the streams of uses that are in direct conflict with their naturally and environmentally accepted purpose (Havlick, 1974). In the Wa case, construction of physical structures in streams have created an enabling environment for floods even with the least amount of rainfall. Floods are inevitable in the area and the current state of the streams has serious implications for lives and property since 93.0% of the structures mapped in the buffer zones are residential. It also points out that urbanisation in terms of physical development remains uncontrolled in the Wa Municipality and will lead to the disappearance of the natural water ways if this trend of development is not checked

The occupation of the core zone of the buffer zones in the urban area raises many issues such as lack of enforcement of building regulations, high rate of population growth, scarcity of suitable land for residential purposes close to the CBD, inadequate planning schemes, difficulty in accessing essential services, and high cost of rents (Boamah et al. 2012; Ahmed and Dinye, 2011). The increasing population can no longer be accommodated by the current residential facilities making accommodation an urgent issue in the urban area. This creates market and opportunities for land lords to increase rents which also encourage tenants to build their own houses instead of continuing to rent. Thus the demand for land for residential purposes increases. Lack of potable water in the periphery of the urban area, lack of access roads and high financial burden of extending electricity to the outskirts of the urban area repels people away from the periphery of the town and compels them to develop any available space including streams (Darteh et al. 2010). It points out to the fact that the urban area is experiencing an infill growth pattern and the patches of unoccupied core zone are not free areas. This is exerting a lot of pressure on the natural ways in the urban area. The fact that the land acquisition process in the study sites within the Wa Municipality is initiated by the land lords shows that there is market for the land owners to sell unsuitable land. It also reveals a serious challenge faced by the institutions (Water Resources Commission, the Town and Country Planning and the Wa Municipal Assembly) mandated by law to ensure proper development controls, enforce building regulations and protect natural water ways. The occupation of the buffer zones creates insanitary living conditions for the occupants and others which are silently looked on by both the residents and Wa Municipal authorities. This is simply because the land lords who have accepted to acquire lands in these areas, and the tenants who have accepted to rent such houses have quietly entered into a "Covenant of No Complain" with nature and municipal authorities since physical development in buffer zone is illegal. By this, they have accepted not to complain about the difficulties they face such as floods and insanitary conditions (Figure 2).

Though majority of the land lords did not have any formal education, they are aware of the consequences of developing within the immediate environment of streams (Boamah et al. 2012, Ahmed and Dinye 2011). Plate 5 of Figure 4 clearly supports this as it shows heaps of gravel that are meant to fill the water way before development. So the issue at hand therefore goes beyond ignorance as suggested by Ahmend and Dinye (2011). The fact that the occupation of streams is motivated by land availability explains that prospective land owners see water ways as cheap lands and not as protected areas. The encroachment will continue if this is the perception of the general public.

Conclusions

The paper revealed that the buffer zones in the selected streams in the Wa Urban area are seriously encroached by physical development. The streams by their nature are disappearing thus giving way to settlements. About 93% of the encroachments are private residential facilities. Floods are inevitable in these areas and will have serious repercussions on human lives, property and the development of the urban area in general.

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